Original Article

Comparative evaluation of alteration in taste perception among Gutkha chewers with and without OSMF and healthy subjects: A prospective case-control study

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Abstract

Context and Aim: The major afflictions such as odynophagia (painful swallowing) and trismus that occur in patients with oral submucous fibrosis (OSMF) are well documented, but the impairment of gustatory functions has not received much consideration in the past. The present study was planned with a similar intent to assess and compare the alteration in taste perception among gutkha chewers with and without OSMF and healthy subjects.

Materials and Methods: The present study was designed as a prospective case–control study comprising 90 individuals within an age range of 15–50 years who were divided into three groups with Group A consisting of 30 patients who were gutkha chewers with OSMF, Group B consisting of 30 individuals who were gutkha chewers but without OSMF and Group C consisting of 30 healthy subjects who were included as normal controls. The taste intensity response scores for the four basic tastes were recorded and the results obtained were, then, subjected to statistical analysis.

Statistical Analysis Used: The data were analyzed using SPSS version 16.0 (SPSS Inc., Chicago, IL, USA). Comparison of the said parameters was done using Chi-square test, analysis of variance and Tukey's *post-hoc* test. $P < 0.05$ was considered statistically significant.

Results: The findings of the present study suggested that all taste sensations were affected more in Group A patients than the Group B and Group C individuals.

Conclusion: The results obtained in the present study were found to be encouraging as it was demonstrated that taste perception varied significantly among the patients with OSMF as against those having habit of betel nut/gutkha chewing but those who did not develop OSMF and the normal healthy controls and this data, though, initial, might be used on a scientific basis to improve the quality of life in the affected patients as well as to prevent the further progression of the disease process.

Keywords: Gutkha chewers, oral submucous fibrosis, prospective case-control study, taste perception

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INTRODUCTION

The world of medical science is replete with a plethora of conditions, both physiological and pathological, which exhibit a multitude of symptoms, some of which humankind has managed, while others, he is still waging a relentless war. Oral submucous fibrosis (OSMF) is an old enemy in this context which is gaining repeated mention in the oral health circles. OSMF has become a serious concern to the health-care providers as it largely affects the younger age groups. It is a debilitating condition in which the patients complains of intolerance to spicy food, rigidity in lip and tongue, difficulty in mouth opening and speech and swallowing and has high chances of developing into malignancy, thereby reducing the quality of life (QoL), in other words, leading to increased morbidity as well as associated with a chance of mortality.[1] The prevalence of OSMF in India is estimated to be about 0.2%–0.5%, while the prevalence by gender varies from 0.2%–2.3% in males to 1.2%–4.57% in the females owing to an increased prevalence of the habit of smokeless forms of tobacco usage in the females.[2,3] The malignant transformation rate for OSMF varies from 2.3% to 7.6%.[4] To summarize, OSMF is a unique oral affliction that has infested the oral cavities of "betel nut" and "gutkha" chewers in a pandemic manner having high morbidity and mortality, even in the first few decades of life.[5]

Betel nut chewing, the main cause for the causation of OSMF in India, has been reported as the fourth dependent substance among the substances of abuse, followed by nicotine, alcohol and caffeine.[6] It is directly linked to the oral cavity, and saliva is the first biological fluid exposed to such products.[7,8] During gutkha chewing, many harmful chemicals and metals are leached-out into the saliva.[9] Betel nut, the main ingredient of gutkha, contains alkaloid arecoline which is a known genotoxic constituent, while lime, another significant constituent of gutkha, causes intense local irritation of the mucosa. Another important ingredient of betel nut, Catechu, contains an alkaloid, catechin, which when combined with lime, is known to produce heavy amounts of reactive oxygen species which are also proven to be mutagenic.[10] Therefore, gutkha represents a convoluted mixture of adverse constituents which not only increase the chances of morbidity and mortality in the individuals but alter the salivary parameters including the flow rate of saliva as well as the salivary pH. Several studies have documented the normal range of salivary pH to be within 5.5–7.9, while the normal salivary flow rate is in a range of 0.33–1.42 ml/min.[11] The said alterations in saliva can, further, affect gustation, both qualitatively and quantitatively, because saliva helps to dissolve the substances and carry them to the taste receptors to effectuate gustation, which affects the taste stimuli.

