NVEO
Natural Volatiles &
Essential Oils

Hierarchy Analysis Of Artificial Intelligence In Oral Cancer

Kiran K[1], Rajmohan M[2], Prashanthy M R[3], Prabu D[4], Bharathwaj V V[5], Sindhu R[5], Dinesh Dhamodhar[2], Shreelakshmi S[5]

[1]*Under Graduate Student, SRM Dental College and Hospital, Ramapuram, Chennai, India.*
[2]*Master of Dental Surgery, Reader , Department of Public Health Dentistry, SRM Dental College and Hospital, Ramapuram, Chennai, India*
[3]*Post Graduate Student, Senior lecturer, Department of Public Health Dentistry, SRM Dental College and Hospital, Ramapuram, Chennai, India*
[4]*Master of Dental Surgery, Professor and Head, Department of Public Health Dentistry, SRM Dental College and Hospital, Ramapuram, Chennai, India*
[5]*Master of Dental Surgery, Senior Lecturer, Department of Public Health Dentistry, SRM Dental College and Hospital, Ramapuram, Chennai, India*

ABSTRACT

AIM

The study aims to appraise the role of artificial intelligence in the diagnosis and management of oral cancer by assessing several articles from various electronic databases.

METHODOLOGY

The study has assimilated data on articles published around the globe from different databases like Google Scholar, Cochrane, Web of Science, Grey Literature and PubMed on the aspect of Artificial Intelligence in oral cancer. The articles matching the keywords and with an abstract was taken into consideration. Keywords such as oral cancer, artificial intelligence, machine learning, oral squamous cell carcinoma, premalignant lesions were used. Tabulations were made based on the criteria such as the number of authors, ranking based on citations, outcomes of the research.

RESULT

The citations of the articles range from 46-0. Most of these articles were based on the field of treatment and were conducted mostly between the years 2010-2020 with a maximum number of articles being joint authorship articles.

CONCLUSION

The establishment of a better life for an oral cancer patients is well within reach if we are ready to device a resourceful approach in implementing A. I and its subsets in the field of oral cancer. A. I can contribute immensely to the diagnostic and prognostic results of oral cancer patients. The development in the adaptation of Artificial Intelligence in oral cancer is of utmost value as it can improve the living standards.

KEYWORDS

Oral cancer, Oral squamous cell carcinoma, Artificial Intelligence, Machine learning, Malignant lesions, premalignant lesions

INTRODUCTION

Artificial intelligence (AI) is a branch of computer science concerned with smart machines capable of performing tasks that typically require human intelligence. AI is an interdisciplinary science with multiple approaches, but advancements in machine learning and deep learning are creating a paradigm shift in virtually every sector of the tech industry. (1) Artificial Intelligence or Artificial neural network is used these days very extensively in all sectors of the economy. It is globally used to aid health care through various mechanical and statistical means. A.I in health care systems is one of the significant advances the health care industry has seen in some decades.

Artificial intelligence is also significantly effective in the field of cancers.[2]It has been widely investigated by scientists and doctors from the early 19th century. Here we are mainly focusing on the aid of A. I in oral cancers. Artificial Intelligence has been useful and valuable in dentistry for various ways. The multiple methods of Artificial Intelligence which are being functional in dentistry include artificial neural networks (ANN), genetic algorithms (G.A.), and fuzzy logic. (2) All these focus mainly on the implementation of Artificial Intelligence in all fields of dentistry. In the case of oral cancers, such neural networks can be beneficial in early identification and diagnosis on various types of oral cancer such as oral squamous cell carcinoma, leukoplakia, and other malignant and premalignant conditions. The neural network is of great value for the identification of individuals with a high risk of oral cancer or precancerous lesions. (3) Although these Artificial intelligence algorithms were initially developed for non-medical applications such as product labelling and credit card fraud detection, many of these new technologies were quickly adopted to solve head and neck treatment, planning problems such as intensity-modulated radiotherapy (IMRT) dose prediction, automated treatment planning, clinical decision support, outcome modelling, and auto segmentation for head and neck cancer patients. (4)

Oral cancer can be due to multiple etiological factors and is most often rarely diagnosed in its early stages. It can be due to many reasons, including the presence of numerous contributing factors. The potential to overcome this difficulty in diagnosis is well within the hands of Artificial Intelligence, providing useful statistical analysis and machine learning.

The implementation of Artificial Intelligence doesn't end with diagnosis. Even if there is a delay in diagnosis, the treatment modalities can be widely improved with the help of these neural networks. The ability of current staff to cope with the growing workload as well as to innovate and benefit from modern technology is limited by access to sufficient human resources[5]. Humans working together with machine learning will shorten the time needed to train staff as the algorithm can learn as well as train staff. It is best demonstrated by the rapid developments of modern chess players in rapidly learning hundreds of years of chess developments in a matter of months by repetitively training against the best computer A.I. programs[6-7].

The study here is to evaluate the importance of implementing machine learning, neural networks, deep learning, and data mining, all being the detachment of artificial intelligence in oral cancer management. When trained ANNs were tested and compared with the diagnosis of a surgeon, the results revealed high sensitivity and specificity of ANN, thereby insisting on the importance of A.I. in achieving correct interpretations and reducing human errors. (8) Thus the human resources must be pointed more towards the direction of researches and development of these neural diagnosis systems. Even though the use of Artificial Intelligence technology is now beginning to catch up, there are several disadvantages to it as well. Advantages of Artificial Intelligence are accuracy in diagnosis, standardization of procedures, and saves time. Disadvantages of Artificial Intelligence are the complexity of the mechanism and the cost involved in the setup (9).

Nevertheless, no price can be placed upon a human life which is why the introduction of these systems into fields of utmost importance like cancer is significant. Further progressing to the role of Artificial Intelligence in treatment planning, the neural networks when optimally trained concerning lower third molars are found to have high specificity and sensitivity equivalent to specialist consultation in categorizing tooth to "gold standard" based on National Institute of Health consensus criteria (10). When it comes down to implementing ANN in clinical practice, it has sufficient precision for the design and chair side manufacturing of dental prostheses, based on digital image acquisition following tooth cusps assessment (11). ANN is found to act as a second opinion to locate the minor apical foramen, thereby enhancing the accuracy of working length determination by radiographs (12). All these various studies and results furthermore prove how intricate and precise the world of Artificial Intelligence and thus, how much it can contribute to the field of oral cancer. This study is to evaluate the implementation of Artificial Intelligence in oral cancer

METHODOLOGY

The study focuses on gathering and formulating data collected from various articles all around the world on the breakdown of artificial intelligence in oral cancer. The data was collected from several databases including PUBMED, GOOGLE SCHOLAR, WEB OF SCIENCE, GREY LITERATURE and COCHRANE LIBRARY.

Keywords such as oral cancer, oral squamous carcinoma, artificial intelligence, machine learning, malignant lesions, and premalignant lesions were used in the advanced search category in the databases as mentioned above.

