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Exploring the Impact of Artificial Intelligence in Oral Pathology: Insights from a Questionnaire-Based Survey

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Abstract

Introduction: Oral Pathology has undergone significant changes with the introduction of immunohistochemistry and, more recently, with Genomic Medicine. A third revolution that is poised to make a strong impact on pathology is Artificial Intelligence (AI). It is being employed in the medical field for detecting conditions such as lung cancer or strokes based on CT scans, assessing the risk of heart diseases using ECG and cardiac MRI images, identifying skin lesions in images, developing drugs, personalizing treatments, and more. The introduction of AI has the potential to challenge traditional practices and open up an entirely new realm for pathology diagnostics. The impact of these technologies on Oral Pathologists (OPs) is a subject of significant speculation.

Objective: The objective is to analyze the knowledge, attitude, and awareness of Artificial Intelligence among Oral Pathologists.

Materials & Method: A cross-sectional survey using a validated questionnaire through Google Forms was conducted among Oral Pathologists.

Results: A total of 224 oral pathologists participated in the survey. Among them, 69.8% had knowledge, 96.8% had awareness of Artificial Intelligence, and 93.1% expressed a positive attitude toward the integration of Artificial Intelligence in Oral pathology.

Conclusion: While AI is rapidly becoming integral to our daily lives, its full integration is yet to be realized in India. Oral Pathologists in India exhibit a positive attitude toward incorporating AI into their pathology practice. Therefore, it is imperative to train Oral Pathologists with new modules on AI to prepare them for the next era of diagnostic pathology.

Keywords: Artificial Intelligence, awareness, knowledge, questionnaire

Introduction

In recent years, the field of Oral Pathology has witnessed a surge in interest, particularly in artificial intelligence (AI) and deep learning. AI, defined as the "computational understanding of intelligent behavior," has become an integral part of our daily lives[1]. The growth of AI technology, including machine learning and deep learning, facilitated by advancements in computer and informatics technology, has permeated health information systems. In data-intensive specialties like radiology, pathology, and ophthalmology, AI has found widespread integration into decision support systems (DSSs)[2]. The potential of AI in transforming clinical practices is especially prominent in diagnostic fields like radiology and pathology. In pathology, AI-based diagnostic platforms contribute to image analysis for tissue histology, analyze molecular outputs from diagnostic tests like next-generation sequencing (NGS), and integrate these with clinical and radiological characteristics to enhance traditional pathology approaches' predictive and prognostic power[3].

AI's applications in healthcare extend to the analysis of medical images and electronic health records, aiding in diagnosis and treatment design, monitoring treatment plans, assisting in drug discovery, and extracting information on potential drug interactions[4]. In dentistry, AI holds the promise of reducing diagnostic and treatment costs by overcoming subjective variability, integrating curated and structured data management, and enhancing dental imaging[5]. The shift from conventional slide examination to digitally scanned whole slide images (WSI) has seen a significant impact on diagnostic pathology, with AI's pattern recognition capabilities adding value to digital pathology[6].

Considering recent reports on cancer, oral cancer stands out as a highly prevalent type, affecting 4.5 million individuals according to the WHO, with approximately 85% responsible for fatalities[7]. Early detection is crucial, with the potential to reduce the death rate by 70%. The diagnosis and grading of oral epithelial dysplasia rely on a combination of architectural changes and the appearance of specific histological features. Pathologists face challenges in this process, with its time-consuming nature and subjectivity, leading to inconsistencies due to inter and intra-observer variations[8]. This underscores the need for a computer-aided image classification system with quantitative analysis of histological features for rapid, consistent, and quantitative cancer diagnosis. Hence, we are conducting a survey among oral pathologists to explore the role of artificial intelligence in addressing these challenges.

Materials and Method:

A cross-sectional study was conducted to analyze the knowledge, attitude, and awareness toward Artificial Intelligence among the Oral Pathologists of India. A validated and structured questionnaire consisting of 15 open-ended questions organized in Google form was circulated amongst them (Table 1). A total of 224 participants with 95 faculty members,75 PG students, and 54 consultants participated in the survey. With informed consent from all participants, data was collected and analyzed. The results were calculated on a percentage basis and tabulated (Graph 1).

