Content available at: https://www.ipinnovative.com/open-access-journals

Journal of Oral Medicine, Oral Surgery, Oral Pathology and Oral Radiology

Journal homepage: www.joooo.org

Review Article

Artificial intelligence in oral and maxillofacial surgery: A road ahead

Shallu Bansal[1]*, **Anil Managutti**[2], **Aishwarya Babhulkar**[1], **Neha Patel**[1]

[1]*Dept. of Oral and Maxillofacial Surgery, Geetanjali Dental and Research Institute, Udaipur, Rajasthan, India*
[2]*Dept. of Oral and Maxillofacial Surgery, Narsinhbhai Patel Dental College & Hospital Dental School, Visnagar, Gujarat, India*

ARTICLE INFO

Article history:
Received 02-09-2024
Accepted 02-11-2024
Available online 18-12-2024

Keywords:
Artificial intelligence
Oral & maxillofacial surgery
Virtual surgical assistant
Threedimensional planning
Predictive analysis
Innovation

ABSTRACT

Artificial intelligence has emerged as a transformative force in the healthcare system. It has revolutionized the traditional approach to diagnosis, treatment planning, and surgical outcomes. Oral and Maxillofacial Surgery also stands at the forefront of this technological revolution by enhancing surgical procedures, optimizing treatment outcomes, and improving patient satisfaction. However, integrating AI into the healthcare system also presents unique challenges, including data privacy concerns, regulatory compliance issues, and the need for ongoing training for clinicians. This article provides a comprehensive overview of AI applications within Oral and Maxillofacial Surgery, highlighting key developments, challenges, and future directions.

1. Introduction

Artificial Intelligence (AI) has revolutionized healthcare by enhancing diagnostic precision, streamlining treatment planning, and improving surgical outcomes. In the specialized field of oral and maxillofacial surgery (OM FS), AI is emerging as a crucial tool, addressing the increasing complexity of procedures and the demand for personalized care. AI can integrate into various aspects of patient management in OMS, including image analysis, data processing, virtual surgical planning, outcome prediction, and clinical decision-making.[1,2]

The rapid development and implementation of AI-based solutions in healthcare aim to enhance patient outcomes, reduce costs, and boost the efficiency of healthcare systems. In OMS, AI has been employed to develop predictive models capable of identifying high-risk patients in complex procedures such as oral cancer resections, orthognathic surgeries, facial cosmetic operations, and even routine procedures like dental implants and the extraction of impacted third molars. These advancements promise to elevate the precision and efficacy of treatments, offering significant potential for improving patient care in the field.[3–5]

AI encompasses a wide array of technologies capable of accomplishing tasks traditionally reserved for humans, such as learning, perception, reasoning, and recognition. AI algorithms currently in use in healthcare, including oral and maxillofacial surgery (OMS), are considered "weak" AI. This means they are designed to perform specific tasks without self-awareness or independent reasoning. They rely heavily on the data and instructions fed into them, processing this information to execute precise tasks such as image analysis, predictive modelling, and treatment planning. Although oral maxillofacial surgeons may not need an in-depth understanding of AI's mathematical structures, a basic grasp of these models is beneficial.[6]

AI uses deep learning algorithms, often through convolutional neural networks (CNNs), which mimic the function of human neurons. These models have supplanted

* *Corresponding author*.
E-mail address: drshallu23@yahoo.com (S. Bansal).

https://doi.org/10.18231/j.jooo.2024.050

traditional methodologies in diagnostic systems, as they can extrapolate and learn from vast, associated datasets. Essentially, the more a system is trained with high-quality data, the more accurate it becomes in diagnosing conditions. Automated diagnostic and prognostic systems have the potential to precisely identify pathologies, fractures, and diseases, while also suggesting optimal treatment options.[7]

However, the discussion around AI in healthcare must also consider its current limitations and ethical challenges. While AI-powered image analysis has demonstrated significant potential in detecting and diagnosing conditions in oral and maxillofacial surgery, concerns about data security, patient privacy, and the inherent bias in AI algorithms continue to raise ethical questions. Moreover, the effectiveness and safety of AI-based solutions still require further research and validation. Despite these challenges, the transformative potential of AI in oral and maxillofacial surgery remains considerable.[7]

In this article, we will explore the current state of AI-based solutions in oral and maxillofacial surgery, the benefits and challenges of AI integration into patient care, and potential future directions for research and development in this rapidly evolving field.

