Association of oral candidiasis with diabetic control

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SUMMARY Factors associated with oral candidiasis in 51 diabetics were examined. The prevalence of oral yeast infection was 49 (n = 25)%. The association with diabetic control, as measured by fasting blood glucose concentration, urinary glucose concentration, and glycosylated haemoglobin, with the presence of yeast was analysed in the 51 diabetic patients. Glycosylated haemoglobin above 12% was strongly associated with oral yeast infection (odds ratio = 13.00) (p < 0.001), while fasting blood and urinary glucose concentrations were not. The risk of oral candidiasis among diabetics wearing dentures was significantly higher than among dentate diabetics (odds ratio = 4.78). After controlling for the effect of denture wearing, glycosylated haemoglobin greater than 12% remained highly predictive of oral yeast infection, particularly among diabetics without dentures.

Degree of diabetic control, as measured by blood and urinary glucose concentration, has previously been associated with the presence of oral yeasts and humoral precipitating antibodies to *Candida albicans* in some studies.¹ Other investigators have found that blood and urinary glucose concentrations were unrelated to oral candidiasis,² even after diabetics and controls were matched for age, sex, smoking and dental state.³⁻⁶ Glycosylated haemoglobin (HbA1c) concentrations reflect the degree of diabetic control during the preceding two months. It has been shown that estimation of glycosylated haemoglobin is a better method of measuring diabetic control than the usual criteria of determining fasting blood glucose and glycosuria.^{7,8} This study assessed the value of using glycosylated haemoglobin concentrations to predict the prevalence of oral yeast in 51 diabetics in a multiple variable analysis, including age, sex, smoking and dental histories, blood and urinary glucose concentrations.

Patients and methods

The study population comprised 51 consecutive diabetic outpatients attending the diabetes clinic of the Victoria General Hospital in Halifax, Canada.

The palatal mucosa and denture base have been shown to support a high rate of yeast colonisation,⁹ so specimens for candidiasis were taken from these sites. The prevalence of oral yeasts was determined by

obtaining fungal cultures from the palatal mucosa and denture base (if any) of each subject by rolling cotton swabs moistened in sterile water along the palatal mucosa or denture base and breaking them into a sterile glass phial containing 2 cc of sterile water for transport to the laboratory.

Samples were streaked, using the four quadrant method with a 2 mm wire loop, on Sabouraud's agar plates for semiquantitative analysis. After five to seven days' incubation at room temperature, increasing quantities were rated 1-4+.

A streak was made across yeast colonies initially grown from the samples. These pooled yeast colonies were then streaked on Bromocresol green agar plates to distinguish between morphologically similar species. Single colonies were picked from each differently pigmented colony and grown on Sabouraud's agar slants for examination of morphological and cultural properties. If no chlamydospores formed on Dalmau plates of cornmeal and Tween 80 agar, or if germ tubes did not form after 30 minutes' incubation in fetal calf serum at 37°C, then API 20 C (Analytab Products, Division of Ayerst Labs, Plainview, New York, USA) carbohydrate utilisation tests were carried out for identification of yeast species.

Three clinical chemistry tests were used to assess the degree of diabetic control. The fasting serum glucose concentration (Trinder glucose oxidase method; Boehringer-Mannheim Corporation, 1974), degree of glycosuria (Chemstrip; Boehringer-Mannheim Corporation), and glycosylated haemoglobin concentration (HA8110 BioRad Analyser; Daiichi, Japan) of

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each diabetic studied was taken on the day that oral yeast cultures were made.

Chandler and Chandler were able to show an increased carriage of *C albicans* in diabetics with the poorest control, which they defined as "persistent fasting sugars above 200 mg/dl, glycosuria equal to or greater than 3%, and past episodes of diabetic ketoacidosis".⁶ Because of their findings, we analysed diabetic control by comparing fasting sugars above and below 12 mmol/l and urinary sugars above and below 3+ (7 gl dl). The normal range of glycosylated haemoglobin in routine use at the diabetes clinic was 5.5–8.2%. In this study patients with poor diabetes control did not show evidence of oral yeast infection until HbA1c was > 12%.

Data were analysed using the BMDP statistical programs. Odds ratios were calculated and Pearson χ^2 tests were used to determine differences in proportions. Stepwise logistic regression analysis was applied to the data to adjust for the effects of extraneous variables.

Results

The mean age, age range, sex, presence or absence of dentures and smoking history of the 51 diabetics are shown in table 1. Twenty five diabetics harboured oral yeasts. Species other than *C albicans* were found in two cases.