Table 1:

Responses of the participants to the questions related to Artificial Intelligence

Sr No.	Questions	Results
1.	Have you heard about Artificial Intelligence?	
	Yes	100%
	No	0%
2.	Are you aware of the applications of AI in day-to-day life?	
	Yes	93.8%
	No	16.3%
3.	Can AI facilitate the preservation of patient information, data, and accessibility accurately?	
	Yes	88.4%
	No	11.6%
4.	Do you think AI is used in the field of pathology for accurate reading of tissue samples and assists in diagnosis?	
	Yes	79%

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	No	21%
5.	Do you think AI could increase the accuracy of histopathological diagnosis?	
	Yes	58.9%
	No	6.3%
	Maybe	34.8%
6.	Do you think AI applications will be useful to differentiate benign and malignant lesions?	
	Yes	49.1%
	No	1.8%
	Maybe	49.1%
7.	Can AI be used for IHC analysis?	
	Yes	89.7%
	No	10.3%
8.	Do you think AI can be used in the early detection of Oral cancer?	
	Yes	92.4%
	No	7.6%
9.	Can AI help in the detection of metastasis and lymph node examination?	
	Yes	50.4%
	No	5.8%
	Maybe	43.8%
10.	Can AI guide strategy for treatment and better outcomes of disease?	
	Yes	56.7%
	No	3.1%
	Maybe	40.2%
11.	Can AI predict survival outcomes based on WSI findings alone?	
	Yes	37.5%
	No	17.4%
	Maybe	45.1%
12.	Do you think AI can be used as a diagnostic tool to facilitate improvements in workflow efficiency?	
	Yes	95.5%
	No	4.5%

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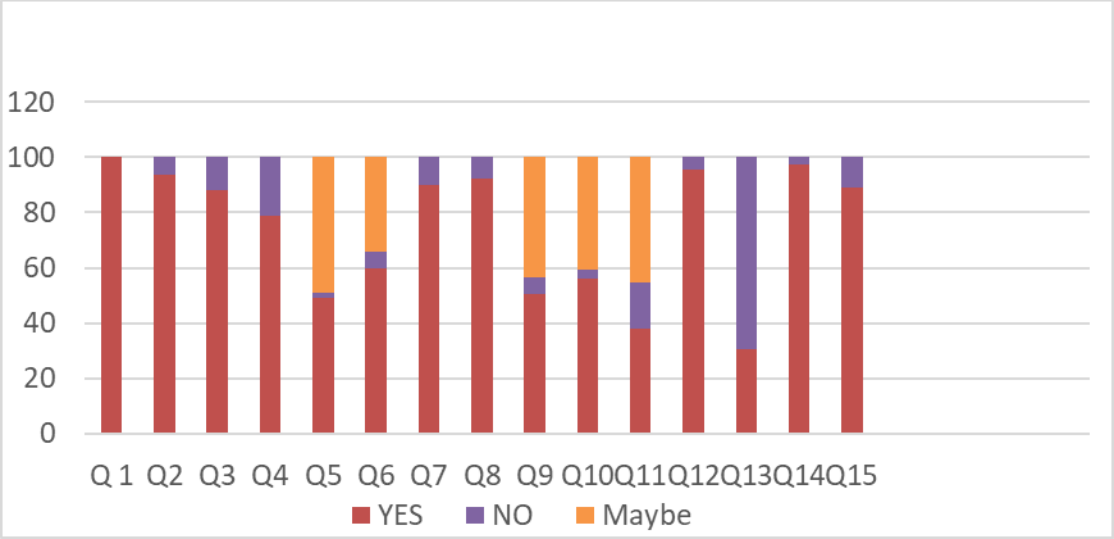
13.	Have you had any opportunity to try AI as a diagnostic tool at any point in your practice?	
	Yes	31.3%
	No	68.8%
14.	Do you think oral pathologists should be equipped/trained with technical knowledge regarding AI?	
	Yes	97.3%
	No	2.7%
15.	Do you expect AI to be integrated into routine diagnostic pathology in India in the near future?	
	Yes	88.4%
	No	11.6%

Graph 1: Questionnaire survey Analysis by Oral Pathologists



Results:

In this study, a total of 224 participants, comprising 95 faculty members, 75 PG students, and 54 consultants, took part in the survey (refer to Table 2). All oral pathologists were familiar with Artificial Intelligence, with 93.8% being aware of its applications in day-to-day life. Approximately 88.4% agreed that AI could facilitate the accurate preservation of patient information, data, and accessibility.