2. History

2.1. 1950s - Birth of AI

The concept of artificial intelligence emerged in the 1950s, with Alan Turing's groundbreaking work on computational intelligence and the Turing Test.[8]

2.2. 1956 - The dartmouth conference

The term "artificial intelligence" was coined at the Dartmouth Conference in 1956, where researchers including John McCarthy, Marvin Minsky, Nathaniel Rochester, and Claude Shannon gathered to discuss the potential of creating machines capable of intelligent behaviour.[9]

2.3. 1960s - Early AI programs

In the 1960s, researchers developed early AI programs such as the Logic Theorist by Allen Newell and Herbert A. Simon, which could prove mathematical theorems.[10]

2.4. 1970s - AI winter

The 1970s saw a decline in AI research funding and interest, known as the "AI winter," due to limited progress and unrealistic expectations.[11]

2.5. 1980s - Expert systems and neural networks

In the 1980s, the focus shifted to expert systems, AI programs that used knowledge bases to mimic human expertise in specific domains.[12] Additionally, neural networks gained popularity as a model for machine learning.[13]

2.6. 1990s - Rise of machine learning

The 1990s witnessed significant advancements in machine learning algorithms, such as support vector machines[14] and Bayesian networks,[15] paving the way for practical applications in various fields.

2.7. 2000s - Big data and deep learning

In the 2000s, the emergence of big data technologies and the resurgence of interest in AI led to breakthroughs in deep learning and neural network architectures.[16]These advancements fuelled progress in speech recognition, image classification, and natural language processing.

2.8. 2010s - AI renaissance

The 2010s marked a period of rapid progress and widespread adoption of AI technologies, driven by the availability of massive datasets, powerful computing resources, and algorithmic advancements.[17] AI applications proliferated across industries, from healthcare and finance to transportation and entertainment.

2.9. Present - AI in everyday life

Today, AI permeates everyday life, powering virtual assistants, recommendation systems, autonomous vehicles, and medical diagnostics. The field continues to evolve rapidly, with ongoing research in areas such as reinforcement learning, explainable AI, and AI ethics.

3. Uses of AI in Oral & Maxillofacial Surgery

3.1. AI-assisted surgical planning

AI-assisted surgical planning uses advanced technology to help surgeons prepare for complex procedures. With AI-powered imaging tools, surgeons can get a detailed look at the area they need to operate on, which helps them plan the surgery more precisely. For example, in surgeries like orthognathic surgery, maxillofacial trauma, Surgical excision of oral cancer, tumors or cysts, TMJ (Temporo-mandibular joint) Surgeries, correcting facial deformities, placing dental and patient specific implants, extraction of impacted tooth AI tools can be very helpful. These AI systems can analyze the images and provide recommendations on how to approach the surgery, helping surgeons choose the best techniques. This can lead to fewer complications, faster recoveries, and better overall results for patients. Essentially, AI helps surgeons plan more efficiently and improve the chances of successful outcomes.[1,2]

3.2. Automated detection of pathologies

AI is transforming medical diagnosis by analyzing images like X-rays, CT scans, and MRIs to detect abnormalities such as tumors or fractures faster than traditional methods. For pathologists, AI is especially useful in spotting early signs of disease that may be hard to see, helping with early diagnosis and treatment. AI scans medical images for patterns, speeding up diagnoses and reducing human error, though it should complement, not replace, human expertise.

In oral and maxillofacial pathology, AI shows promise in accurately detecting conditions like oral cancer and predicting treatment outcomes. Despite its potential, AI still requires validation and further research to optimize its use in complex cases. It can improve diagnostic consistency, helping pathologists focus on more challenging cases.[2,18]

3.3. Virtual surgical assistants

Virtual surgical planning (VSP) greatly enhances surgical accuracy and outcomes, particularly in complex procedures like orthognathic surgery. Using advanced 3D imaging such as CBCT scans and computer-aided simulations, VSP allows surgeons to visualize patient anatomy far more clearly than traditional 2D methods. This is especially beneficial for addressing challenges like facial asymmetry, occlusal plane issues, and jawbone discrepancies, resulting in more precise surgical planning and improved outcomes.

