ORIGINAL RESEARCH PAPER

Oral Pathology

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ARTIFICIAL INTELLIGENCE IN ORAL PATHOLOGY – BOON OR BANE?: A NARRATIVE REVIEW

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ABSTRACT

Background: Over the past 20 years, the field of artificial intelligence (AI) has grown and developed remarkably. Recent advancements in computing infrastructure, machine learning, and digital data collection have allowed AI applications to spread into fields previously regarded as the domain of human expertise. **Aim:** The purpose of this article is to inform oral pathologists on the application of artificial intelligence to the early detection, prognosis, and treatment planning of oral cancer. **Review Results:** The application of artificial intelligence (AI) in dentistry and other fields expedites the work of oral pathologists and offers critical diagnosis for a range of oral illnesses. AI might be able to anticipate the start of precancerous diseases with larger data sets. AI can more accurately predict results in urgent diagnosis since it can identify tiny details that the human eye is unable to see. **Conclusion:** Artificial intelligence will prove to be a powerful and precise tool that is also user-friendly for detecting oral cancer and other premalignant lesions. Therefore, no pathologist should be concerned that these developments in pathology would result in their job loss.

INTRODUCTION:-

Over the years, new medical equipment has been developed, and we have seen the value of medical imaging techniques like computed tomography, magnetic resonance imaging, ultrasound, and X-rays in the accurate diagnosis and treatment of a variety of ailments.[1].

There has recently been a significant growth of data across several industries as a result of information science and technological advancements.[2]. Artificial intelligence (AI) is now thought to be helpful in diagnosing diseases, predicting prognoses, or creating patient-specific treatment plans.[3].

While AI offers considerable benefits for both dental clinics and patients, we may anticipate seeing an expanding impact of this technology in dentistry in the future. With the use of a patient's medical records and radiological imaging, artificial intelligence can diagnose a patient with more accuracy and less inaccuracy.[4].

History Of Artificial Intelligence:-

Several academics cited Aristotle as having first recorded the concept of artificial intelligence. McCulloch and Walter Pits finished the critical work that is directly recognized as AI in 1943. The phrase "artificial intelligence" was originally used by American computer scientist John McCarthy at the Dartmouth Conference.[5]. Popular science fiction has long been supported by artificial intelligence. It was first used in the "Imitation Game" or "Turing Test" by Alan Turing. In the year 1955, logic theorists Allen Newell and Herbert Simon created the first-ever AI program.[3].

Several decades later, deep learning and convolutional neural networks (CNNs) were developed by Hinton et al. (2006) and presented at the Image Net Large-Scale Visual Recognition Challenge in 2012.[1]

What Is Artificial Intelligence?

A group of fundamental technologies that allow digital systems or computers to carry out tasks requiring human-like intellect are collectively referred to as artificial intelligence (AI).[1]. It can be described as a series of actions intended to carry out a particular task. Systems using artificial intelligence have historically carried out certain tasks by applying specific rules to them. Machine learning and deep learning are currently the two disciplines of AI that are most often used.[6]. Machine learning was first used by Simon Cowell in 1959. In order to provide a better diagnostic outcome, it calculates the information received and recognizes input data using algorithms and computer processes. ML techniques are divided into supervised and unsupervised categories.[3]

The dataset's elements are correctly labelled and separated at random into a training dataset and a test (validation) dataset. Using the tagged training dataset, AI algorithms derive some patterns that they then apply to the test dataset for prediction or classification. In the unsupervised learning method, the learning algorithm is given an unlabeled training dataset and is left to its own devices to identify structure in the input. The previously learned features are used to identify the class of the data when the new unlabeled testing dataset is introduced.[7]

Neural networks and deep learning are both methods that use nonlinear processing units with numerous layers to learn, recognize, and link output with pertinent input [3](Fig.1).