Gustation/taste perception is an act or sensation of tasting. It is a paramount chemical sense, and its disturbances in the form of hypogeusia, ageusia and/or dysgeusia can be very troublesome. Humans are able to perceive 4 basic types of taste sensations including the salty, sweet, sour and bitter, while some studies have reported about one more kind of taste "Umami."[12,13] Taste sensation is produced when a reaction occurs in between the taste receptors which are present within the taste buds and the food ingested. Taste buds are located not only on the tongue but also on the palate, uvula, epiglottis, pharynx and the upper parts of the esophagus.[14] In literature, numerous reasons for alteration in gustatory perception are documented. The most acceptable and commoner causes for the same include inflammatory reactions with or without infections in the oral cavity, which reduce blood flow causing alteration in the normal physiology and function of the taste buds, bringing about the atrophy of the papillae with the progression of the disease process.[15] Studies have found that there is an alteration of taste perception in OSMF patients, too, due to xerostomia and atrophy of the papilla seen in OSMF, this, in turn, hampering the nutritional status of the affected individuals and the oral mucosa which subsequently, becomes even more vulnerable for the further initiation of pathologic changes. The major afflictions such as odynophagia (painful swallowing) and trismus that occur in patients with OSMF are well documented, but the impairment of gustatory functions has not received much consideration in the past.[16] Due to a scarcity of the literature on this aspect of the disease process and influence of gutkha chewing on taste perception, the present study intended to assess and compare the alteration in taste perception among gutkha chewers with and without OSMF and healthy subjects.

MATERIALS AND METHODS

The present study was designed as a prospective case–control study comprising 90 individuals within an age range of 15–50 years who had reported to the Outpatient Department and were divided into three groups with Group A consisting of 30 patients who were gutkha chewers with OSMF [Figures 1-4], Group B consisting of 30 individuals who were gutkha chewers but without OSMF and Group C consisting of 30 healthy subjects who were included as normal controls. The study was conducted over a period of 18 months, while ethical clearance was obtained from the Institutional Ethics

Figure 1: Blanching seen in right buccal mucosa in a patient

Figure 2: Blanching seen in left buccal mucosa

Figure 3: Blanching seen in relation to lower labial mucosa

Figure 4: Blanching seen in relation to soft palate with shrunken uvula;

Committee before the start of study. The subjects were informed in detail about the study, and a written, informed consent was obtained from each participant before the start of study after which the patients were examined thoroughly [Figures 5 and 6], and a detailed case history was recorded in a specially designed proforma. Significant inclusion criteria included a positive history for gutkha chewing habit of more than 6 months duration and with clinically diagnosed OSMF in case of Group A while a positive history for gutkha chewing habit of more than 6 months duration but with no clinical evidence of OSMF in case of Group B. Group C consisted of 30 healthy subjects who were not positive for a history of habit and who were included as the normal controls. Individuals with habits such as smoking and/or alcohol consumption, patients with any known systemic disorders, pregnant and lactating females and patients who had received any type of treatment for OSMF or frank malignancies were excluded from the study. The demographic details, habit history, if found positive and clinical parameters, were recorded in the predetermined proforma after a thorough clinical examination in daylight [Figure 7].

Determination of taste sensation/gustatory sense (spatial/localized testing by using liquid tastants for four basic tastes): Four different solutions for four basic tastes (sweet, salty, sour and bitter) were freshly prepared for gustatory testing. Sucrose for sweet (0.1 gm/ml, 0.4 gm/ml and 2 gm/ml), sodium chloride for salty (0.075 gm/ml, 0.15 gm/ml and 0.36 gm/ml), citric acid for sour (0.05 gm/ml, 0.1 gm/ml and 0.15 gm/ml) and quinine sulfate for bitter taste (0.0005 gm/ml, 0.001 gm/ml and 0.01 gm/ml) were used [Figure 8].[17,18] Before assessing the taste impulses, the subjects were asked not to eat and/or drink 1 h before the procedure. The four different tastants (sweet, salty, sour and bitter) in three progressively increasing concentration were, then, directly applied with a dropper over the taste buds on the dorsum of the tongue approximately for 5 s and taste intensity response score was recorded [Figure 9].[19]