A total of 79% of Oral Pathologists (OPs) agreed that AI could be instrumental in the field of pathology, specifically for the accurate reading of tissue samples and assistance in diagnosis. Around 49.1% of OPs concurred that AI applications would be valuable in differentiating benign and malignant lesions (refer to Graph 3).

Additionally, 58.9% of OPs agreed that AI could enhance the accuracy of histopathological diagnosis, and a substantial 89.7% were aware that AI could be used for IHC analysis (refer to Graph 4). Furthermore, 50.4% of OPs agreed that AI could aid in the detection of metastasis and lymph node examination (refer to Graph 5). Moreover, 56.7% of OPs concurred that AI could guide treatment strategies for better disease outcomes. About 37.5% of respondents agreed that AI

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could predict survival outcomes based solely on Whole Slide Image (WSI) findings.

An overwhelming majority, 95.5% of OPs, acknowledged that AI could serve as a diagnostic tool, facilitating improvements in workflow efficiency. However, only 31.3% of OPs had the opportunity to try AI as a diagnostic tool in their practice. Furthermore, 97.3% agreed that oral pathologists should be equipped and trained with technical knowledge regarding AI (refer to Graph 6).

Lastly, 88.4% of OPs expressed an expectation that AI would be integrated into routine diagnostic pathology in India in the near future. In summary, 69.8% had adequate knowledge, 96.8% were aware of the role of Artificial Intelligence in Oral Pathology, and 93.1% had a positive attitude towards the incorporation of Artificial Intelligence in Oral Pathology (refer to Graph 2).

Table 2: Demographic characteristics of study participants:

Characteristics	**Frequency (%)**
1. Qualification	
Faculty	42.4%
PG student	33.5%
Consultant	24.1%
2. Years of experience	
1-5yrs	56.3%
6-10yrs	6.3%
11-15yrs	15.6%
>20yrs	21.9%

Statistical Analysis:

The collected data were entered into a Microsoft Office Excel spreadsheet (Office 2013, Microsoft Corp., Redmond, USA) and analyzed using the Statistical Package for Social Sciences (SPSS) trial version. Descriptive statistics were employed to summarize the samples and participants' responses. The questionnaire was validated following all necessary guidelines.

In the present study, the analysis revealed that 69.8% of participants possessed adequate knowledge, 96.8% demonstrated awareness, and 93.1% expressed a positive attitude towards the incorporation of Artificial Intelligence in oral pathology (refer to Graph 2).