The data collected constituted of articles belonging to the keywords as mentioned above. They were assessed for bibliometric analysis which includes the number of citations, journal name, no. of authors, year of publication, the outcome of the research and type of articles. The aspect of the influence of artificial intelligence in oral cancer are charted
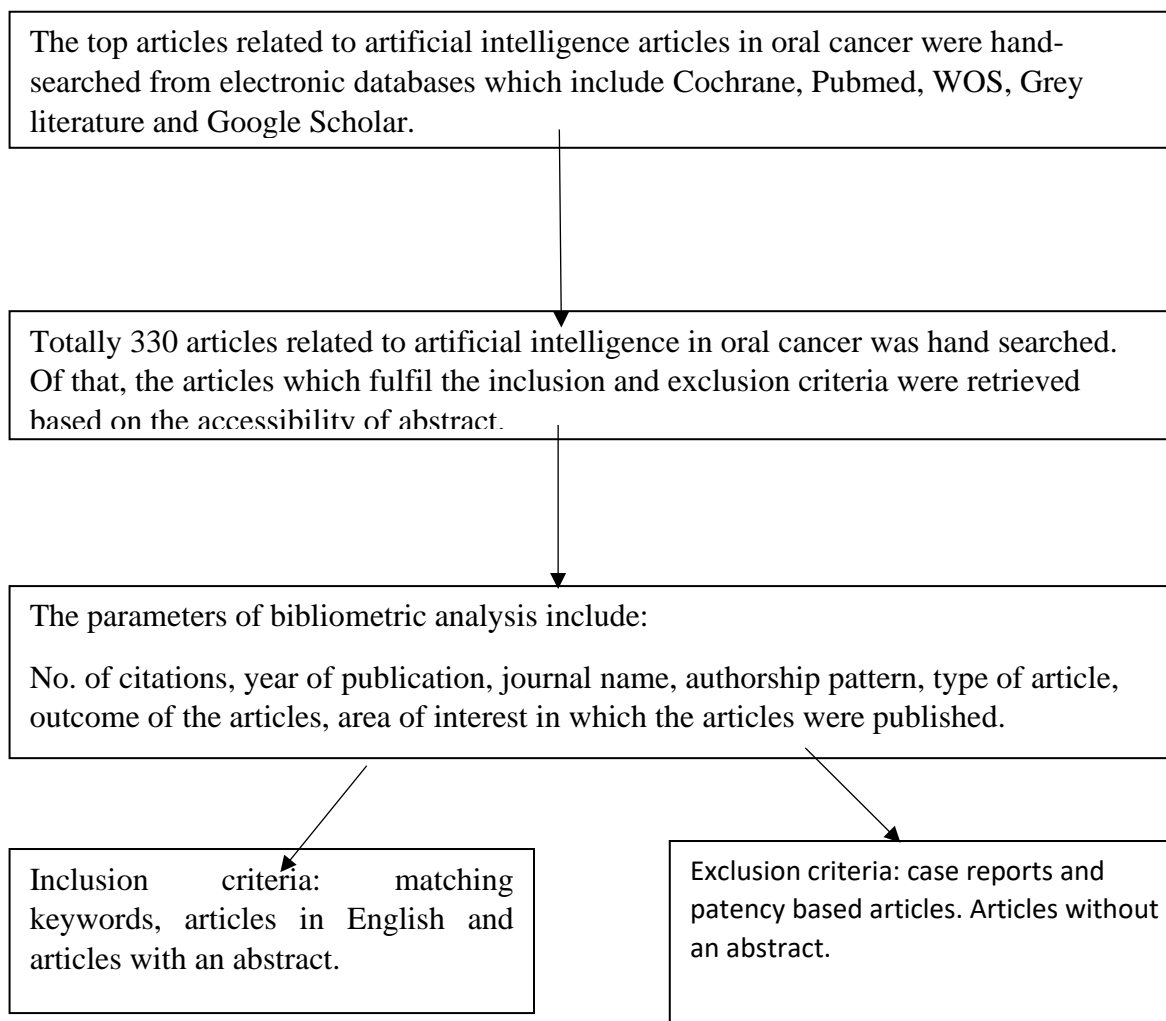
based on three essential levels of a cancer treatment protocol, screening, diagnosis and lastly but most importantly, treatment procedures.

Inclusion criteria

All articles constituting of any or all of the keywords as mentioned above with an accessible abstract were included. Articles published only in the English language were considered.

Exclusion criteria

All articles which fail to accommodate the keywords, case reports and patency related articles were excluded from the study.

The top articles related to artificial intelligence articles in oral cancer were hand-searched from electronic databases which include Cochrane, Pubmed, WOS, Grey literature and Google Scholar.

Totally 330 articles related to artificial intelligence in oral cancer was hand searched. Of that, the articles which fulfil the inclusion and exclusion criteria were retrieved based on the accessibility of abstract.

The parameters of bibliometric analysis include:

No. of citations, year of publication, journal name, authorship pattern, type of article, outcome of the articles, area of interest in which the articles were published.

Inclusion criteria: matching keywords, articles in English and articles with an abstract.

Exclusion criteria: case reports and patency based articles. Articles without an abstract.

RESULTS

TABLE 1

LIST OF ARTICLES RELATED TO ARTIFICIAL INTELLIGENCE IN ORAL CANCER

SL: NO	NAME OF THE ARTICLE	YEAR
1	Improving Oral Cancer Outcomes with Imaging and Artificial Intelligence	2020
2	Improvement of oral cancer screening quality and reach: The promise of artificial intelligence	2020
3	The NAD +-mitophagy axis in healthy longevity and in artificial intelligence-based clinical applications	2020
4	The use of artificial intelligence, machine learning and deep learning in oncologic histopathology	2020

5	Comparison of supervised machine learning classification techniques in prediction of loco regional recurrences in early oral tongue cancer	2020
6	Image processing analysis of oral cancer, oral potentially malignant disorders, and other oral diseases using optical instruments	2020
7	Use of artificial intelligence in diagnosis of head and neck precancerous and cancerous lesions: A systematic review	2020
8	Staging and grading of oral squamous cell carcinoma: An update	2020
9	Transcriptome analyses identify hub genes and potential mechanisms in adenoid cystic carcinoma	2020
10	Weighted Gene Co-Expression Network Analysis Identifies Hub Genes Associated with Occurrence and Prognosis of Oral Squamous Cell Carcinoma	2019
11	Screening and bioinformatics analysis of mRNA, long non-coding RNA and circular RNA expression profiles in mucoepidermoid carcinoma of salivary gland	2019
12	Contrast-enhanced computed tomography image assessment of cervical lymph node metastasis in patients with oral cancer by using a deep learning system of artificial intelligence	2019
13	Machine learning application for prediction of loco regional recurrences in early oral tongue cancer: a Web-based prognostic tool	2019
14	Identification for Exploring Underlying Pathogenesis and Therapy Strategy of Oral Squamous Cell Carcinoma by Bioinformatics Analysis	2019
15	Computer-assisted medical image classification for early diagnosis of oral cancer employing deep learning algorithm	2019
16	Texture-Map-Based Branch-Collaborative Network for Oral Cancer Detection	2019
17	Fog Computing Employed Computer Aided Cancer Classification System Using Deep Neural Network in Internet of Things Based Healthcare System	2019
18	FTIR-based spectrum of salivary exosomes coupled with computational-aided discriminating analysis in the diagnosis of oral cancer	2019
19	A smart tele-cytology point-of-care platform for oral cancer screening	2019
20	Machine learning to predict occult nodal metastasis in early oral squamous cell carcinoma	2019
21	Future Prospective of Light-Based Detection System for Oral Cancer and Oral Potentially Malignant Disorders by Artificial Intelligence Using Convolutional Neural Networks	2019
22	Predicting cancer outcome: Artificial intelligence vs. pathologists	2019
23	Integrated analyses utilizing metabolomics and transcriptomics reveal perturbation of the polyamine pathway in oral cavity squamous cell carcinoma	2019
24	Integrated analysis of lncRNA-miRNA-mRNA ceRNA network in squamous cell carcinoma of tongue	2019
25	Machine learning and its potential applications to the genomic study of head and neck cancer-A systematic review	2019
26	Inferring novel genes related to oral cancer with a network embedding method and one-class learning algorithms	2019