One major advantage of VSP is its ability to streamline cephalometric analysis, splint creation, and surgical simulations. It minimizes the risk of complications like bone contact problems and misaligned rotations during surgery. The use of 3D printing adds further precision by producing customized surgical guides and splints designed to each patient's needs.

VSP also aids real-time decision-making during operations, enhancing safety and efficiency. It can reduce surgery duration and speed up patient recovery. As AI technology advances, it has the potential to complement VSP, improving access to surgery and patient outcomes, particularly in resource-limited or remote areas. AI-powered monitoring systems can detect complications early, alerting surgeons to take action, while AI chatbots and virtual assistants enhance patient communication, easing anxiety and confusion.[3,4,19]

3.4. Patient-specific treatment planning

AI algorithms analyze patient data to create personalized treatment plans by considering factors like medical history, anatomy, and genetic predispositions. This approach optimizes treatment outcomes, reduces complications, and enhances accuracy. AI also minimizes the need for revisions and ensures precise surgical resections.

In complex cases such as orbital reconstruction, TMJ prostheses, and full-mouth rehabilitation after mucormycosis, AI assists in designing patient-specific prostheses. For orbital reconstruction, AI helps create custom implants that restore both function and appearance. In TMJ prostheses, AI ensures accurate fitting, improving jaw function and reducing long-term complications. Full-mouth rehabilitation, guided by AI, enhances aesthetics and functionality by customizing dental implants and prosthetics to match the patient's unique needs.[19]

AI also supports physicians in matching patient symptoms to the right specialists, ensuring more accurate diagnoses and prognoses. Beyond surgery, AI aids in drug discovery, language translation, and organizing medical records, streamlining medical workflows and improving patient care across all areas.[1]

3.5. Predictive analytics

AI uses large amounts of data to predict post-surgery complications, treatment responses, and long-term outcomes for oral surgery patients. This helps doctors make timely decisions, allowing for early interventions and personalized follow-up care. AI can provide 24/7 clinical support, connecting patients with healthcare providers and aiding in decision-making.

AI improves surgeons' efficiency by assisting with automated diagnoses from radiology images and updating patient records. It enhances patient safety by spotting drug interactions and correcting potential prescription errors. An AI-powered app can ensure both safety and efficiency by making predictions, supporting doctors, and helping patients stay informed and protected throughout their treatment.[5]

4. Advantages of AI in Oral & Maxillofacial Surgery

4.1. Enhanced surgical planning

AI assist in analysing complex anatomical structures from medical imaging data, leading to more precise 3D (three Dimensional) surgical planning and execution, while also facilitating the design and implementation of patient-specific implants for optimized outcome.[1]

4.2. Reduced surgical risks and complications

AI powered systems can help to identify potential risks and complications preoperatively, allowing surgeons to take preventive measures and minimize adverse outcomes during various surgical procedures.[2]

4.3. Time and cost efficiency

AI technologies streamline workflow processes by automating tasks such as image analysis, diagnosis, and treatment planning ultimately leading to time and cost savings for both healthcare providers and patients.[3]

4.4. Personalized treatment approach

AI powered systems analyse patient-specific data can help the surgeons to plan the treatment as per individual needs, which ultimately optimizes treatment outcomes and improving patient satisfaction.[4]

4.5. Continuous learning and improvement

AI systems can continuously learn from new data and surgical experiences, leading to ongoing improvement in diagnostic accuracy, treatment efficacy, and patient care outcomes.[5]

5. Disadvantages of AI in Oral & Maxillofacial Surgery

5.1. Over-reliance on technology

Excessive dependence on AI systems can lead to complacency among surgeons, potentially reducing their critical thinking skills and ability to make independent decisions during complex surgical procedures. As surgeons become more accustomed to relying on AI for diagnosis and surgical planning, they might overlook subtle clinical signs or fail to question AI-generated recommendations. This could lead to errors, especially in unexpected situations where human judgment is essential.

Furthermore, over-reliance on AI may cause surgeons to lose confidence in their own expertise over time, weakening their problem-solving abilities. It's crucial that AI is seen as a tool to assist, not replace, human decision-making, ensuring that surgeons maintain their critical skills and are always ready to take control when technology falls short. Balance between AI and human expertise is key to providing safe, high-quality care to the patients.[19]

5.2. Data privacy and security concerns

The use of AI-powered systems in healthcare raises significant concerns regarding data privacy and security. These systems often handle sensitive patient information, making them attractive targets for cyberattacks. A security breach could expose personal health data, leading to potential misuse or identity theft, which can have serious consequences for patients.