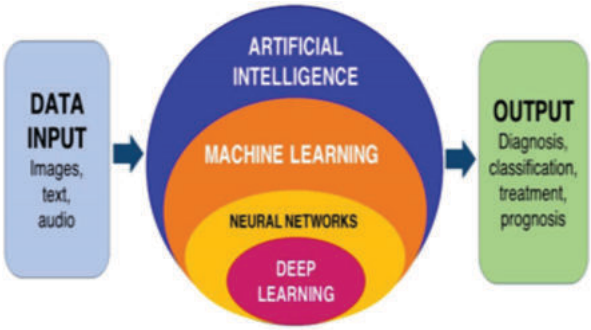

Fig. 1: Schematic representation of working of Artificial intelligence

Applications Of Artificial Intelligence In Dentistry:-

The most common condition is dental caries, and reducing caries-related illnesses in patients depends on early identification. With excellent results, AI models have been applied to diagnose dental caries using clinical imaging data from multiple sources. On a bitewing radiograph, the deep neural network can be utilized to identify early caries lesions

with more accuracy than dentists. [6]. Using CBCT and panoramic pictures, artificial intelligence (AI) can accurately identify vertical root fractures. [8]

The findings of investigations by Kunz et al. [9], and Hwang et al. [10], using automated identification systems based on deep learning and specialized artificial intelligence algorithms, respectively, showed great accuracy in detecting the landmarks, comparable to qualified human examiners. Yu et al. [11] demonstrated successful automatic skeletal categorization using lateral cephalometry based on the AI model.

The deep neural network (DNN) was trained to detect dental landmarks on the radiographs, and then the periodontal bone loss was measured using these landmarks by the DNN model in diagnosing periodontal diseases. [3]. According to Lee et al., [12], CAD systems based on deep convolutional neural network can detect joint disorders accurately.

Artificial Intelligence In Oral Pathology:-

Artificial Intelligence In Oral Cytopathology:-

The application of ML and ANNs for a more objective morphometric interpretation is ideal for cytopathology since it includes a very subjective evaluation of images of the cytosmears. Convolutional Neural Network (CNN) has recently been shown to be accurate for image classification tasks involved in cytopathology, along with methods like mobile microscopes, telecytology, and cytology-on-a-chip techniques. [13]

A Prognostic Model For Oral Cancer Using Artificial Intelligence:-

According to the WHO, oral cancer is the most prevalent malignancy, affecting 4.5 million people and causing mortality in about 85% of cases. Early detection will result in a 70% decrease in the death rate. [14] Due to inter- and intra-observer variances, pathologists find that this process, or the accuracy of cancer diagnosis, is time-consuming, subjective, and inconsistent. [15]. The automatic identification of cancer with the aid of classifiers and improved features has been investigated throughout the years to overcome restrictions such as clinicopathological acumen, the experience of oral oncopathologists, and interobserver differences. [16].

An automated color-based feature extraction technique was created by Sun et al. to segment and categorise OSCC stained with an anti-CD34 antibody. For OSCC stages I through IV, the results showed sensitivities of 49.11%, 64.17%, 58.55%, and 79.60%, respectively. [17].

AI makes automatic learning possible without human judgement. On the basis of the most recent measurements, these models forecast future events. [18]. Risk assessments can be created by combining micromorphological features with geographic information, risk variables, varying signal intensities, and patterns. [19]. Kim et al. observed that a deep learning program had superior diagnostic performance when used to forecast the survival of OC patients. They came to the conclusion that AI-based anticipation and prediction may deliver satisfactory outcomes. [20]

Intensity-modulated radiation (IMRT) dosage calculation, treatment outcome, and auto-segmentation for cancer patients are only a few of the issues that AI has been employed to solve in the planning of head and neck cancer treatment. [21]. According to a systematic review by Alabi et al., deep learning algorithms helped doctors make well-informed decisions, choose appropriate treatments, and manage OSCC more effectively. [22].

Oral Epithelial Dysplasia Grading With Computer Assistance:-

There has always been a strong correlation between oral epithelial dysplasia (OED) and substantial inter- and intraobserver disagreement. Oral pathologists have therefore strongly supported the necessity for computer-assisted grading and diagnosis of OED in order to increase the accuracy of the grading systems. [7]. It was suggested by Sami et al. to examine photomicrographs of the oral epithelium. A classification of OED by several authors into mild, moderate, and severe epithelial dysplasia has an accuracy of about 92%. [23].