27	Point-of-care, smartphone-based, dual-modality, dual-view, oral cancer screening device with neural network classification for low-resource communities	2018
28	The application of artificial intelligence in the IMRT planning process for head and neck cancer	2018
29	Enhanced Computational Model for Gravitational Search Optimized Echo State Neural Networks Based Oral Cancer Detection	2018
30	Automatic identification of clinically relevant regions from oral tissue histological images for oral squamous cell carcinoma diagnosis	2018
31	Toward complete oral cavity cancer resection using a handheld diffuse reflectance spectroscopy probe	2018
32	Biological information analysis of differentially expressed genes in oral squamous cell carcinoma tissues in GEO database	2018
33	Detection of cervical lymph node metastasis from oral cavity cancer using a non-radiating, noninvasive digital infrared thermal imaging system	2018
34	Automatic Classification of Cancerous Tissue in Laserendomicroscopy Images of the Oral Cavity using Deep Learning	2017
35	Risk prediction for oral potentially malignant disorders using fuzzy analysis of cytomorphological and auto fluorescence alterations in habitual smokers	2017
36	Identification of Key Genes and Pathways in Tongue Squamous Cell Carcinoma Using Bioinformatics Analysis	2017
37	Complex integrated analysis of lncRNAs-miRNAs-mRNAs in oral squamous cell carcinoma	2017
38	Pre-cancer risk assessment in habitual smokers from DIC images of oral exfoliative cells using active contour and SVM analysis	2017
39	A genetic programming approach to oral cancer prognosis	2016
40	Transoral robotic surgery for the management of head and neck squamous cell carcinoma of unknown primary	2015
41	Potential Compounds for Oral Cancer Treatment: Resveratrol, Nimbolide, Lovastatin, Bortezomib, Vorinostat, Berberine, Pterostilbene, Deguelin, Andrographolide, and Colchicine	2015
42	Usage of Probabilistic and General Regression Neural Network for Early Detection and Prevention of Oral Cancer	2015
43	The application of data mining techniques to oral cancer prognosis	2015
44	A systematic approach to prioritize drug targets using machine learning, a molecular descriptor-based classification model, and high-throughput screening of plant derived molecules: a case study in oral cancer	2015
45	Functional outcomes after Transoral robotic surgery for squamous cell carcinoma of the oropharynx	2015
46	Integrated microRNA-mRNA analysis revealing the potential roles of microRNAs in tongue squamous cell cancer	2015
47	Transoral Endoscopic Head and Neck Surgery and Its Role Within the Multidisciplinary Treatment Paradigm of Oropharynx Cancer: Robotics, Lasers, and Clinical Trials	2015
48	Anatomical features of skull base and oral cavity: a pilot study to determine the accessibility of the sella by Transoral robotic-assisted surgery	2015
49	Trans-oral robotic surgery and surgeon-performed trans-oral ultrasound for intraoperative location and excision of an isolated retropharyngeal lymph node metastasis of papillary thyroid carcinoma	2015
50	Mandibular osteotomy for expanded Transoral robotic surgery: a novel technique	2014
51	A systematic review of Transoral robotic surgery and radiotherapy for early oropharynx cancer: a systematic review	2014
52	Transoral robotic surgery (TORS) for tongue base tumors	2013
53	Robotic surgery for primary head and neck squamous cell carcinoma of unknown site	2013

54	Oral cancer prognosis based on clinic pathologic and genomic markers using a hybrid of feature selection and machine learning methods	2013
55	Robotic surgery for oropharynx cancer: promise, challenges, and future directions	2012
56	Robot-assisted Supraomohyoid neck dissection via a modified face-lift or retro auricular approach in early-stage cN0 squamous cell carcinoma of the oral cavity: a comparative study with conventional technique	2012
57	Transoral robotic surgery for the management of head and neck cancer: a preliminary experience	2009

Table 1 indicates that there is an increase in the publication of articles in the late 20s and early 21st century, pointing towards development in this field of Artificial Intelligence in recent times. Furthermore, the rest of the articles dates from the years 2010-2020 and few from the late 90s

TABLE 2
PATTERNS OF AUTHORSHIP

SL:NO	NAME OF THE ARTICLE	NO OF AUTHORS
1	Contrast-enhanced computed tomography image assessment of cervical lymph node metastasis in patients with oral cancer by using a deep learning system of artificial intelligence	9
2	Improving Oral Cancer Outcomes with Imaging and Artificial Intelligence	4
3	Machine learning application for prediction of loco regional recurrences in early oral tongue cancer: a Web-based prognostic tool	11
4	The application of artificial intelligence in the IMRT planning process for head and neck cancer	5
5	FTIR-based spectrum of salivary exosomes coupled with computational-aided discriminating analysis in the diagnosis of oral cancer	5
6	A smart tele-cytology point-of-care platform for oral cancer screening	25
7	Machine learning to predict occult nodal metastasis in early oral squamous cell carcinoma	9
8	Improvement of oral cancer screening quality and reach: The promise of artificial intelligence	7
9	Future Prospective of Light-Based Detection System for Oral Cancer and Oral Potentially Malignant Disorders by Artificial Intelligence Using Convolutional Neural Networks	1
10	Predicting cancer outcome: Artificial intelligence vs. pathologists	1
11	Identification of Key Genes and Pathways in Tongue Squamous Cell Carcinoma Using Bioinformatics Analysis	4
12	The NAD +-mitophagy axis in healthy longevity and in artificial intelligence-based clinical applications	13
13	Pre-cancer risk assessment in habitual smokers from DIC images of oral exfoliative cells using active contour and SVM analysis	6
14	Enhanced Computational Model for Gravitational Search Optimized Echo State Neural Networks Based Oral Cancer Detection	2
15	Integrated analyses utilizing metabolomics and transcriptomics reveal perturbation of the polyamine pathway in oral cavity squamous cell carcinoma	10
16	Integrated analysis of lncRNA-miRNA-mRNA ceRNA network in squamous cell carcinoma of tongue	7
17	Complex integrated analysis of lncRNAs-miRNAs-mRNAs in oral squamous cell carcinoma	9
18	Artificial neural network analysis to assess hyper nasality in patients treated for oral or oropharyngeal cancer	6
19	Comparison of supervised machine learning classification techniques in prediction of loco regional recurrences in early oral tongue cancer	10