Figure 5: Maximal mouth opening in patient

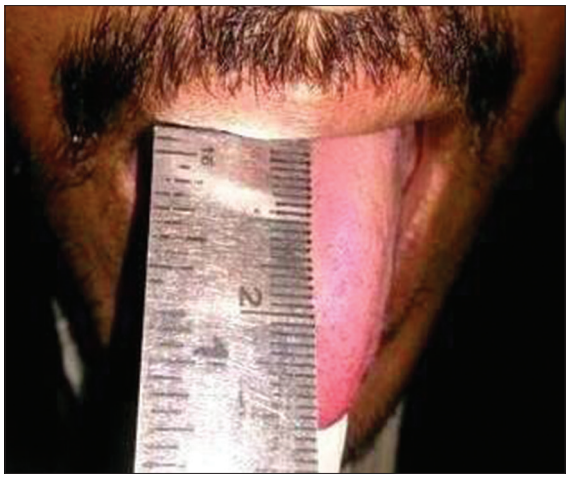

Figure 6: Tongue protrusion test;

Figure 7: Armamentarium for clinical examination

Figure 8: Four basic tastant solutions for taste perception;

Statistical analysis used

The data was analyzed using SPSS version 16.0 (SPSS Inc., Chicago, IL, USA). Comparison of the said parameters was done using Chi-square test, analysis of variance and Tukey's *post-hoc* test. $P < 0.05$ was considered statistically significant.

RESULTS

Table 1 provides the distribution of subjects according to age in patients with OSMF (Group A), patients with betel nut/gutkha chewing habit but without OSMF (Group B) and controls (Group C), wherein 9 (30.0%) patients from Group A, 7 (23.3%) patients from Group B and 13 (43.3%) individuals from Group C were found to be in the age range of 15 to 25 years, while 10 (33.3%) patients from Group A, 13 (43.3%) from Group B and 15 (50%) from Group C were in the age range of 26–35 years. Furthermore, 11 (36.7%) patients from Group A, 10 (33.3%) patients from Group B and 2 (6.7%) from Group C were in the age range of 36–45 years. The mean age in Group A was found to be 30.96 (±7.51) years, in Group B, it was 32.2 (±7.12) years, while in Group C was 27.5 (±6.05) years. There was no statistically significant difference between three groups with respect to age distribution ($P > 0.05$). Table 2 shows the distribution of subjects as per the sex wherein the total number of male patients in Group A were found to be 28 (93.3%), 22 (73.3%) in Group B and 21 (70%) in Group C. The total number of females, 2 (6.7%) in Group A, 8 (26.7%) in Group B and 9 (30%) in Group C were found to be lower than the total number of males in the present study, although, this difference was found to be statistically insignificant ($P > 0.05$). Table 3 shows the distribution of stages of OSMF in Group A wherein out of 30 patients of OSMF, 8 (26.7%) were in Stage I, 12 (40%) were in Stage II, while 10 (33.3%) were found to be in Stage III. Table 4 shows the distribution of habit among all 3 groups wherein it was observed that 3 (10%)

Table 1: Age wise distribution of patients among oral submucous fibrosis patients, patients with betel nut/gutkha chewing habit without oral submucous fibrosis and control group

	OSMF (%)	Without OSMF (%)	Control (%)	P
Mean age (years) with SD (parentheses)	30.96 (±7.51)	32.2 (±7.12)	27.5 (±6.05)	0.09
15–25	9 (30.0)	7 (23.3)	13 (43.3)	0.06
26–35	10 (33.3)	13 (43.3)	15 (50.0)	
36-45	11 (36.7)	10 (33.3)	2 (6.7)	

Chi-square test. OSMF: Oral submucous fibrosis, SD: Standard deviation

Table 2: Gender wise distribution of patients among oral submucous fibrosis patients, patients with betel nut/gutkha chewing habit without oral submucous fibrosis and control group

Sex	OSMF (%)	Without OSMF (%)	Control (%)	*P*
Male	28 (93.3)	22 (73.3)	21 (70.0)	0.06
Female	2 (6.7)	8 (26.7)	9 (30.0)	

Chi-square test. OSMF: Oral submucous fibrosis

Table 3: Distribution of patients according to stages of oral submucous fibrosis in Group A

Stages of OSMF	n (%)
Stage I	8 (26.7)
Stage II	12 (40)
Stage III	10 (33.3)
Total	30 (100)

OSMF: Oral submucous fibrosis

Table 4: Distribution of habit among oral submucous fibrosis patients, patients with betel nut/gutkha chewing habit without oral submucous fibrosis and control group