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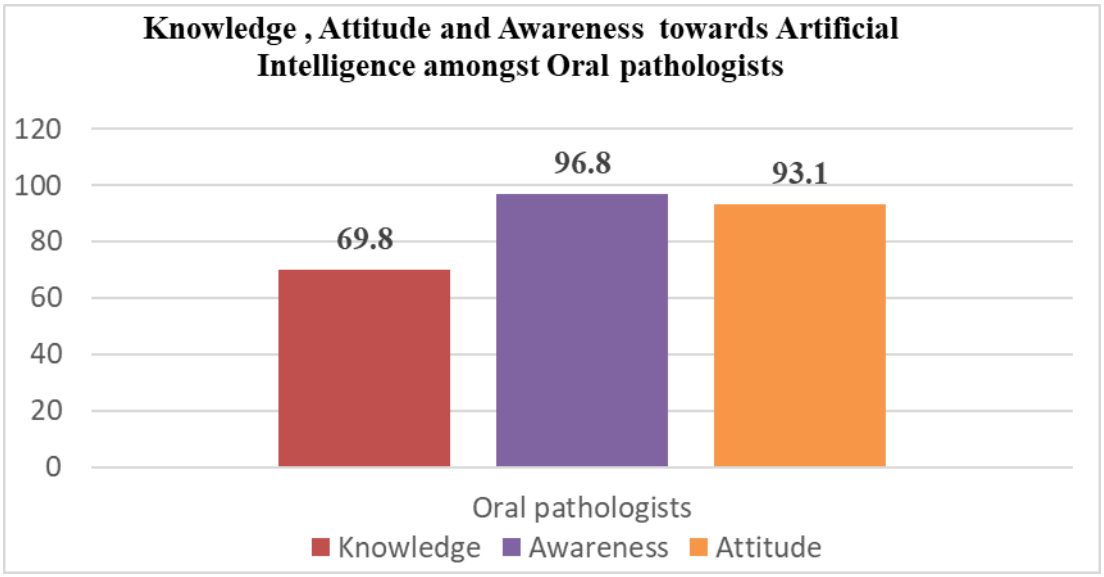
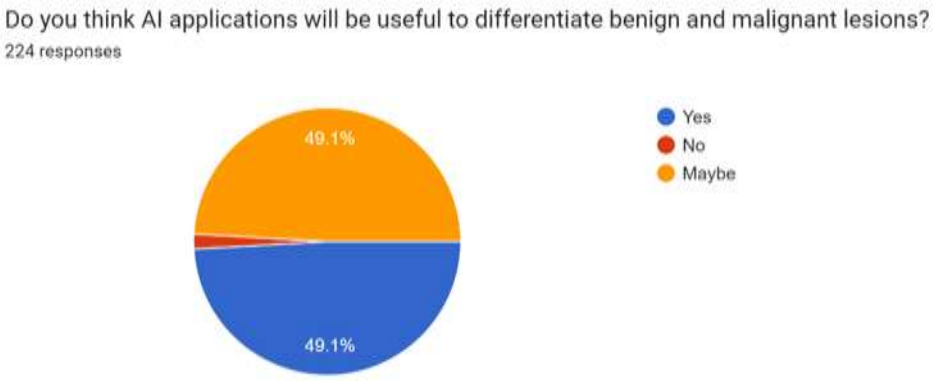
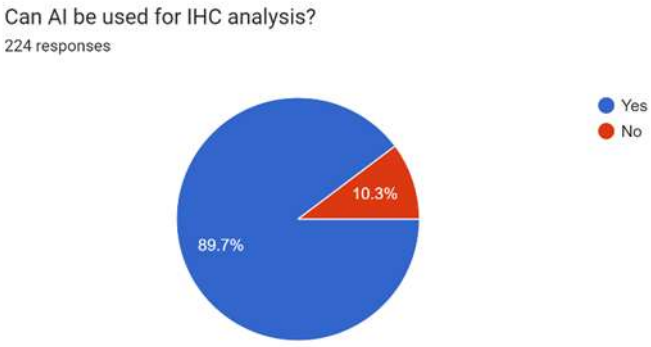
Graph 2: Knowledge and Awareness regarding Artificial Intelligence in Oral Pathology



Graph 3: Artificial Intelligence will be useful to differentiate benign and malignant lesions



Graph 4: Artificial Intelligence can be used in IHC analysis



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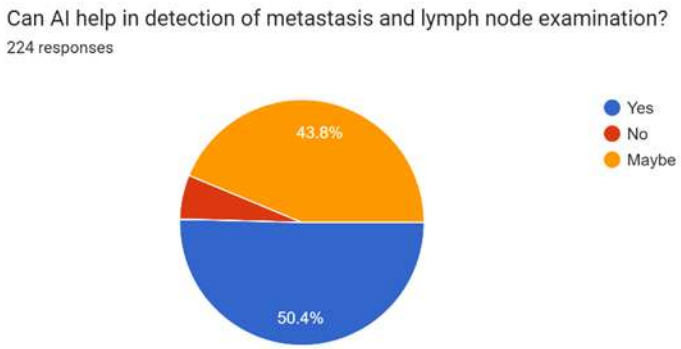
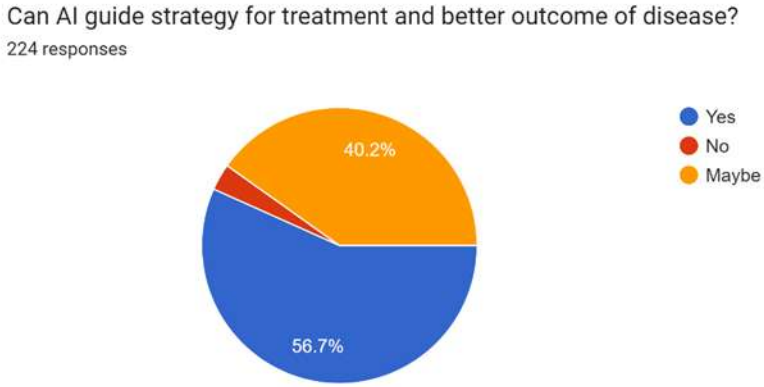
Graph 5: Artificial Intelligence can help in detection of metastasis and lymph node examination



Graph 6: Artificial Intelligence can guide for treatment and better outcome of disease



Discussion: **Unlocking the Potential of Artificial Intelligence in Oral Pathology**

Artificial intelligence (AI) has traversed a remarkable journey since its inception in the 1950s, evolving into a specialized field of computer science that tackles intricate problems beyond the reach of traditional computing[9]. With its roots in knowledge and probability, AI has become a key player in scientific research, demonstrating promise in solving complex issues, especially in areas abundant with data but lacking theoretical frameworks. The current discourse highlights the growing interest in applying AI techniques to biomedical engineering and informatics, spanning from knowledge-based reasoning for disease classification to the discovery of novel biomedical knowledge for disease treatment[1].