20	A genetic programming approach to oral cancer prognosis	6
21	The use of artificial intelligence, machine learning and deep learning in oncologic histopathology	5
22	The use of artificial intelligence to identify people at risk of oral cancer and precancer	5
23	Potential Compounds for Oral Cancer Treatment: Resveratrol, Nimbolide, Lovastatin, Bortezomib, Vorinostat, Berberine, Pterostilbene, Deguelin, Andrographolide, and Colchicine	3
24	Machine learning and its potential applications to the genomic study of head and neck cancer-A systematic review	9
25	Role of artificial intelligence in diagnostic oral pathology-A modern approach	4
26	Fog Computing Employed Computer Aided Cancer Classification System Using Deep Neural Network in Internet of Things Based Healthcare System	4
27	Automatic identification of clinically relevant regions from oral tissue histological images for oral squamous cell carcinoma diagnosis	6
28	Feature selection methods for optimizing clinic pathologic input variables in oral cancer prognosis	6
29	Usage of Probabilistic and General Regression Neural Network for Early Detection and Prevention of Oral Cancer	2
30	Identification for Exploring Underlying Pathogenesis and Therapy Strategy of Oral Squamous Cell Carcinoma by Bioinformatics Analysis	3
31	Computer-assisted medical image classification for early diagnosis of oral cancer employing deep learning algorithm	2
32	Texture-Map-Based Branch-Collaborative Network for Oral Cancer Detection	6
33	The application of data mining techniques to oral cancer prognosis	5
34	Oral cancer prognosis based on clinic pathologic and genomic markers using a hybrid of feature selection and machine learning methods	4
35	A systematic approach to prioritize drug targets using machine learning, a molecular descriptor-based classification model, and high-throughput screening of plant derived molecules: a case study in oral cancer	3
36	Point-of-care, smartphone-based, dual-modality, dual-view, oral cancer screening device with neural network classification for low-resource communities	13
37	Inferring novel genes related to oral cancer with a network embedding method and one-class learning algorithms	6
38	Toward complete oral cavity cancer resection using a handheld diffuse reflectance spectroscopy probe	9
39	Robotic surgery for oropharynx cancer: promise, challenges, and future directions	2
40	Functional outcomes after Transoral robotic surgery for squamous cell carcinoma of the oropharynx	5
41	Transcriptome analyses identify hub genes and potential mechanisms in adenoid cystic carcinoma	3
42	Robot-assisted Supraomohyoid neck dissection via a modified face-lift or retro auricular approach in early-stage cN0 squamous cell carcinoma of the oral cavity: a comparative study with conventional technique	7
43	Transoral robotic surgery (TORS) for tongue base tumors	5
44	Integrated microRNA-mRNA analysis revealing the potential roles of microRNAs in tongue squamous cell cancer	4
45	A systematic review of Transoral robotic surgery and radiotherapy for early oropharynx cancer: a systematic review	10

46	Trans-oral robotic surgery and surgeon-performed trans-oral ultrasound for intraoperative location and excision of an isolated retropharyngeal lymph node metastasis of papillary thyroid carcinoma	3
47	Robotic surgery for primary head and neck squamous cell carcinoma of unknown site	11
48	Transoral robotic surgery for the management of head and neck squamous cell carcinoma of unknown primary	7
49	Transoral robotic surgery for the management of head and neck cancer: a preliminary experience	3
50	[Transoral robotic surgery for head and neck tumors: a series of 17 patients]	5
51	Transoral Endoscopic Head and Neck Surgery and Its Role Within the Multidisciplinary Treatment Paradigm of Oropharynx Cancer: Robotics, Lasers, and Clinical Trials	2
52	Anatomical features of skull base and oral cavity: a pilot study to determine the accessibility of the sella by Transoral robotic-assisted surgery	8
53	Mandibular osteotomy for expanded Transoral robotic surgery: a novel technique	3
54	Image processing analysis of oral cancer, oral potentially malignant disorders, and other oral diseases using optical instruments	5
55	Use of artificial intelligence in diagnosis of head and neck precancerous and cancerous lesions: A systematic review	6
56	A surprising cross-species conservation in the genomic landscape of mouse and human oral cancer identifies a transcriptional signature predicting metastatic disease	13
57	Biological information analysis of differentially expressed genes in oral squamous cell carcinoma tissues in GEO database	3

Table 2 shows the authorship of the articles on Artificial Intelligence in oral cancer, indicating that a significant sum of the total 57 articles are by joint authors and only a handful by single authors.
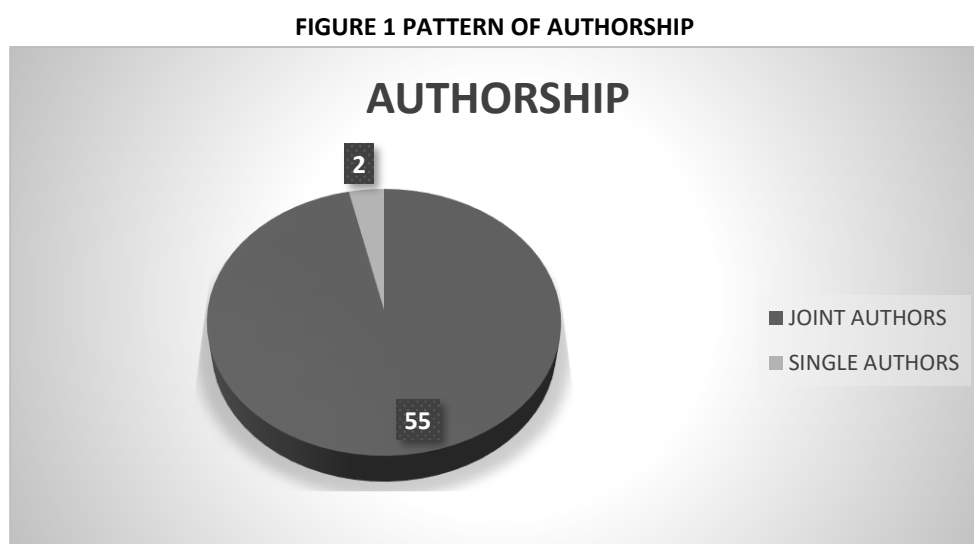
FIGURE 1 PATTERN OF AUTHORSHIP

Figure 1 shows the authorship pattern of artificial intelligence-related articles. Out of 57 articles, 55 articles were joint authors, whereas two articles were single authors.