Moreover, there are concerns about how patient data is stored, shared, and used. Patients may not fully understand how their information is being utilized or whether it is being shared with third parties without their consent. This lack of transparency can erode trust between patients and healthcare providers.

Ensuring robust data protection measures, such as encryption and secure access protocols, is essential to safeguard patient information. It is also crucial for healthcare organizations to establish clear policies on data usage and to obtain informed consent from patients. Addressing these concerns is vital to maintain patient trust and ensure the ethical use of AI in healthcare.[18–20]

5.3. Algorithm bias and error

AI systems rely on the data they are trained on, and if that data is incomplete or biased, it can result in incorrect diagnoses, treatment recommendations, or surgical planning. When the data isn't fully representative or is missing key information, AI may struggle to provide accurate assessments. This can lead to errors in medical decision-making, affecting the quality of care.

Additionally, if data input is incomplete or outdated, AI systems may produce inaccurate predictions or recommendations. In critical fields like surgery, even minor errors can have significant consequences, so it's essential that healthcare professionals oversee AI outputs to ensure patient safety and accuracy.[6,7,18,19]

5.4. Limited generalizability

AI-generated models that are developed in one healthcare setting or population may not work effectively in different patient groups or clinical environments. This means that the results and predictions made by these models might not be accurate or relevant for everyone, which can lead to suboptimal performance and poorer patient outcomes.

For example, an AI model trained on data from a specific hospital may not perform well when applied in another hospital with different patient demographics or treatment protocols. Differences in factors such as age, ethnicity, and underlying health conditions can significantly impact how patients respond to treatments.

To improve the effectiveness of AI in healthcare, it is essential to validate these models across various settings and diverse populations. This ensures that the AI tools are adaptable and can provide reliable support to healthcare providers, regardless of the patient demographics or clinical circumstances they encounter. Continuous monitoring and updating of AI models are also necessary to maintain their relevance and accuracy in a changing healthcare landscape.[6,7,18,18]

5.5. Ethical and legal implications

The use of AI in surgery introduces significant ethical dilemmas, particularly around patient consent and accountability for errors. Patients may not fully understand how AI systems are utilized in their care, raising questions about informed consent. It is essential that patients are adequately informed about the role of AI in their diagnosis and treatment options to ensure they can make informed choices about their care.

Additionally, determining who is accountable when an AI system makes an error is complex. If a surgical complication arises due to an AI-generated recommendation, it may be unclear whether the

responsibility lies with the surgeon, the developers of the AI system, or the healthcare institution. This ambiguity can create legal challenges and complicate malpractice claims.

Moreover, there are concerns about the potential for bias in AI algorithms, which can result in unequal treatment for different patient groups. Addressing these ethical and legal challenges is crucial for the responsible integration of AI in surgical practice, ensuring that patient rights are protected and that the use of technology enhances rather than undermines the quality of care.[6,7,20–24]

6. Future Consideration

6.1. Interdisciplinary collaboration

It means that experts from different fields work together to solve complex problems. In the future, advancements in AI in oral and maxillofacial surgery will greatly benefit from more teamwork between oral and maxillofacial surgeons, computer scientists, engineers, and ethicists. Oral and maxillofacial surgeons can provide insight into the medical side of surgery, while computer scientists and engineers can help develop the AI technology. Ethicists play an important role by ensuring that these new technologies are used in ways that are fair, safe, and ethical. By working together, these professionals can address the challenges of AI in oral surgery and create better solutions for patient care.[21–23]

6.2. Explainable AI models

As AI systems become more integrated into oral surgery, there is a pressing need for models that offer clear and understandable explanations for their decisions. This transparency is essential for building trust among surgeons, patients, and regulatory bodies. When AI provides insights into how it arrived at a specific diagnosis or treatment recommendation, it allows surgeons to validate and contextualize those suggestions, enhancing their confidence in using the technology.

Moreover, patients are more likely to accept and adhere to treatment plans when they understand the reasoning behind the recommendations. Clear explanations can empower patients to engage actively in their care and make informed decisions.