The emergence of AI marks an impending "third revolution," knocking firmly at the door of pathology, ushering in both opportunities and challenges. Representing advanced machine technologies, AI can extract meaning and understanding from vast data inputs, mimicking human capabilities such as image perception[9]. In pathology, this manifests primarily in the automated interpretation of pathological images, propelled by computer algorithms and the recent revolution in "deep learning" methods.

AI algorithms are enabling precise and automated identification of tissue patterns, traditionally the exclusive domain of pathologists and the human visual cortex[10]. This goes beyond quantitative analysis of Immunohistochemistry (IHC) using image analysis, extending to the automated analysis of complex Haematoxylin and Eosin (H&E) tissue patterns—the core of pathologists' interpretations and where significant diagnostic challenges exist. Notable opportunities arise for enhancing diagnostic practices,

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encompassing distinctions between benign and tumor tissues, grading dysplasia, determining invasion extent, identifying micro metastases, IHC/ISH scoring, evaluating tumor content, extracting new patterns, and streamlining pathology workflow[11].

The field of dentistry has embraced AI, leveraging its effectiveness in diagnosing, treatment planning, predicting prognosis, and data management. Studies across various dental branches and forensic odontology have yielded promising results. The application of AI has delved into newer depths of cellular and molecular investigation, revolutionizing the field of Histopathology (HP). A comprehensive understanding, a positive attitude, and extensive practice of AI breakthroughs are crucial for Oral Pathologists (OPs).

The cross-sectional survey conducted aimed to assess the knowledge, attitude, and awareness of OPs in India regarding the integration of AI in diagnostic HP. In this study, 69.8% of OPs demonstrated a robust knowledge and understanding of AI applications. This contrasts with a study by Indu et al., where only 8.8% of OPs exhibited a similar understanding[12]. Additionally, 37% of OPs in our study were aware that AI algorithms could be effectively applied with Whole Slide Image (WSI) findings alone, aligning with 62% in the study by Indu et al.

The OPs' attitude towards diagnostic accuracy and proficiency was encouraging. In our study, 49.1% agreed that AI could be useful in differentiating benign and malignant lesions, whereas 63.7% held this belief in the study by Indu et al. Furthermore, 89.7% agreed that AI could be used in Immunohistochemistry (IHC) analysis, aligning with 70.8% in Indu et al. A survey by Sarwar et al. showed that 75% believed AI could facilitate improvements in workflow efficiency, while in our study, an overwhelming 95.5% of OPs concurred[3]. It was also noted that as the age and experience of OPs increased, knowledge regarding AI in pathology increased.

However, there was a mixed response regarding the timescale for implementing AI in conventional Histopathology (HP) across India. In our study, 93.1% of OPs expected AI to be integrated into Oral Pathology practice in India in the near future, while 43.9% anticipated integration into histopathological practice over the next ten years. Few participants were anxious that the incorporation of AI would have a negative impact on the residents' HP training and traditional diagnostic skills. Sarwar et al. reported that around 80% of respondents predicted the introduction of AI technology in pathology laboratories within the coming decade[3].

A slight gap in knowledge and a lack of facilities create hurdles in embracing this new technology in the diagnostic field. The application of AI in medicine, particularly in HP, is an inevitable change in the near future. While OPs are aware of AI and its applications, there are lacunae that need addressing. Despite a collective appreciation for tuning towards AI, OPs across the country do not believe AI will replace them in the foreseeable future. The future of AI in Oral Pathology promises transformative advancements, with OPs standing at the forefront of integrating these technologies into their diagnostic practices.

Conclusion:

AI is making strides in day-to-day life but is yet to be fully integrated in India. OPs in India express a positive attitude toward incorporating AI into their pathology practice. Therefore, it is crucial to equip Oral Pathologists with new modules on AI, preparing them for the upcoming era of diagnostic pathology.

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