TABLE 3 RANKING OF ARTICLES RELATED TO ARTIFICIAL INTELLIGENCE IN ORAL CANCER BASED ON THE NUMBER OF CITATIONS

SL: NO	NAME OF THE ARTICLE	NUMBER OF CITATIONS
1	Transoral robotic surgery for the management of head and neck cancer: a preliminary experience	46

2	A surprising cross-species conservation in the genomic landscape of mouse and human oral cancer identifies a transcriptional signature predicting metastatic disease	42
3	Transoral Endoscopic Head and Neck Surgery and Its Role Within the Multidisciplinary Treatment Paradigm of Oropharynx Cancer: Robotics, Lasers, and Clinical Trials	39
4	A systematic review of Transoral robotic surgery and radiotherapy for early oropharynx cancer: a systematic review	38
5	Complex integrated analysis of lncRNAs-miRNAs-mRNAs in oral squamous cell carcinoma	30
6	Robot-assisted Supraomohyoid neck dissection via a modified face-lift or retro auricular approach in early-stage cN0 squamous cell carcinoma of the oral cavity: a comparative study with conventional technique	21
7	Oral cancer prognosis based on clinic pathologic and genomic markers using a hybrid of feature selection and machine learning methods	18
8	Automatic Classification of Cancerous Tissue in Laser endomicroscopy Images of the Oral Cavity using Deep Learning	14
9	Robotic surgery for primary head and neck squamous cell carcinoma of unknown site	13
10	Transoral robotic surgery (TORS) for tongue base tumors	12
11	Identification of Key Genes and Pathways in Tongue Squamous Cell Carcinoma Using Bioinformatics Analysis	11
12	FTIR-based spectrum of salivary exosomes coupled with computational-aided discriminating analysis in the diagnosis of oral cancer	9
13	Potential Compounds for Oral Cancer Treatment: Resveratrol, Nimbolide, Lovastatin, Bortezomib, Vorinostat, Berberine, Pterostilbene, Deguelin, Andrographolide, and Colchicine	9
14	Integrated analysis of lncRNA-miRNA-mRNA ceRNA network in squamous cell carcinoma of tongue	8
15	The application of data mining techniques to oral cancer prognosis	8
16	Point-of-care, smartphone-based, dual-modality, dual-view, oral cancer screening device with neural network classification for low-resource communities	7
17	Trans-oral robotic surgery and surgeon-performed trans-oral ultrasound for intraoperative location and excision of an isolated retropharyngeal lymph node metastasis of papillary thyroid carcinoma	7
18	Transoral robotic surgery for the management of head and neck squamous cell carcinoma of unknown primary	7
19	[Transoral robotic surgery for head and neck tumors: a series of 17 patients]	7
20	Contrast-enhanced computed tomography image assessment of cervical lymph node metastasis in patients with oral cancer by using a deep learning system of artificial intelligence	6
21	Integrated microRNA-mRNA analysis revealing the potential roles of microRNAs in tongue squamous cell cancer	6
22	Robotic surgery for oropharynx cancer: promise, challenges, and future directions	5
23	The application of artificial intelligence in the IMRT planning process for head and neck cancer	3

24	Machine learning to predict occult nodal metastasis in early oral squamous cell carcinoma	3
25	Integrated analyses utilizing metabolomics and transcriptomics reveal perturbation of the polyamine pathway in oral cavity squamous cell carcinoma	3
26	Computer-assisted medical image classification for early diagnosis of oral cancer employing deep learning algorithm	3
27	A systematic approach to prioritize drug targets using machine learning, a molecular descriptor-based classification model, and high-throughput screening of plant derived molecules: a case study in oral cancer	3
28	Toward complete oral cavity cancer resection using a handheld diffuse reflectance spectroscopy probe	3
29	Biological information analysis of differentially expressed genes in oral squamous cell carcinoma tissues in GEO database	3
30	Pre-cancer risk assessment in habitual smokers from DIC images of oral exfoliative cells using active contour and SVM analysis	2
31	The use of artificial intelligence to identify people at risk of oral cancer and pre-cancer	2
32	Feature selection methods for optimizing clinic pathologic input variables in oral cancer prognosis	2
33	Usage of Probabilistic and General Regression Neural Network for Early Detection and Prevention of Oral Cancer	2
34	Functional outcomes after trans oral robotic surgery for squamous cell carcinoma of the oropharynx	2
35	Improving Oral Cancer Outcomes with Imaging and Artificial Intelligence	1
36	Machine learning application for prediction of loco regional recurrences in early oral tongue cancer: a Web-based prognostic tool	1
37	A smart tele-cytology point-of-care platform for oral cancer screening	1
38	The NAD +-mitophagy axis in healthy longevity and in artificial intelligence-based clinical applications	1
39	Artificial neural network analysis to assess hyper nasality in patients treated for oral or oropharyngeal cancer	1
40	A genetic programming approach to oral cancer prognosis	1
41	Machine learning and its potential applications to the genomic study of head and neck cancer-A systematic review	1
42	Automatic identification of clinically relevant regions from oral tissue histological images for oral squamous cell carcinoma diagnosis	1
43	Inferring novel genes related to oral cancer with a network embedding method and one-class learning algorithms	1
44	Transcriptome analyses identify hub genes and potential mechanisms in adenoid cystic carcinoma	1
45	Anatomical features of skull base and oral cavity: a pilot study to determine the accessibility of the sella by Transoral robotic-assisted surgery	1
46	Mandibular osteotomy for expanded Transoral robotic surgery: a novel technique	1
47	Detection of cervical lymph node metastasis from oral cavity cancer using a non-radiating, noninvasive digital infrared thermal imaging system	1
48	Risk prediction for oral potentially malignant disorders using fuzzy analysis of cytomorphological and auto fluorescence alterations in habitual smokers	1

49	Weighted Gene Co-Expression Network Analysis Identifies Hub Genes Associated with Occurrence and Prognosis of Oral Squamous Cell Carcinoma	1
50	Screening and bioinformatics analysis of mRNA, long non-coding RNA and circular RNA expression profiles in mucoepidermoid carcinoma of salivary gland	1
51	Improvement of oral cancer screening quality and reach: The promise of artificial intelligence	0
52	Future Prospective of Light-Based Detection System for Oral Cancer and Oral Potentially Malignant Disorders by Artificial Intelligence Using Convolutional Neural Networks	0
53	Predicting cancer outcome: Artificial intelligence vs. pathologists	0
54	Enhanced Computational Model for Gravitational Search Optimized Echo State Neural Networks Based Oral Cancer Detection	0
55	Comparison of supervised machine learning classification techniques in prediction of loco regional recurrences in early oral tongue cancer	0
56	The use of artificial intelligence, machine learning and deep learning in oncologic histopathology	0
57	Role of artificial intelligence in diagnostic oral pathology-A modern approach	0

Table 3 shows about the citation based ranking of the top articles on artificial intelligence in oral cancer. The citation of these articles ranges from 46-0.A large number of articles had less than 10 citations.

FIGURE 2 DISTRIBUTION OF ARTICLES BASED ON THE FIELD OF RESEARCH.

Figure 2 depicts the distribution of articles based on the field of medicine. It shows the highest number of articles (28) belongs to the area of diagnosis, and the lowest number of articles belong to the sector of treatment (16).