Regulatory bodies also require explainability to ensure compliance with legal and ethical standards. This includes understanding how AI models handle data and make decisions, as well as ensuring that they do not perpetuate bias or inequalities in treatment.

Developing explainable AI models will be crucial for the widespread adoption of this technology in oral surgery, ensuring that it complements clinical expertise while maintaining patient safety and ethical integrity. This focus on explainability can ultimately lead to improved patient outcomes and a more collaborative relationship between technology and healthcare professionals.[24–26]

6.3. Education and training

AI technologies are revolutionizing the education and training of surgeons by providing innovative tools that enhance learning experiences. Surgical simulation models powered by AI can replicate real-life surgical scenarios, allowing trainees to practice techniques in a safe and controlled environment. These simulations can mimic a variety of procedures and complications, helping surgeons develop their skills without the risks associated with live surgeries.

Additionally, virtual reality (VR) environments offer immersive training experiences, allowing surgeons to interact with 3D models of anatomical structures and practice surgical techniques from different perspectives. This hands-on approach helps improve spatial awareness and procedural skills, crucial for successful surgeries.

Skill labs equipped with AI-driven tools enable trainees to receive immediate feedback on their performance, helping them identify areas for improvement. These labs can incorporate haptic feedback systems that simulate the tactile sensations of surgery, further enhancing the realism of the training experience.

Furthermore, AI can analyse a surgeon's performance over time, providing personalized training recommendations based on individual strengths and weaknesses. By integrating AI into surgical education, we can create more effective training programs that prepare surgeons for the complexities of real-world practice, ultimately improving patient safety and surgical outcomes.[22–24]

6.4. Ethical and regulatory frameworks

Future efforts should focus on developing ethical guidelines and regulatory frameworks to ensure the responsible use of AI in surgery, addressing concerns around patient privacy, data security, and algorithmic transparency. The use of AI in plastic surgery raises ethical issues, such as potential discrimination based on ethnicity and gender. Limited dataset sizes also challenge AI accuracy and generalizability, making it essential to gather more diverse data from various demographics. AI-based assessments of attractiveness are subjective and culturally influenced, potentially reflecting biases. It is crucial that AI supports, rather than replaces, shared decision-making between doctors and patients, ensuring that technology enhances rather than dictates patient care.[18]

6.5. Integration with robotics

The integration of AI algorithms with robotic surgical systems represents a significant advancement in oral surgery, allowing for more precise and minimally invasive

procedures. By combining the precision of robotics with the analytical capabilities of AI, surgeons can perform complex operations with enhanced accuracy and control.

AI algorithms can process real-time data during surgery, allowing robotic systems to adapt to unexpected changes in the surgical environment. This dynamic response can help minimize risks and complications, leading to better patient outcomes. For instance, AI can assist in identifying critical anatomical structures, enabling surgeons to navigate delicate areas more safely.

Moreover, robotic systems equipped with AI can facilitate advanced techniques, such as computer-assisted navigation and enhanced visualization, which improve the surgeon's ability to see and operate on intricate structures. This capability not only enhances surgical precision but also reduces the overall trauma to surrounding tissues, leading to quicker recovery times for patients.

The synergy between AI and robotics in oral surgery has the potential to transform surgical practices, making procedures safer, more effective, and more efficient. As technology continues to evolve, we can expect even greater innovations that will further enhance the capabilities of surgeons and improve patient care.[20]

7. Limitations of this Review

This review highlights the existing knowledge and emphasizes the need for further research in the field, unlike a systematic review that evaluates the quality and reliability of current findings, including bias risk assessment. The data search was restricted to English-language articles, omitting relevant studies in other languages. Furthermore, the review's reliance on existing literature may not fully capture the latest advancements in AI applications within oral surgery, as the field is rapidly evolving. Despite my efforts to thoroughly review the available research, there is always the possibility that some relevant studies or emerging trends were unintentionally overlooked due to human error. This underscores the inherent limitations in relying solely on current literature, where findings may also vary across different studies. It may also not fully address the potential long-term implications and outcomes of AI integration. Finally, the fast-paced development of technology means that some insights may quickly become outdated as new advancements arise.

