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CLASSIFICATION OF LEUKOPLAKIA USING SVM

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ABSTRACT

Precancerous lesions such as leukoplakia possess a high risk of transformation into oral cancer. This can be prevented if they are diagnosed and treated in the earlier stages. Besides various available pathological investigations and molecular research works , attempts are also being made by computer analysts to find out a technique that could accurately diagnose and classify these diseases. One such attempt has been made in this research work by using SVM (Support Vector Machine) to classify leukoplakia lesions from normal oral mucosa. BICC (Block Intensity Code Comparison) features were extracted from microscopic images of leukoplakia -affected mucosae and used for the aboveesaid classification. The performance was evaluated based on the sensitivity, specificity and accuracy of the results.

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INTRODUCTION

Oral cancer has been one of the most dreadful cancers affecting the human population with an unchanged mortality rate for almost a decade. Precancerous lesions and conditions, otherwise called as potentially malignant disorders (PMDs) pose a potential threat of malignant transformation as compared to normal oral mucosa. Among them, leukoplakia is the most common PMD. Most often it is diagnosed by exclusion of other similar white lesions such as oral lichen planus, leukoedema, white sponge nevus, etc. Leukoplakia is defined as a 'predominantly white lesion of the oral mucosa that cannot be characterized as any other definable lesion; some oral leuokoplakia will transform into cancer.' It may be homogenous or heterogenous and focal or disseminated in distribution. Homogenous lesions are regular, smooth and white surfaced whereas heterogenous are mixed with an erythematous component called erythroplakia which comparatively has higher risk of malignant transformation. Leukoplakia possesses 25% of malignancy risk, thus necessitates an accurate diagnosis and early management.

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It has been proved that leukoplakia is more frequent in tobacco smokers than others. In addition, nutrition deficiencies, constant irritants have also been suggested as other etiological factors. Histopathological analysis of the tissue sections obtained from biopsies has been the only reliable method to diagnose precancerous and cancerous lesions. Dysplastic changes in the tissue sections of leukoplakia and other PMDs are graded as mild/moderate/ severe and thus the risk of transforming into oral cancer is assessed. Since such evaluation methods are highly subjective and hence end up in individual variations.

Related Works

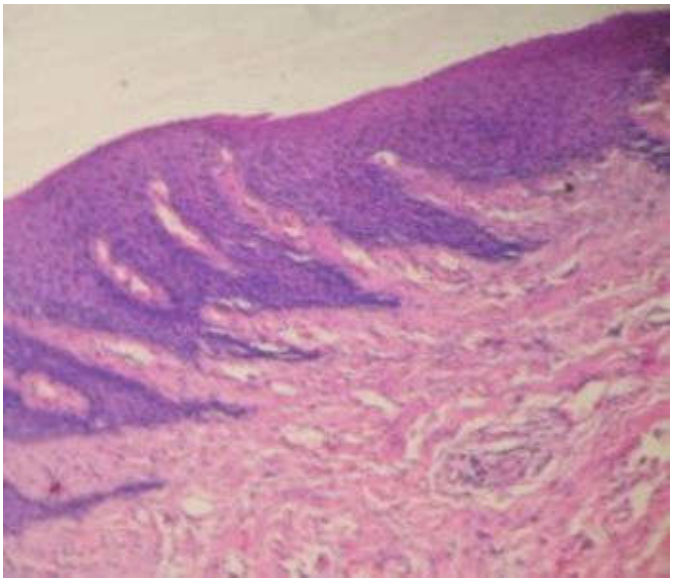
A lot of studies and research has been conducted on this topic. In April 2012, Byakodi R, Byakodi S, Kiremath S, Bya Kodi J, Adaki S, Marathe K andMahiral P described Oral cancer [Byakodi, 2012] as one of the most fatal health problems faced by the mankind today. In India, because of cultural, ethnic, geographic factors and the popularity of addictive habits, the frequency of oral cancer is high. It ranks number one in terms of incidence among men and third among women. Several factors like tobacco and tobacco related products, alcohol, genetic predisposition and hormonal factors are suspected as possible causative factors.