TABLE 4 MENTIONING THE OUTCOME OF STUDY

SL:NO	NAME OF THE ARTICLE	OUTCOME OF THE STUDY
1	Contrast-enhanced computed tomography image assessment of cervical lymph node metastasis in patients with oral cancer by using a deep learning system of artificial intelligence	Deep learning system valuable for diagnostic support
2	Improving Oral Cancer Outcomes with Imaging and Artificial Intelligence	Combined imaging and A.I can improve oral cancer outcomes
3	Machine learning application for prediction of loco regional recurrences in early oral tongue cancer: a Web-based prognostic tool	ANN helps in recurrence prediction of early OTSCC

4	The application of artificial intelligence in the IMRT planning process for head and neck cancer	A.I has potential applications in head and neck cancer patients receiving IMRT
5	FTIR-based spectrum of salivary exosomes coupled with computational-aided discriminating analysis in the diagnosis of oral cancer	Optimized artificial neural networks with small data sets useful in detection of malignant transformation.
6	A smart tele-cytology point-of-care platform for oral cancer screening	Establishes the applicability of tele-cytology for accurate, remote diagnosis and use of automated ANN-based analysis in improving its efficacy.
7	Machine learning to predict occult nodal metastasis in early oral squamous cell carcinoma	Machine learning improves prediction of pathologic nodal metastasis in patients with clinical T1-2N0 OCSCC compared to methods based on DOI
8	Improvement of oral cancer screening quality and reach: The promise of artificial intelligence	Potential effect on improving mortality and unequal access to health care around the world.
9	Identification of Key Genes and Pathways in Tongue Squamous Cell Carcinoma Using Bioinformatics Analysis	deepen our understanding of the molecular mechanisms of carcinogenesis and development of the disease
10	The NAD +-mitophagy axis in healthy longevity and in artificial intelligence-based clinical applications	Advances in our understanding of the molecular and cellular roles of NAD+ in mitophagy will lead to novel approaches
11	Pre-cancer risk assessment in habitual smokers from DIC images of oral exfoliative cells using active contour and SVM analysis	Accuracy of the developed SVM based classification has been found to be 86% with 80% sensitivity and 89% specificity in classifying the features from the volunteers having smoking habit.
12	Enhanced Computational Model for Gravitational Search Optimized Echo State Neural Networks Based Oral Cancer Detection	The excellence of the oral cancer detection system is evaluated using simulation results.
13	Integrated analyses utilizing metabolomics and transcriptomics reveal perturbation of the polyamine pathway in oral cavity squamous cell carcinoma	Potential metabolic biomarkers and therapeutic targets for use in the treatment of OSCC.
14	Integrated analysis of lncRNA-miRNA-mRNA ceRNA network in squamous cell carcinoma of tongue	A new lncRNA-associated ceRNA that could help in the diagnosis and treatment of SCCT.
15	Complex integrated analysis of lncRNAs-miRNAs-mRNAs in oral squamous cell carcinoma	Findings uncover the pathogenesis of OSCC and might provide potential therapeutic targets.
16	Artificial neural network analysis to assess hyper nasality in patients treated for oral or oropharyngeal cancer	Nasalance distinguished significantly between patients and controls
17	Comparison of supervised machine learning classification techniques in prediction of loco regional recurrences in early oral tongue cancer	The application of boosted decision tree machine learning algorithm can stratify OTSCC patients and thus aid in their individual treatment planning.
18	A genetic programming approach to oral cancer prognosis	we found that the G.P. outperformed the SVM and L.R. in oral cancer prognosis.

19	The use of artificial intelligence, machine learning and deep learning in oncologic histopathology	machine learning methods on OSCC digital histopathologic images is very valuable.
20	The use of artificial intelligence to identify people at risk of oral cancer and precancer	neural network may be of value for the identification of individuals with a high risk of oral cancer or precancer for further clinical examination or health education.
21	Potential Compounds for Oral Cancer Treatment: Resveratrol, Nimbolide, Lovastatin, Bortezomib, Vorinostat, Berberine, Pterostilbene, Deguelin, Andrographolide, and Colchicine	Some of the potential therapeutic compounds identified in the current study are resveratrol, Nimbolide, lovastatin, Bortezomib, Vorinostat, Berberine, Pterostilbene, Deguelin, Andrographolide, and colchicine
22	Machine learning and its potential applications to the genomic study of head and neck cancer-A systematic review	Our findings showed that ML techniques for the analysis of genomic data can play a role in the prognostic prediction of HNC.
23	Role of artificial intelligence in diagnostic oral pathology-A modern approach	A.I can detect cancer with more accuracy than humans.
24	Fog Computing Employed Computer Aided Cancer Classification System Using Deep Neural Network in Internet of Things Based Healthcare System	The developed system can be used in IoT based diagnosis in health care systems, where accuracy and real time diagnosis are essential.
25	Automatic identification of clinically relevant regions from oral tissue histological images for oral squamous cell carcinoma diagnosis	The proposed texture-based random forest classifier has achieved 96.88% detection accuracy for detection of keratin pearls.
26	Feature selection methods for optimizing clinic pathologic input variables in oral cancer prognosis	Reduced models with feature selection method are able to produce more accurate prognosis results than the full-input model and single-input model.
27	Usage of Probabilistic and General Regression Neural Network for Early Detection and Prevention of Oral Cancer	The classification accuracy of PNN/GRNN model is 80% and hence is better for early detection and prevention of the oral cancer.
28	Identification for Exploring Underlying Pathogenesis and Therapy Strategy of Oral Squamous Cell Carcinoma by Bioinformatics Analysis	Integrated bioinformatics analysis might provide valuable information for exploring potential new molecular biomarkers and therapeutic targets for OSCC.
29	Computer-assisted medical image classification for early diagnosis of oral cancer employing deep learning algorithm	quality of diagnosis is increased by proposed regression-based partitioned CNN learning algorithm
30	Texture-Map-Based Branch-Collaborative Network for Oral Cancer Detection	The average sensitivity and specificity of detection are up to 0.9687 and 0.7129, respectively based on wavelet transform.
31	The application of data mining techniques to oral cancer prognosis	decision tree and artificial neural network models showed superiority to the traditional statistical model
32	Oral cancer prognosis based on clinic pathologic and genomic markers using a hybrid of feature selection and machine learning methods	The results revealed that the prognosis is superior with the presence of both clinic pathologic and genomic markers.