Habit	OSMF (%)	Without OSMF (%)	Control (%)	*P*
Absent	0	0	30 (100.0)	0.01
Betel nut	3 (10.0)	10 (33.3)	0	
Gutkha	23 (76.7)	19 (63.3)	0	
Both	4 (13.3)	1 (3.3)	0	

Chi-square test. OSMF: Oral submucous fibrosis

patients from Group A were having habit of chewing betel nut, 23 (76.7%) patients were having habit of chewing gutkha and 4 (13.3%) patients were having a habit of both chewing betel nut and gutkha chewing habit. In Group B, 10 (33.3%) patients were having habit of chewing betel nut, 19 (63.3%) had gutkha chewing habit and 1 (3.3%) showed a habit of chewing both betel nut and gutkha. Since Group C was the control group, none of the individuals included had any type of habit and the difference, in this case, was found to be statistically significant ($P = 0.01$). Table 5 shows distribution of the habit among all three groups according to the frequency, exposure and duration of the habit wherein it was observed that 6 (20.0%) patients from Group A were having a frequency for consumption of the said products 1–3 times a day, 16 (53.3%) showed a frequency of 4–5 times per day consumption, 5 (16.7%)

Figure 9: Evaluation of taste perception

showed a frequency of 6–7 times per day consumption, while 3 (10%) patients showed a frequency of more than 8 times per day consumption of betel nut or, gutkha or, both. In Group B, 22 (73.3%) patients showed a frequency for the habit of 1–3 times per day, 2 (6.7%) patients showed a frequency of 4–5 times per day, 5 (16.7%) showed a frequency of 6–7 times per day while only 1 (3.3%) patient showed a frequency of more than 8 times per day consumption of the deleterious products and this difference between the distribution of the frequency among all three groups, too, was found to be statistically significant ($P = 0.01$) in the present study. In relation to exposure, the findings of the present study suggested 3 (10%) patients in Group B having an exposure time for habit consumption of 2–5 min while 3 (10.3%) patients from Group A and 13 (43.3%) patients from Group B showed an exposure time for habit consumption of 5–10 min. As against these patients, 26 (89.7%) patients from Group A and 14 (46.7%) from Group B showed an exposure time of more than 11 min, and the difference was found to be statistically significant ($P = 0.002$). In Group B, two patients had a habit of <1-year duration, 2 (6.7%) patients in Group A and 6 (20.0%) patients in Group B had a habit of 1–3-year duration, 2 (6.7%) patients from Group A and 3 (10%) patients from Group B were having a habit of about 3–5 years duration while 26 (86.7%) patients from Group A and 19 (63.3%) patients from Group B were having a habit of more than 5 years duration, however, this difference was not found to be statistically significant ($P = 0.15$) in the present study. Table 6 provides the comparison of taste perception among all three groups included in the study, wherein 2 (6.7%) patients from Group A revealed complete ageusia, while 17 (56.7%) showed hypogeusia and 11 (36.7%) patients showed normal sweet taste perception. In Group B and Group C each, only 1 (3.3%) individual showed complete hypogeusia, while all other patients showed normal sweet taste

Table 5: Distribution of participants according to frequency, exposure and duration of habit

Habit	OSMF (%)	Without OSMF (%)	Control	*P*
Frequency				
1-3	6 (20.0)	22 (73.3)		0.01
4-5	16 (53.3)	2 (6.7)		
6-7	5 (16.7)	5 (16.7)		
>8	3 (10.0)	1 (3.3)		
Exposure (min s)				
2-5	0	3 (10.0)		0.002
5-10	3 (10.3)	13 (43.3)		
>11	26 (89.7)	14 (46.7)		
Duration (years)				
<1	0	2 (6.7)		0.15
1-3	2 (6.7)	6 (20.0)		
3-5	2 (6.7)	3 (10.0)		
>5	26 (86.7)	19 (63.3)		

Chi-square test. OSMF: Oral submucous fibrosis

Table 6: Comparison of taste perception among oral submucous fibrosis patients, patients with betel nut/gutkha chewing habit without oral submucous fibrosis and control group

