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Early Detection of Oral Potentially Malignant Disorders by Using Auto Fluorescence Imaging Non-Invasive System in Industrial Workers – A Prospective Study

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ABSTRACT

Oral cancer is the sixth most common cancer in the world, oral cancer is strongly associated with tobacco habits either in the form of smoking and chewing. Consumption of tobacco either in the form of chewing or smoking was cause oral mucosal changes. Oral cancer may transformation from oral potentially malignant disorders. Morphological alterations among those who consumption tobacco may increases potential for malignant transformation. Autofluorescence imaging (AFI) has emerged as a promising adjunctive tool for the early detection of OPMDs. Prospective study aims to early detection of oral potentially malignant disorders by using Auto fluorescence imaging non-invasive system in Industrial workers**.** Methods and material: A total of 260 individuals participated in this study. The age distribution was 27.20 ± 5.40 in males whereas 25.32 ± 6.84. 56.76% males were having habits of smoking. The distribution of gender in relation with habits showed statistically significant with $p \leq 0.05$. The relationship between habits and oral mucosal lesions 82.91% of chewers showed oral mucosal lesions. In association between smoking and chewing in relation with autofluorescence and oral mucosal changes in chewers 70.10% and in smokers 29.90 % positivity. The association between habits in relation with habits and histopathological diagnosis and follow-up first six months oral mucosal changes showed statistically significant $p \leq 0.05$. This study concludes that the autofluorescence imaging emerges as a promising, non-invasive adjunct for early detection of oral potentially malignant disorders, especially in high-risk occupational settings. Broader implementation of autofluorescence imaging within industrial health surveillance frameworks could lead to earlier diagnosis and better clinical outcomes, thereby reducing the burden of oral cancer among vulnerable working populations.

Keywords: Oral potentially malignant disorders, Smoking and chewing, industrial workers

INTRODUCTION

Oral cancer remains a significant public health burden, particularly in developing countries, where it ranks among the top three most common malignancies.[1] The disease often develops from precursor lesions known as

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oral potentially malignant disorders (OPMDs), such as leukoplakia, erythroplakia, oral submucous fibrosis, and lichen planus, which can undergo malignant transformation if not identified and managed in time.[2] The prevalence of OPMDs is especially high among industrial workers who are frequently exposed to risk factors such as tobacco, betel nut, alcohol, and occupational carcinogens.[3] Traditional diagnostic methods, such as visual-tactile examination and biopsy, although effective, are often limited by subjectivity, invasiveness, and poor compliance, especially in low-resource and occupational settings. This underscores the urgent need for a rapid, non-invasive, and cost-effective screening modality to enhance early detection and intervention.[4]

Autofluorescence imaging (AFI) has emerged as a promising adjunctive tool for the early detection of OPMDs. AFI operates on the principle of tissue autofluorescence loss due to structural and metabolic changes associated with dysplastic and neoplastic transformation. Normal oral mucosa emits a green autofluorescence under specific wavelengths, while dysplastic tissues exhibit fluorescence loss or shift due to altered collagen cross-links and metabolic activity.[1] Several commercial autofluorescence devices, such as VELscope, have demonstrated potential in enhancing visualization of suspicious lesions and improving diagnostic sensitivity, especially when used by trained personnel.[5] This prospective study aims to Early detection of oral potentially malignant disorders by using Auto fluorescence imaging non-invasive system in Industrial workers**.**

MATERIALS & METHODS

It is a prospective cross-sectional study among the individual's working in industries was include both males and females with or without tobacco habits either in the form of chewing or smoking. We were be invited to participate in the research by explaining the benefits and risks present in the research if the participants are willing to participate then informed written consent was be obtained. The study was obtained clearance with Institutional Ethics Committee with Pr.169/IEC/SIBAR/2022.

Inclusion criteria were Individuals who attended industry and willing to participate the study with age group between 20 – 55 years and Individuals with or without habits of tobacco consumptions in any form of chewing or smoking and there was no clinically no evidence of oral potentially malignant disorders. Exclusion criteria were those individuals with clinical evident of potentially malignant disorders, treatment for any oral potentially malignant disorders and malignancy. Sample size was calculated using G * power 3.1.9.7 with effect size 0.33, α error probability 0.05 and power was 0.97 and total sample was 258 and made it into 260 individuals.