33	A systematic approach to prioritize drug targets using machine learning, a molecular descriptor-based classification model, and high-throughput screening of plant derived molecules: a case study in oral cancer	The small molecules identified in this study can be ideal candidates for trials as potential novel anti-oral cancer agents.
34	Point-of-care, smartphone-based, dual-modality, dual-view, oral cancer screening device with neural network classification for low-resource communities	a convolutional neural network (CNN) were able to classify 170 image pairs into 'suspicious' and 'not suspicious' with sensitivities, specificities, positive predictive values, and negative predictive values ranging from 81.25% to 94.94%.
35	Inferring novel genes related to oral cancer with a network embedding method and one-class learning algorithms	The inferred genes were also different from previous reported genes and some of them have been included in the public Oral Cancer Gene Database.
36	Toward complete oral cavity cancer resection using a handheld diffuse reflectance spectroscopy probe	Accurate validation methods are warranted for larger sampling depths to allow for guidance during oral cavity cancer excision.
37	Robotic surgery for oropharynx cancer: promise, challenges, and future directions	The complex management of oropharyngeal cancers should utilize the available treatment modalities to optimize outcomes and stratify patients to different treatment based on risk status.
38	Functional outcomes after transoral robotic surgery for squamous cell carcinoma of the oropharynx	TORS is feasible and safe as well as oncologically and functionally efficacious.
39	Transcriptome analyses identify hub genes and potential mechanisms in adenoid cystic carcinoma	This study indicated that identified DEGs and hub genes might promote our understanding of molecular mechanisms, which might be used as molecular targets or diagnostic biomarkers for ACC.
40	Robot-assisted Supraomohyoid neck dissection via a modified face-lift or retroauricular approach in early-stage cN0 squamous cell carcinoma of the oral cavity: a comparative study with conventional technique	obot-assisted SOND via a modified face-lift or retroauricular approach in cN0 oral cavity SCC was feasible compared to conventional technique and showed a clear cosmetic benefit.
41	Transoral robotic surgery (TORS) for tongue base tumours	ORS can represent the definitive treatment in selected T1-T2 cases of base of the tongue tumours without adverse features and allow the possibility for the deintensification of adjuvant treatments.
42	Integrated microRNA-mRNA analysis revealing the potential roles of microRNAs in tongue squamous cell cancer	In the present study, a novel differential miRNA-mRNA expression network was constructed, and further investigation may provide novel targets for the diagnosis of TSCC.
43	A systematic review of transoral robotic surgery and radiotherapy for early oropharynx cancer: a systematic review	This review suggests that survival estimates are similar between the two modalities and that the differences lie in adverse events.
44	Trans-oral robotic surgery and surgeon-performed trans-oral ultrasound for	Retropharyngeal metastases are a known location for regional spread of WDTC and are

	intraoperative location and excision of an isolated retropharyngeal lymph node metastasis of papillary thyroid carcinoma	amenable to evaluation and biopsy using TO-US by both surgical and non-surgical providers.
45	Robotic surgery for primary head and neck squamous cell carcinoma of unknown site	demonstrate that TORS is a useful approach to identify and treat the primary site in patients with HNSCC who present with an unknown primary site.
46	Transoral robotic surgery for the management of head and neck squamous cell carcinoma of unknown primary	The primary tumour was identified by TORS in seven of the 13 patients (54%) at the lingual tonsils. Human papillomavirus DNA and p16 were positive in all identified primary tumour specimens and in the corresponding lymph node metastases.
47	Transoral robotic surgery for the management of head and neck cancer: a preliminary experience	TORS is a safe, feasible, and minimally invasive alternative to classic open surgery or endoscopic transoral laser surgery in patients with early cancer of the head and neck. With increasing experience, surgical setup as well as operative time will continue to decrease.
48	[Transoral robotic surgery for head and neck tumors: a series of 17 patients]	Tumors of the tongue base and oropharynx could be easily visualized with help of the da Vinci-system. The resection of supraglottic tumors can be challenging, due to the arrangement of the robotic-arms and the narrow anatomic conditions. Despite its high costs, the da Vinci-system is a potentially interesting supplementation to existing surgical techniques.
49	Transoral Endoscopic Head and Neck Surgery and Its Role Within the Multidisciplinary Treatment Paradigm of Oropharynx Cancer: Robotics, Lasers, and Clinical Trials	we review the fundamentals of transoral endoscopic head and neck surgery, with robotics and laser technology, and discuss ongoing clinical trials for patients with OPC.
50	Anatomical features of skull base and oral cavity: a pilot study to determine the accessibility of the sella by transoral robotic-assisted surgery	From these anatomical features and previous cadaveric dissections, we assume that TORS may be feasible on a majority of patients to remove pituitary adenomas.
51	Mandibular osteotomy for expanded transoral robotic surgery: a novel technique	Mandibular osteotomies increase exposure to oral cavity and oropharyngeal lesions in the setting of TORS.
52	Image processing analysis of oral cancer, oral potentially malignant disorders, and other oral diseases using optical instruments	Fluorescence visualization with subjective and objective evaluation using optical instruments is useful for oral cancer screening.
53	Use of artificial intelligence in diagnosis of head and neck precancerous and cancerous lesions: A systematic review	highlights the need for development of state-of-the-art deep learning techniques in future head and neck research.
54	A surprising cross-species conservation in the genomic landscape of mouse and human oral cancer identifies a transcriptional signature predicting metastatic disease	demonstrate surprising cross-species genomic conservation that has translational relevance for human oral squamous cell cancer.

55	Biological information analysis of differentially expressed genes in oral squamous cell carcinoma tissues in GEO database	This study was helpful to further study the relationship between OSCC gene directions.
56	Automatic Classification of Cancerous Tissue in Laserendomicroscopy Images of the Oral Cavity using Deep Learning	The present approach is found to outperform the state of the art in CLE image recognition with an area under the curve (AUC) of 0.96 and a mean accuracy of 88.3%
57	Detection of cervical lymph node metastasis from oral cavity cancer using a non-radiating, noninvasive digital infrared thermal imaging system	The EGSVM-based infrared thermal imaging system is a promising non-radiating, noninvasive tool for the detection of lymph node metastasis from oral cavity cancer.

Table 4 shows the outcome of artificial intelligence articles in the field of oral cancer. Most of these articles were focused on the treatment of oral cancer, and the result of these articles shows that clinical screening and diagnosis are very efficient and effective by using artificial intelligence in oral cancer.

DISCUSSION

This article was aimed at providing the right direction for the human resources available to contribute more towards the area of artificial intelligence and its application in the field of oral cancer. Artificial Intelligence is a field of research since its adaptation with cancer developments can contribute towards excellent diagnosis and prognosis in the years to come. The study reported the work of collecting and tabulating different articles on the role of artificial intelligence in oral cancer made by several authors and tabulated them based on the number of authors, ranking based on citations, type of the research and the outcomes of the study.

The study described the number of articles, year of publication and name of the scientific papers related to artificial intelligence in oral cancer. There were a total number of 63 articles that match the inclusion criteria. Among these, most of the articles were published between the years 2010-2020. There were only a few articles from the late 90s, and most of them belonged to the late 20th and early 21st century. It shows a trend in the field of Artificial Intelligence in oral cancer. The pattern of authorship of all the articles which were published by joint authors with more than ten authors. Out of the total number of 57 articles, only two articles were by single authors, and 55 articles were by joint authors.