	OSMF (%)	Without OSMF (%)	Control (%)	*P*
Sweet				
Ageusia	2 (6.7)	0	0	0.001
Normal	11 (36.7)	29 (96.7)	29 (96.7)	
Hypogeusia	17 (56.7)	1 (3.3)	1 (3.3)	
Salt				
Ageusia	1 (3.3)	0	0	0.001
Normal	18 (60.0)	28 (93.3)	30 (100.0)	
Hypogeusia	11 (36.7)	2 (6.7)	0	
Sour				
Ageusia	0	0	0	0.02
Normal	25 (83.3)	30 (100.0)	29 (96.7)	
Hypogeusia	5 (16.7)	0	1 (3.3)	
Bitter				
Ageusia	0	0	0	0.04
Normal	27 (90.0)	30 (100.0)	30 (100.0)	
Hypogeusia	3 (10.0)	0	0	
Total	30 (100)	30 (100)	30 (100)	

One-way ANOVA/*Kruskal–Wallis* H *test*. OSMF: Oral submucous fibrosis, ANOVA: Analysis of variance

perception, and this difference was found to be statistically significant ($P = 0.001$). Thus, it could be inferred from the findings of the present study that sweet taste was affected more in Group A patients than the Group B and Group C individuals. For the salty taste perception, 1 (3.3%) patient showed complete ageusia while 11 (36.7%) showed hypogeusia to the salty taste in Group A. Only 2 (6.7%) patients from Group B showed hypogeusia to the salty taste, while the remaining 28 (93.3%) individuals showed normal taste perception. In Group C, normal healthy controls, all the individuals included revealed normal salty taste perception, and this difference, again, was found to be statistically significant ($P = 0.001$) in the present study. Thus, it could be inferred that salty taste, too, was affected more in Group A patients than as compared to the Group B and Group C individuals. For the sour taste perception, 5 (16.7%) patients from Group A revealed complete hypogeusia, while 25 (83.3%) patients showed normal sour taste perception. From Group B, all 30 (100%) individuals showed normal sour taste perception, while in Group C, only 1 (3.3%) individual showed complete hypogeusia to the sour taste perception, and this difference, too, was found to be statistically significant ($P = 0.02$) concluding that in this case, too, sour taste perception was affected more in Group A patients than the Group B and Group C individuals. For bitter taste, 3 (10%) patients showed complete hypogeusia, while 27 (90%) patients showed normal bitter taste perception in Group A patients. As against this, in both Group B and Group C individuals, a normal bitter taste perception was observed, and the difference was found to be statistically significant ($P = 0.04$) concluding that bitter taste perception, too, was affected more in Group A patients than the Group B and Group C individuals. Table 7 shows the comparison of taste perception among the various stages of OSMF wherein it was found that 3 (37.5%) patients of Stage I OSMF revealed hypogeusia to sweet taste while no patient (0%) showed ageusia and 5 (62.5%) patients showed normal sweet perception. In Stage II OSMF, 8 (66.7%) patients showed hypogeusia and 1 (8.3%) patient showed complete ageusia, while 3 (25.0%) patients showed normal sweet taste perception. In Stage III OSMF, 1 (10%) patient showed complete ageusia, while 6 (60%) patients showed hypogeusia and 3 (30%) patients showed normal sweet taste perception and this difference was found to be statistically insignificant ($P = 0.59$). For salty taste, only 1 (12.5%) patient showed hypogeusia and 7 (87.5%) patients showed normal salt taste perception among Stage I OSMF, while 6 (50.0%) patients showed hypogeusia and 6 (50%) showed normal salty taste perception among stage II OSMF patients. In Stage III OSMF, 1 (10%) patient showed complete ageusia and 4 (40%) patients showed hypogeusia to salty taste and 5 (50%) patients showed normal salty taste perception, and this difference, too, was found to be statistically insignificant ($P = 0.28$). For sour taste, only 1 (12.5%) patient showed hypogeusia, while 7 (87.5%) showed normal sour taste perception among Stage I OSMF patients. Among Stage II OSMF patients, 1 (8.3%) patient showed hypogeusia and 11 (91.7%) patients showed normal sour taste perception. Likewise, in Stage II OSMF, 3 (30%) patients showed hypogeusia to sour taste, though, the difference was found to be statistically insignificant ($P = 0.38$). For bitter taste perception, no patient showed complete ageusia to bitter taste in all the three stages of OSMF, however, 1 (12.5%) patient from Stage I and 2 (20.0%) patients from Stage III showed hypogeusia to bitter taste and the difference was found to be statistically insignificant ($P = 0.29$).