Fig.1. Homogenous Leukoplakia

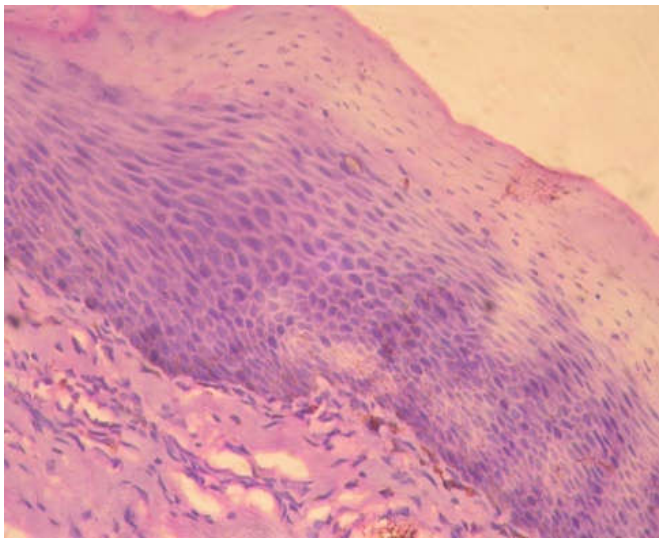
Fig.2. Heterogenous Leukoplakia

Fig. 3. Oral Cancer arising from Leukoplakia; OC-Oral Cancer, L-Leukoplakia

Hence the study was designed to determine the prevalence of Oral Cancer in patients who attended the outpatient department, at Bharati Vidyapeeth Deemed University Dental College Sangli India during a period of 24 months in 2009–2010. Further various modes of tobacco and alcohol consuming habit were assessed along with the site of occurrence of oral cancer. About 35,122 subjects belonging to a semi-urban district of Sangli in Western Maharashtra (India) were screened. Tobacco and alcohol consumption was the common habit among the study population. Out of these about 112 cases showed Oral Cancer. The prevalence of Oral Cancer was 1.12%. Statistical analysis was done using the SPSS software 11. The findings in the present study reveal a high prevalence of Oral Cancer and a rampant misuse of variety of addictive substances in the community. Close follow up and systematic evaluation is required in this population. Education about ill effects of tobacco and alcohol consumption is necessary at a broader scale. There is an urgent need for awareness programs involving the community health workers, dentists and allied medical professionals.



(a)



(b)

Fig. (a) Normal microscopic image
(b) Leukoplakia microscopic image

Table 5.1. Average performance of normal and Leukoplakia classification by SVM model using BICC features

Types of kernel	Accuracy (%)					
	Feature vector dimensions (No. of BICC features)					
	10		45		105	
	Normal	Leukoplakia	Normal	Leukoplakia	Normal	Leukoplakia
Polynomial	75.0	79.0	79.0	82.0	80.0	81.0
Gaussian	80.0	83.0	84.0	88.0	90.0	92.0
Sigmoidal	89.0	91.4	89.0	92.0	91.0	93.0