The authorship distribution pattern which also confirmed that earlier establishment by indicating that 97% of the articles were by joint authors whereas only a mere 3% is by single authors. The study reported that the ranking of all the articles in the list based on the number of citations. These articles were ranked based on the number of citations which ranges from 46-0. Among these top-cited articles, the article with the title "Transoral robotic surgery for the management of head and neck cancer: a preliminary experience" published in the year 2009 by three authors had the most number of citations because the article was based on robotic surgery Now a days, scientific technology was emerging in robotic procedures and it was planned to implement in most of the hospitals. The articles were grouped under screening, diagnosis and treatment by understanding their outcomes. There were 28 articles based on treatment which was the highest followed by 19 articles based on screening and then finally a count of 16 articles in the field of diagnosis. Ramesh et al., 2004 reported that the importance and necessity of artificial intelligence in the field of medicine in general. (13) Stamey et al. developed a neural network derived classification algorithm called ProstAsure Index, which can classify prostates as benign or malignant. This model which was subsequently validated in prospective studies had a diagnostic accuracy of 90%, with a sensitivity of 81% and specificity of 92%. (14) The study showed the outcome of artificial intelligence articles in the field of oral cancer. Most of these articles were focused on the treatment of oral cancer, and the result of these articles shows that clinical screening and diagnosis are very efficient and effective by using artificial intelligence in oral cancer. The application of A.I. technology in the field of surgery was first successively investigated by Gunn in 1976 when he explored the possibility of diagnosing acute abdominal pain with computer analysis. (15)The outcome of these articles shows that artificial intelligence was instrumental in making a correct clinical decision by analysing the exact disease and helps dental professionals to treat patients appropriately. It was not only useful for the dental professionals but also to the public by providing the self-assessment of their oral health which helps to prevent and reduce the progression of the disease at an earlier stage.

The ever-growing need for faster health care services, including early diagnosis and quicker treatment protocols, are visible in the past few decades. This need indeed asks for an increase in new developments in various fields of medicine, and Artificial Intelligence is proving to be one of the most effective outcomes. One of the most pioneering applications of Artificial Intelligence was seen in the field of "bio printing", where living tissue including organs can be fabricated in consecutive thin layers of cells which in future may be used for reconstruction of oral hard and soft tissues lost due to pathological or accidental reasons. (16)

The use of Artificial Intelligence was not to be strictly limited to oral cancer but also to various fields of health systems including imaging procedures, congenital disease management and even to evaluate and control different types of pandemics or epidemics. Thus, proper attention and resources for its development and implementation must be given. This article helps us to conclude that the role of Artificial intelligence in the field of oral cancer is useful in providing mind-blowing results. It is one of the most wonderful advancements in technology that is yet to be unleashed to its full potential. Technology has also revolutionized the field of medicine and dentistry in the last decade. (17)

As clearly pointed out in this article earlier, It ought to be realized, the number of resources aimed at the development of Artificial Intelligence is very minimal even from the economically profiting countries. Also analysing the frequency of publication of the article into this field is critical as by doing so we can bring forth a significant development in providing the best health care to all.

This articles also indicates the fact that the number of oral cancer patients are increasing on a very alarming rate which is mainly due to the delay in early recognition or diagnosis followed by the treatment modalities coming up short. On the other side, we had also discussed earlier on how Artificial Intelligence, data mining, and ANN are significant and operative in several aspects of dentistry.

As the different cases or incidences of new types of viruses and bacteria being recognized throughout the world in increasing, so is the pathological effects it brings to the human body. Thus the need for an extra mind is always useful to the field of health sciences. since the applications of these Artificial Intelligence technologies like Expert systems, Game playing, and Theorem-proving, Natural language processing, Image recognition and Robotics in various fields like telecommunication and aerospace have already proven to step in the right direction. (18)

LIMITATIONS

The limitations of this study are only articles with an abstract or full text were selected. Most of the articles which outfit the inclusion criteria are excluded and only limited number of articles were selected. Other databases should also be considered to get a more relevant outcome.

CONCLUSION

In this study, we conclude that the field of oral cancer is very unpredictable and restricting one. Still, the adaptation of artificial intelligence and its subsets into oral cancer developments may prove to be life-changing to millions of people who are continually asking for betterment in diagnosis and treatment options. Thus Artificial Intelligence will not disappoint instead provide a boost of confidence to the medical society and thereby to the whole world.

REFERENCES

1. Khanna SS, Dhaimade PA. Artificial Intelligence: Transforming dentistry today. Indian J Basic Appl Med Res 2017;6(1);161-7.

2. Kalappanavar A, Sneha S, Annigeri RG. Artificial intelligence: A dentist's perspective. Journal of Medicine, Radiology, Pathology and Surgery. 2018 Mar 1;5(2);2-4.

3. Speight PM, Elliott AE, Jullien JA, Downer MC, Zakzrewska JM. The use of artificial intelligence to identify people at risk of oral cancer and precancer. Br Dent J 1995;179(1);382-7

4. Kearney V, Chan JW, Valdes G, Solberg TD, Yom SS. The application of artificial intelligence in the IMRT planning process for head and neck cancer. Oral Oncology. 2018 ;87(1);111-6.

5. Boon IS, Au Yong T, Boon CS. Assessing the role of artificial intelligence (AI) in clinical oncology: utility of machine learning in radiotherapy target volume delineation. Medicines. 2018 ;5(4);131-135.

6. Chang SW, Abdul-Kareem S, Merican AF, Zain RB. Oral cancer prognosis based on clinicopathologic and genomic markers using a hybrid of feature selection and machine learning methods. BMC bioinformatics. 2013 ;14(1);170.

7. A. Madabhushi, G. LeeImage analysis and machine learning in digital pathology: challengesandopportunities;Med.ImageAnal.2016;33(2);170-175

8. Coccia M. Deep learning technology for improving cancer care in society: New directions in cancer imaging driven by artificial intelligence. Technology in Society. 2020; 60(1);101198-101203

9. Bas B, Ozgonenel O, Ozden B, Bekcioglu B, Bulut E, Kurt M. Use of artificial Neural network in differentiation of subgroups of temporomandibular internal derangements: A preliminary study. J Oral Maxillofac Surg 2012;70;51-9.

10. Brickley MR, Shepherd JP, Armstrong RA. Neural networks: A new technique for development of decision support systems in dentistry. J Dent 1998;26(1);305-9.

11. Raith S, Vogel EP, Anees N, Keul C, Güth JF, Edelhoff D, et al. Artificial neural networks as a powerful numerical tool to classify specific features of a tooth based on 3D scan data. Comput Biol Med 2017;80(3):65-76.

12. Saghiri MA, Asgar K, Boukani KK, Lotfi M, Aghili H, Delvarani A, et al. A new approach for locating the minor apical foramen using an artificial neural network. Int Endontic J 2012;4;257-65.

13. Ramesh AN, Kambhampati C, Monson JR, Drew PJ. Artificial intelligence in medicine. Annals of the Royal College of Surgeons of England. 2004 ;86(5);334-339

14. Stamey TA, Barnhill SD, Zang Z. Effectiveness of ProstAsureTM in detecting prostate cancer (PCa) and benign prostatic hyperplasia (BPH) in men age 50 and older. J Urol 1996; 155(2); 436A-440A

15. Gunn AA. The diagnosis of acute abdominal pain with computer analysis. J R Coll Surg Edinb 1976; 21; 170–4.

16. Young-Joon Seol, Hyun-Wook Kang, Sang Jin Lee, Anthony Atala and James J. Yoo, Bioprinting technology and its applications, European Journal of Cardio-Thoracic Surgery, 2014, (46) 342-348.

17. Lusted LB. Medical progress – medical electronics. N Engl J Med; 1955, 252; 580–5.

18. Khanna SS, Dhaimade PA. Artificial intelligence: Transforming dentistry today. Indian J Basic Appl Med Res. 2017 Jun;6(3):161-7.