There was some variation in the 1+2+ v 3+4+ colony density, determined by four quadrant semi-quantitative streaking of inoculum among subgroups of patients studied (table 2). Increased density is evident among denture wearers but not among smokers. Significant differences could not be determined due to the small size of the subsample of diabetics with yeast.

The risk of acquiring oral candidiasis was significantly greater among diabetics wearing dentures than among those who did not (table 3). Those over 50 had an increased risk of yeast infection, but this age effect can be explained by the greater number of denture wearers among the older group (88.0%) compared with those aged 50 and younger (11.5%).

Table 1 Characteristics of sample population (n = 51)

Mean age	46.4
Age range	19–77
No of women	30
No of dentures	25
No of smokers	16
No of oral yeast infections	25
<i>Candida albicans</i>	24
Other yeasts	2 (1 = mixed)
Density (1+–2+ growth)	13
Density (3+–4+ growth)	12

Table 2 Density of yeast colonisation in subgroups of diabetics with oral yeast infection (n = 25)

	n	Density 3+–4+	
		Number	(%)
Age			
> 50	(n = 9)	3	33.3
≤ 50	(n = 16)	9	56.2
Sex			
F	(n = 15)	7	46.7
M	(n = 10)	5	50.0
Dentures			
Yes	(n = 17)	10	58.8
No	(n = 8)	2	25.0
Smoker			
Yes	(n = 8)	3	37.5
No	(n = 17)	9	52.9
Glycosylated haemoglobin			
> 12%	(n = 13)	5	38.5
≤ 12%	(n = 12)	7	58.3
Urinary sugar*			
3+–4+	(n = 4)	2	50.2
0–2+	(n = 20)	10	50.2
Fasting sugar			
> 12 mmol/l	(n = 12)	5	41.7
≤ 12 mmol/l	(n = 13)	7	53.8

*One specimen not available.

DEGREE OF DIABETIC CONTROL

Glycosylated haemoglobin concentrations above 12% were significantly associated with oral yeast infection ($p < 0.001$), while fasting blood glucose concentrations > 12 mmol/l and urinary glucose concentrations of > 3+ were not (table 3). Age, sex, dental and smoking state, glycosylated haemoglobin, urinary and blood glucose concentrations were included in a logistic regression model. Stepwise analysis showed that dental state and glycosylated haemoglobin con-

Table 3 Potential risk factors for yeast infection among diabetics (n = 51)

		No with yeast (%)	Odds ratio	95% confidence interval
Age				
> 50	(n = 25)	16 (64.0)	3.36	(1.06, 10.59)
≤ 50	(n = 26)	9 (34.6)	(p = 0.04)	
Sex				
Female	(n = 30)	15 (50.0)	1.10	(0.36, 3.35)
Male	(n = 21)	10 (47.6)	(p = 0.87)	
Dentures				
Yes	(n = 25)	17 (68.0)	4.78	(1.46, 15.62)
No	(n = 26)	8 (30.8)	(p < 0.01)	
Smoker				
Yes	(n = 16)	8 (50.0)	1.06	(0.32, 3.46)
No	(n = 25)	17 (68.0)	(p = 0.92)	
Glycosylated haemoglobin				
> 12%	(n = 15)	13 (86.7)	13.00	(2.52, 67.19)
≤ 12%	(n = 36)	12 (33.3)	(p < 0.001)	
Urinary glucose*				
3+–4+	(n = 7)	4 (57.1)	1.27	(0.25, 6.42)
0–2+	(n = 39)	20 (51.3)	(p = 0.78)	
Fasting glucose				
> 12 mmol/l	(n = 18)	12 (66.7)	3.08	(0.92, 10.25)
≤ 12 mmol/l	(n = 33)	13 (39.5)	(p = 0.06)	

*Five specimens not available.

O = no yeast; X = oral yeast.

of men with genital candidiasis are also not diabetic. The same principle may apply in oral candidiasis—that is, most people with oral yeasts are not diabetic; but very poorly controlled diabetics are significantly more likely to have oral candidiasis as this study suggests.

Tobacco smoking and wearing dentures continuously day and night have been found to be important local factors in chronic oral hyperplastic candidiasis.¹⁴ In the present study the presence of dentures and glycosylated haemoglobin concentrations were independent predictors of the risk of developing candidiasis. This finding suggests that diabetics are relatively more susceptible to fungal infections in areas of moisture and trauma, but in the absence of dentures a high glycosylated haemoglobin concentration is an important risk factor for yeast infection.

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