Table 7: Comparison of taste perception among various stages of oral submucous fibrosis

	Stage I (%)	Stage II (%)	Stage III (%)	*P*
Sweet				
Ageusia	0	1 (8.3)	1 (10.0)	0.59
Normal	5 (62.5)	3 (25.0)	3 (30.0)	
Hypogeusia	3 (37.5)	8 (66.7)	6 (60)	
Salt				
Ageusia	0	0	1 (10.0)	0.28
Normal	7 (87.5)	6 (50.0)	5 (50.0)	
Hypogeusia	1 (12.5)	6 (50.0)	4 (40.0)	
Sour				
Ageusia	0	0	0	0.38
Normal	7 (87.5)	11 (91.7)	7 (70.0)	
Hypogeusia	1 (12.5)	1 (8.3)	3 (30.0)	
Bitter				
Ageusia	0	0	0	0.29
Normal	7 (87.5)	12 (100.0)	8 (80.0)	
Hypogeusia	1 (12.5)	0	2 (20.0)	
Total	30 (100)	30 (100)	30 (100)	

One-way ANOVA/Kruskal–Wallis H test. ANOVA: Analysis of variance

DISCUSSION

OSMF is indeed one of the classic "Diseases of Civilization", now, globally accepted as the disease that belongs to the Indian subcontinent, which has one of the highest rate of malignant transformation among the various oral potentially malignant epithelial lesions (PMELs).[20] A malignant transformation rate of 7.6% over a period of 10 years is reported for OSMF, and the relative risk for malignant transformation may be as high as 11.7%.[21] The condition is characterized by burning sensation and depigmentation of oral mucosa along with reduced movement and depapillation of tongue and progressive reduction of mouth opening. Some patients may, also, have excessive salivation, probably, due to their inability to swallow the normal amount of saliva as a result of reduced tongue movement. Apart from this, some studies have, also, documented dryness of the mouth due to xerostomia and altered taste perception due to xerostomia and atrophy of the papilla.[22] There have been few studies that have been conducted on the assessment of salivary flow rate and pH among OSMF patients and individuals having the habit of betel nut or, gutkha chewing but those who have not developed the same, although there is a relative dearth of studies that have focused on the impairment of taste sensation in the affected individuals. The present study was planned with a similar intent to assess and compare the alteration in taste perception among gutkha chewers with and without OSMF and the normal healthy controls.

The mean age among OSMF patients, in the present study, was found to be 30.96 years similar to the findings in the existing literature, wherein a peak incidence of OSMF has been reported to be in the third decade of life. This observation in the present study was found to be in accordance with the studies conducted by Wahi *et al*.[23] and Sinor *et al*.[24] Noor-Ul-Wahab *et al*.,[25] though, found the maximum number of patients (73%) to be in their second decade of life in their study followed by the third decade wherein the second peak was noted.

Similarly, there have been varying reports on sex ratio in different published studies. In the present study, in the OSMF group, 28 (93.3%) of the patients were males, while only 2 (6.7%) were female patients. A definite male predominance observed in the present study with a male: female ratio of 14:1 was found to be similar to the findings reported by the studies conducted by Wahi *et al*.,[23] Shah and Sharma[26] and Ranganathan *et al*.[27] Another study conducted by Reddy *et al*.,[28] also, showed that out of the 390 patients of OSMF included in their study, 70.26% of the patients were males while only 29.74% were of the patients were females, thereby showing a definite male predominance for the disease process. Furthermore, the peak incidence of the disease was seen in the third decade of life in their study, as well, similar to the findings of the present study. This might be due to more social exposure at this age and relative ease in the availability of such products at this age without any hindrance. Contrary to the findings of the said study, Rao AB,[29] though, reported 29 females and 17 males among the 46 OSMF patients included in their study, thereby showing a female predominance. According to Rajendran *et al*.,[30] a female predominance seen with the said disease process might be related to factors like the more common usage of the smokeless forms of tobacco including betel nut and a relative deficiency of iron, vitamins and many other nutritional factors in the females as prevalent in the Indian subcontinent.