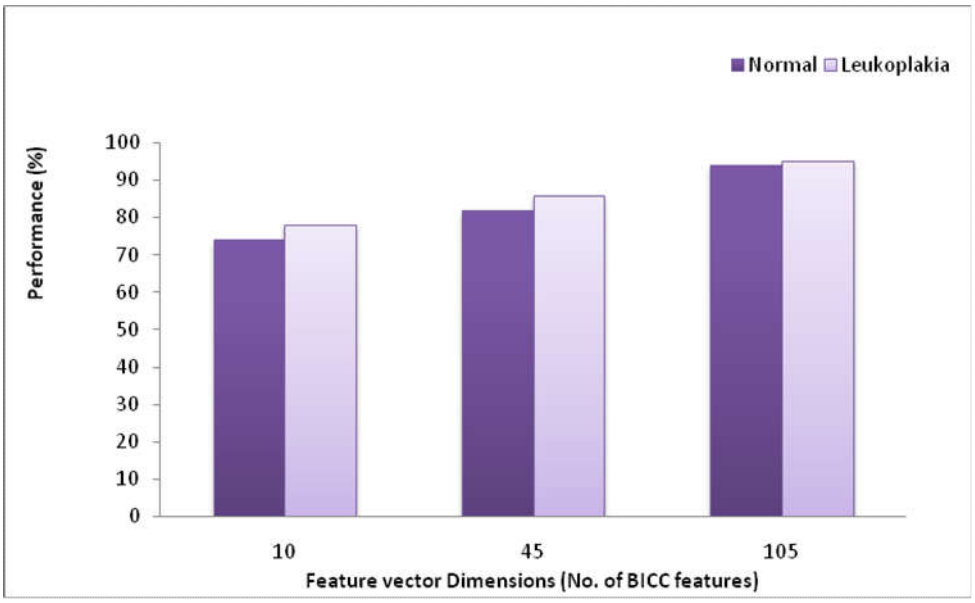


Fig. 5.7. Average performance of normal and Leukoplakia classification by SVM model (sigmoidal kernel) using BICC features

Computer analysis of images

Research works on computer applications in oral lesions had been done since 1970s. 1. Application of Cluster analysis and Discrimant analysis by Krameret al., for grouping lesions into keratosis, leukoplakia and lichen planus 2 work on 2-D section of histopathological images of oral cancer and precancer by Landini and Rippin 3.R.R.Paul's research on electron microscopicimages of OSMF (Oral submucous fibrosis) to train on Artificial neural network 4. Interactive image analysis system in classifying normal, precancerous and cancer images by Gao et al., in 1992 are a few examples of the various attempts to apply computer based analysis of oral histological images.

Current research

With a motivation from the pioneered research works on image analysis of oral cancer and precancer, an attempt has been made in this research to classify normal mucosa and leukoplakia-affected mucosa using image analysis of BICC features extracted from those images. Photomicrograhc images of normal and leokoplakia affected mocosae were obtained from the department of Oral Pathology, Rajah Muthiah Dental College and Hospital. BICC features were extracted from the images.Pattern lassification was done using SVM. The above images show a normal mucosa with a normal unaffected epithelium and an underlying connective tissue.

The leukoplakia affected mucosa shows a hyperkeratinised epithelium with mild dyplasia and a few inflammatory cells in the connective tissue.

EXPERIMENTAL RESULTS

A total of 200 microscopic images which consists of 100 Leukoplakia images and 100 normal images are considered. For four fold cross validation training data gf_i (i=1,2,3,4) consisting of 150 microscopic images [50 images (25 Normal + 25 Leukoplakia) + 50 images (25 Normal + 25 Leukoplakia) + 50 images (25 Normal + 25 Leukoplakia)] are used. For testing, 50 microscopic images (25 Normal and 25 Leukoplakia) are used.

Evaluation using SVM

A non-linear support vector classifier is used to discriminate the two categories. The N class classification problem can be solved using N SVMs. Each SVM separates a class from the other class. Support Vector Machine is trained to distinguish BICC features of a category from other category. Two SVMs are created for each BICC feature and also for each category. Microscopic images of 100 normal oral mucosal tissue samples and 100 Leukoplakia affected images were collected from RMDCH. For evaluating the performance of leukoplakia classification system, BICC features are extracted from the images as described in Section.

A non-linear support vector classifier is used to classify leukoplakia and normal images. The performance is studied for blocks of size 5 x 5, 10 x 10 and 15 x 15, resulting in 10, 45 and 105 dimensional feature vectors respectively. Table 5.1 shows the performance of normal and Leukoplakia classification for SVM Model using BICC Features. These features are used to train the support vector machine. The training process analyzes training data to find an optimal way to classify images into their respective classes. The derived support vectors are used to classify image data. For testing the BICC features are extracted from the test image and given as input to SVM which classifies the input image into one of the predefined categories (normal or Leukoplakia) affected images. From Fig. 5.7, it is obvious that maximum performance is achieved for 105 BICC features which were obtained by dividing the image into blocks of size 15 x 15. Repeated experiments were carried out for 10, 45 and 105 features

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