Artificial Intelligence In Clinical Imaging:three Basic Stages:-

1) Pre-processing, 2) image segmentation, and 3) post processing. (Fig.2)

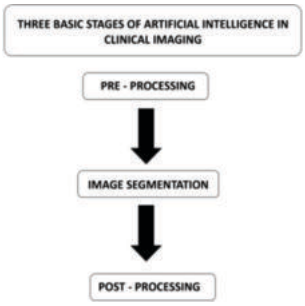

Fig.2: Basic steps of artificial intelligence in clinical imaging

Pre-processing:-

To reduce misunderstanding, undesirable optical data should be removed from the images. The use of filters can reduce optical ambiguity. Changes are made to the contrast to aid in differentiating and defining different structures, such as normal versus dysplastic cells. [5].

Image Segmentation:-

At this point, the region of interest is identified and illustrated. In disease imaging, pathogenic regions of lesions are separated from nonpathological parts. [5]

Post-processing:-

Convolutional neural networks (CNNs), recurrent neural networks, and multi-scale CNNs are some of the post processing methods used in clinical imaging. Network performance is tested using additional informational collections, and the outcomes are compared to findings from the gold standard (for example, histopathology). [8]. The processes are demonstrated in the following picture. (Fig.3).

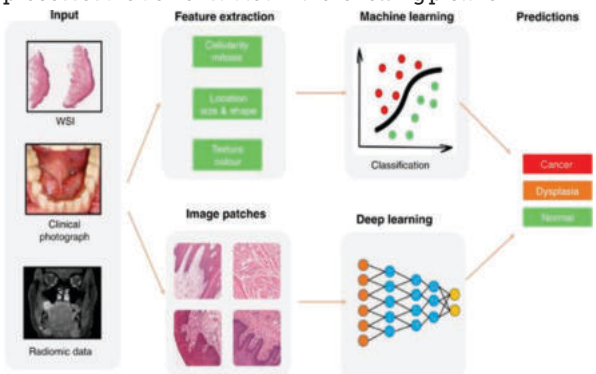

Fig.3: Basic steps of artificial intelligence in clinical imaging

Pitfalls Of Artificial Intelligence:-

Most of dental AI is still in its infancy. It has not yet made it into routine dentistry. Until technology can effortlessly integrate into diagnostics and healthcare, there are still many obstacles to overcome. Large amounts of data are needed for machine learning, and private dental setups and universities have these data. Federated regulations and legislation are necessary to address the challenges of data sharing and privacy. [3].

DISCUSSION:-

Research on the creation of AI has advanced quickly, especially with the emergence of high-performance computers in the 1980s. In reality, a wide variety of architectures were developed for statistical analysis in the 1990s, laying the groundwork for modern AI technology. Several researchers have tried to use AI in the medical profession since the 1970s. There is a relatively recent history of the application of AI in the dentistry profession; however, the oldest paper on the subject was just published in 1996. In order to segment target areas (such as organs) and detect lesion areas via radiography (i.e., computer-aided detection), medical companies have developed a variety of products. These products also aim to increase productivity when reading radiographs. [24-25].

This review demonstrates the enormous potential for medical image analysis and oral pathology researchers to create new techniques that support histopathological diagnosis using cutting-edge AI techniques like deep learning.

CONCLUSION:-

Artificial intelligence will prove to be a powerful and precise tool that is also user-friendly for detecting oral cancer and other premalignant lesions. Although the expansion of the pathologic sector in AI to include disease severity evaluation and prognosis prediction is positive, a significant amount of data is still required to construct AI that can handle a variety of clinical scenarios. Therefore, no pathologist should be concerned that these developments in pathology would result in their job loss. On the other hand, a pathologist will be best suited to interpret the results using DL and AI, which could result in fresh study directions.

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Conflicts Of Interest:- Nil

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