In the present study, out of the 30 OSMF patients included, 12 (40%) patients were having stage II OSMF which was higher as compared to the ratio of patients having Stage I and stage III OSMF in contrast to the study conducted by Nigam *et al*.[31] who observed a maximum number of patients in their study to be in Stage I OSMF followed by Stage II and Stage III, respectively. Reddy *et al*.,[28] though, found more number of patients in Stage II in their study similar to the findings of the present study with Stage I OSMF seen with 197 (50.51%) patients, Stage II OSMF found with 110 (28.20%) patients while Stage III OSMF with 83 (21.28%) patients. Different hypotheses, put forth, suggest that OSMF is a multi-factorial disease process with areca nut chewing being the major etiological factor behind the causation of OSMF as suggested in the various epidemiological and *in-vitro* experimental studies conducted so far, although, there might be seen regional variations

in the different parts of the subcontinent depending on the various forms and concentrations and additives used with this form of smokeless, areca nut chewing habit. Areca or betel nut is the inner kernel or seed which is obtained after removing husk of areca nut and gutkha is a mixture of areca nut, tobacco, slaked lime, catechu and numerous other spices which was introduced in the Indian market in 1980's.[32] In the present study, out of the 30 patients included with OSMF, patients having habit of gutkha chewing (76.7%) showed a significant increase in the incidence of OSMF as compared to the patients having habit of betel nut chewing (10.0%), and both betel nut and gutkha chewing (13.3%) habit which was in accordance with the findings of the study conducted by Sharma R *et al*.[33] which reported that among the 231 OSMF patients included in the study, 135 (58.44%) patients had habit of gutkha chewing while 52 (22.51%) had a habit of areca nut and tobacco and 44 (19.04%) patients had areca nut chewing habit. Contrary to these findings, the study conducted by Reddy *et al*.[28] showed areca nut to be the main etiologic factor followed by gutkha and other areca nut products such as tobacco and mawa in the causation of OSMF.

The present study also revealed that increase in the frequency and exposure of the habit significantly increased the incidence of OSMF, thereby highlighting a dose-dependence relationship between areca nut and OSMF as has been confirmed in the published literature, though, the study did not find a significant association of OSMF with the duration of the habit. However, it did not show a significant relation with habit duration as against the finding of the study conducted by Reddy *et al*.[28] which showed that increase in habit frequency, duration and exposure were all the primary etiological factors deciding the causation of OSMF. Another similar study conducted by Sinor *et al*.[24] also showed that the relative risk of OSMF gets increased with the duration as well as the frequency of areca nut chewing, with yet another study highlighting the dose-dependence relationship between areca nut and the causation of OSMF. On similar grounds, another study conducted by Maher *et al*.[34] reported that the frequency of areca nut chewing was more important than duration of the habit in the causation of OSMF while yet another study conducted by Abdul Khader and Dyasanoor[9] found duration of the habit to be more important than frequency and exposure. In contradiction to these studies, Pindborg *et al*.[35] reported 31.8% of the patients out of the 63 patients of OSMF included in their study not to have any positive history of any habit, be it in the smoked or smokeless forms of the tobacco or areca and betel nut chewing habit.

As far as taste perception is concerned, saliva is an important body fluid as it is essential in maintaining oral health in a multitude of ways among which gustation is an important component. Saliva plays an important role in lubrication of the oral mucosal tissues, re-mineralization of the initially de-mineralized defects of dental hard tissues, pH balance as well as facilitation of the processes leading to mastication and deglutition and digestion of the ingested food. As saliva modulates the ecosystem, it plays an important role in maintaining oral homeostasis. During betel nut chewing, the physicochemical composition of saliva gets altered as many chemicals and metals leach out into the saliva during ingestion of such products. Saliva is the most easily accessible fluid in the human body. The normal daily saliva production is between 0.5 and 1.5 l. In literature, alteration in salivary flow rate and pH have been reported in a few studies in individuals with habit of areca or, betel nut chewing, though, numerous studies have also documented a change in the flow rate of saliva under physiological conditions.[36]