Data collection procedure:

Individual those willing for participants for this study after obtained informed consent and demographic details was included for our study. The study population was included with habits of tobacco consumption in any form either smoking or chewing. Intra oral examination was done using standard aseptic condition with disposable mouth mirror and probe. I st visit (Base line) intra oral examination was done and without any mucosal changes patients was selected for our study. Using autofluorescence imaging system to identification of any mucosal changes in all individuals who are willing to participate. If any mucosal changes observed using autofluorescence then advise for biopsy for histopathological grading of dysplasia. If there were no mucosal changes observed then those individuals, we were follow-up for 6 months again same procedure we were repeat the procedure using autofluorescence. If we observed any mucosal changes then we were going for biopsy for histopathological grading for dysplasia. If we have not found any mucosal changes then we follow-up same patients for III visit i.e. 12 months.

Statistical analysis:

The data was entered in excel sheet and using SPSS 20.0 version. Descriptive statistics was calculated to determine the total number of lesions confirmed. Chi-square test was done to know the association between age, nativity and prevalence of Oral Potentially Malignant disorders (OPMDs). The association between habits with age and gender was done using Chi-square test with $p \leq 0.05$. Concordance rate between Autofluorescence imaging technique and biopsy was be expressed as percentage agreement

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RESULTS

A total 260 individuals were screened in industries with inclusion and exclusion criteria with mean age distribution in different gender the maximum in age distribution was 27.20 ± 5.40 in males followed by females 25.32 ± 6.84. The maximum number of male patients was smokers 84 (56.76%) followed by chewers 64 (43.24%), whereas in female subjects was more in chewing tobacco with 112 (100,0%) and there were no female indidulas having smoking habits. The distribution of gender in relation with habits showed stastically significant p≤ 0.05. The maximum number of subjects within the 30 – 39 years of age group. When compared between the habits in relation with smoking 20-29 years of the age group. Compared between habits in relation with age showed statistically not significant. The association between smokers and chewers habits, chewers showed maximum compared with smoking. Pan masala and pan chewers was more observed, where as in smoker's cigarette smoking was more when compared with other habits such as bedi, chutta. The association between habits such as smoking and chewing with presence or absence of oral mucosal lesions. The subjects with chewing habits showed more like to have oral mucosal lesions with 82.91 % where as in smokers 44.76% of the subjects showed oral mucosal lesions. The association of chewing and smoking in relation with presence or absence of oral mucosal lesions showed statistically significant p≤ 0.05**.(Table 1)** The association between the habits in relation with clinical diagnosis showed statististically highly significant with p≤0.000. **(Table 2)** The association between smoking and chewing in relation with autofluorescence and mucosal changes using autofluorescence in chewers 70.10% and in smokers 29.90% positivity. When compared between oral mucosal lesions in association with autofluorescence was not statistically significant with p≥ 0.05. The 70.0% of the subjects who were having habit of chewing habits accepted for biopsy where as 30.0% of the subjects who were having habit of smoking habits were accepted for biopsy. The association in relation with habits and histopathological diagnosis showed statistically significant p≥ 0.05. **(Table 3)** The association between habits with follow-up first 6 months in relation with mucosal changes using chi square test, in chewers the mucosal changes were absent in 104 (65.00%) and present only 38 (92.68%) and patients didn't turn out after six months were 34 (57.63%). The association between habits with follow up first six months mucosal changes showed statistically significant p≥ 0.05**.(Table 4)**

DISCUSSION

The early diagnosis of oral cancer is very challenging because of patients awareness on oral mucosal changes and hard to detect clinically because the lesion may not be palpable. [6] So need to improve the diagnostic efficacy clinically and different techniques should be incorporated along with clinical examination to facilitate the identification of initial changes of the moral mucosa and potentially malignant disorders.[7] There are different light-based techniques developed along with clinical examination of oral mucosa and oral potentially malignant disorders.[8] The light-based technique such as Chemiluminescent first used by Huber et al., 2004 and this was compared with conventional method in oral leukoplakia cases.[10]

This prospective study evaluated the utility of autofluorescence imaging as a non-invasive diagnostic adjunct for the early detection of oral potentially malignant disorders in industrial workers, a group particularly vulnerable due to regular exposure to known carcinogens such as tobacco. Our findings support the effectiveness of autofluorescence imaging in enhancing the visualization of premalignant mucosal changes that may not be apparent under conventional white light examination. The results are in line with previous literature suggesting that autofluorescence imaging improves the sensitivity of oral mucosal screenings by identifying biochemical and structural tissue alterations through loss of autofluorescence.[10,11] This ability to detect early epithelial dysplasia and field cancerization is critical in high-risk populations, where lesions often go unnoticed until advanced stages.[12]