Gustation or taste perception is mediated with the help of specific receptors that act as the primary site for the stimulation of salivary secretion. These receptors are constantly exposed to different types of substances taken as food, drug or the substances of abuse including the tobacco, areca nut and gutkha. According to Matsuo R,[37] saliva plays an important role in the maintenance of taste sensation. Human beings are able to perceive four basic tastes including the sweet, salty, sour and bitter. Recently, the fifth taste, umami, was also verified. In the present study, different solutions were used to evaluate the taste perception in accordance with the study conducted by Srinath *et al*.[14] and Deeplaxmi *et al*.[19] while electrogustometry method was used in another similar study conducted by Soni *et al*.[16] and edible taste strips were used in the study conducted by Smutzer *et al*.[38] A study conducted by Pingel *et al*.[18] reported that there was an alteration in the taste perception with the normal aging of an individual which was, also, confirmed in yet another study conducted by Winkler *et al*.[39] who found a decrease in the salty and bitter taste perception in the aging individuals. Fukunaga *et al*.[40] also found significant age-related deterioration in taste perception in their study and concluded that as the age advances, there was observed a decrease in the acuity of the taste perception as well and that the taste perception is delayed. According to Gondivkar *et al*.,[41] too, patients with systemic diseases like Diabetes showed delayed taste perception as was confirmed in their study. This formed the reason for the selective inclusion of individuals who did not report with evidence of any other systemic disease. In the present study, 17 (56.7%) OSMF patients showed

hypogeusia to one or the other tastes similar to the findings of the study conducted by Deeplaxmi *et al*.[19] which revealed hypogeusia in relation to the sweet followed by the salty, bitter and sour tastes.

The taste perception among various stages of OSMF, though, was not found to be statistically significant in the present study contrary to the findings of the study conducted by Dyasanoor and Abdul Khader[42] which showed hypogeusia to sweet, salty and bitter taste among stage II OSMF patients as compared to the patients who were reported with Stage I OSMF. Similarly, around 24% of the patients revealed taste impairment in a study conducted by Soni *et al*.[16] and it was related to the severity and extent of the disease process. In the present study, sweet taste was affected more as compared to other tastes suggestive of severe depapillation in the anterior region of the tongue, which was found to be in accordance with the study conducted by Deeplaxmi *et al*.[19] In the present study, among the individuals having habit of betel nut/gutkha chewing, only one patient showed impairment in sweet taste perception and two individuals revealed hypogeusia to the salty taste, while only one control was found to reveal hypogeusia to sweet and to sour taste which was found to be statistically insignificant in accordance with the findings of the study conducted by Khan *et al*.[43] who also did not find any significant long-term effect of tobacco usage on the taste perception among chewers and nonchewers. To conclude, the results obtained in the present study were found to be encouraging as it was demonstrated that taste perception varied significantly among the patients with OSMF as against those having the habit of betel nut/gutkha chewing but those who did not develop OSMF and the normal healthy controls and these data, though, initial, might be used on a scientific basis to improve the QoL in the affected patients as well as to prevent the further progression of the disease process.

CONCLUSION

From the findings of the present study, the following observations were drawn that when patient's age and sex attributes were considered among the OSMF patients, the highest incidence of the disease process was observed in the third decade of life with a definite predilection for the males. A definitive association was also found between the frequency and duration of exposure of the habit and the subsequent incidence of OSMF in such individuals. Again, a statistically significant difference was also observed between patients with OSMF, individuals having the habit of betel nut/gutkha chewing but those who did not reveal any clinical evidence of OSMF and the control group as far as taste impairment was concerned. Thus, from the findings of the present study, it could be concluded that "altered/impaired taste perception could be an initial subjective sign of OSMF." Furthermore, besides increased risk for malignant transformation due to hampering of the nutritional status in the affected individuals and the oral mucosa which subsequently, becomes even more vulnerable for the further initiation of pathologic changes, the change in taste perception in OSMF patients often leads to anorexia, depression and weight loss. An early diagnosis and management of these changes with the help of pharmacotherapy, physiotherapy and a proper, balanced diet by the concerned oral physicians, thus, can not only help such patients to improve their QoL significantly but decrease the chances of the ongoing malignant transformation with early intervention and stoppage of habit.

Limitations of the present study

The major limitation of the present study was seen in the form of impairment of taste perception among the various stages of OSMF which, though, present, did not show any significant difference statistically which, in turn, might be due to the smaller sample size included in the study which mandates further studies to be conducted in this regard to come to valid conclusions. Furthermore, the clinical parameters used in the present study in the form of impairment of taste perception were indicators of an increased morbidity and a subsequent, decreased QoL in the affected individuals, but these cannot be used as the relevant markers for the impending OSMF in such patients. A need for further research in this regard, thus, is highly desirable wherein the clinical data can be used to provide a scientific evidence to control or halt the process of malignant transformation in such patients who are with or, without this deadly, potentially malignant condition, OSMF because the risk of malignant transformation never ends there.

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Conflicts of interest

There are no conflicts of interest.

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