In this study few oral mucosal lesions that showed fluorescence loss correlated strongly with histopathologically confirmed dysplasia, reinforcing the diagnostic potential of autofluorescence imaging. Industrial workers often fall outside the purview of regular oral health screenings, despite their heightened risk. Integrating autofluorescence imaging into occupational health programs can serve as a valuable public health strategy by facilitating early detection, increasing screening participation through its non-invasive nature, and improving clinical outcomes through earlier interventions. Despite its advantages the autofluorescence has certain limitations. The specificity of autofluorescence imaging remains suboptimal, as benign lesions such as

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inflammation, vascular lesions, or trauma-induced changes may also cause Loss of autofluorescence, leading to false positives.[13] Therefore, should be employed as an adjunct tool alongside traditional clinical examinations and confirmed via biopsy when necessary. Operator experience and adequate training are also essential for accurate interpretation of fluorescence patterns. However, the lack of a long-term follow-up component limits our ability to assess lesion progression or recurrence. Future research should include longitudinal monitoring and larger, multicentric cohorts to validate these findings and evaluate cost-effectiveness in large-scale screening.

CONCLUSION

Autofluorescence imaging emerges as a promising, non-invasive adjunct for early detection of oral potentially malignant disorders, especially in high-risk occupational settings. Broader implementation of autofluorescence imaging within industrial health surveillance frameworks could lead to earlier diagnosis and better clinical outcomes, thereby reducing the burden of oral cancer among vulnerable working populations.

Conflict of Interest:

There are no conflicts of interest

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Table 1: Association between habits with presence or absence of oral mucosal lesions

Mucosal lesions	Chewing (%)	Smoking (%)	Total (%)	Chi-square	p-value
Absence	79 (55.24)	64 (44.76)	143 (55.00)	22.5140	0.0001*
Presence	97 (82.91)	20 (17.09)	117 (45.00)		
Total	176 (67.69)	84 (32.31)	260 (100.00)		

*p<0.05

Table 2: Association between habits with Clinical diagnosis

Clinical diagnosis	Chewing (%)	Smoking (%)	Total (%0	Chi-square	p-value
Pigmentation	77 (55.00)	63 (45.00)	140 (53.85)	31.4150	.000*
OSMF	27 (100.0)	0 (0.00)	27 (10.38)		
Leukoplakia	39 (76.47)	12 (23.53)	51 (19.62)		
Snuf pouch keratosis	18 (94.74)	1 (5.26)	19 (7.31)		
No changes	15 (65.22)	8 (34.78)	23 (8.85)		
Total	176 (67.69)	84 (32.31)	260 (100.00)		

*p<0.05

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Table 3: Association between habits with Histopathological diagnosis

Histopathological diagnosis	Chewing (%)	Smoking (%0	Total (%)	Chi-square	p-value
Chronic nonspecific inflammation	41 (56.16)	32 (43.84)	73 (28.08)	30.5990	0.0001*
OSMF	24 (96.00)	1(4.00)	25 (9.62)		
Moderate epithelial dysplasia	32 (78.05)	9 (21.95)	41 (15.77)		
Mild epithelial dysplasia	20 (54.05)	17 (45.95)	37 (14.23)		
Severe epithelial dysplasia	4 (100.0)	0 (0.00)	4 (1.54)		
Verrucous hyperplasia	21 (95.45)	1 (4.55)	22 (8.46)		
Not done	34 (58.62)	24 (41.38)	58 (22.31)		
Total	176 (67.69)	84 (32.31)	260 (100.00)		

*p<0.05

Table 4: The association between habits with Follow-up first 6 months mucosal changes

Follow-up first 6 months mucosal changes	Chewing (%)	Smoking (%)	Total (%)	Chi-square	p-value
Absence	104 65.00)	56 (35.00)	160 61.54)	14.972	0.001*
Presence	38 (92.68)	3 (7.32)	41 (15.77)		
Patient didn't turn out	34 (57.63)	25 (42.37)	59 (22.69)		
Total	176 67.69)	84 (32.31)	260 (100.00)		

*p<0.05

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