8. Conclusion

In conclusion, AI in healthcare, especially in oral and maxillofacial surgery, can help doctors make better diagnoses and create improved treatment plans. It can reduce mistakes, make treatments more personalized, and lower the need for complicated surgeries, which leads to happier patients and lower costs. AI also helps doctors work together more easily by sharing information quickly, which improves patient care. However, using AI in healthcare comes with challenges. It's important to make sure AI systems are fair, accurate, and used by doctors who are properly trained. If these challenges are addressed, AI can greatly improve how healthcare is provided, making it safer and more effective for patients.

9. Source of Funding

None.

10. Conflict of Interest

None.

References

1. Yan KX, Liu L, Li H. Application of machine learning in oral and maxillofacial surgery. *Artif Intell Med Imaging*. 2021;2(6):104–14.
2. Patil S, Albogami S, Hosmani J, Mujoo S, Kamil MA, Mansour MA, et al. Artificial intelligence in the diagnosis of oral diseases: applications and pitfalls. *Diagnostics (Basel)*. 2022;12(5):1029.
3. Su YX, Thieringer FM, Fernandes R, Parmar S. Virtual surgical planning and 3d printing in head and neck tumor resection and reconstruction. *Front Oncol*. 2022;12:960545.
4. Kato RM, Parizotto JD, Oliveira PH, Gonçalves JR. Artificial intelligence in orthognathic surgery-a narrative review of surgical digital tools and 3D orthognathic surgical planning. *J California Dent Assoc*. 2023;51(1):2202444.
5. Hartoonian S, Hosseini M, Yousefi I, Mahdian M, Ahsaie MG. Applications of artificial intelligence in dentomaxillofacial imaging-A systematic review. *Oral Surg Oral Med Oral Path Oral Rad*. 2024;138(5):641–55.
6. Rasteau S, Ernenwein D, Savoldelli C, Bouletreau P. Artificial intelligence for oral and maxillo-facial surgery: A narrative review. *J Stomatol Oral Maxillofac Surg*. 2022;123(3):276–82.
7. Rekawek P, Rajapakse CS, Panchal N. Artificial Intelligence: The Future of Maxillofacial Prognosis and Diagnosis. *J Oral Maxillofac Surg*. 2021;79(7):1396–7.
8. Turing AM. Computing machinery and intelligence. *Mind*. 1950;59:433–60.
9. Mccarthy J, Minsky ML, Rochester N, Shannon CE. A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence, August 31, 1955. *AI Mag*. 2006;27(4):12.
10. Newell A, Shaw JC, Simon HA. Elements of a theory of human problem solving. *Psychol Rev*. 1958;65(3):151.
11. Lighthill J. Artificial intelligence: a general survey', published as part of Science Research Council, Artificial Intelligence: A Paper Symposium. London: SRC; 1973.
12. Duda RO, Hart PE, Nilsson NJ. Subjective Bayesian methods for rule-based inference systems. In: AFIPS '76: Proceedings of the national computer conference and exposition. United States: Association for Computing Machinery; 1976. p. 1075–82.
13. Rumelhart DE, Hinton GE, Williams RJ. Learning representations by back-propagating errors. *Nature*. 1986;323:533–6.
14. Vapnik V. Support-vector networks. *Mach Learn*. 1995;20:273–97.
15. Pearl J. Probabilistic Reasoning in Intelligent Systems: Networks of Plausible Inference. Australia: Newnes; 1988.
16. Lecun Y, Bengio Y, Hinton G. Deep learning. *Nature*. 2015;521(7553):436–44.
17. Russell SJ, Norvig P. Artificial Intelligence: A Modern Approach. Norvig P, editor. Pearson; 2016. p. 1–33.
18. Abdul NS, Shivakumar GC, Sangappa SB, Blasio MD, Crimi S, Cicciù M, et al. Applications of artificial intelligence in the field of oral and maxillofacial pathology: a systematic review and meta-analysis. *BMC Oral Health*. 2024;24(1):122.

19. Miragall MF, Knoedler S, Kauke-Navarro M, Saadoun R, Grabenhorst A, Grill FD, et al. Face the Future-Artificial Intelligence in Oral and Maxillofacial Surgery. *J Clin Med*. 2023;12(21):6843.
20. Bhandari M, Zeffiro T, Reddiboina M. Artificial intelligence and robotic surgery: current perspective and future directions. *Curr Opin Urol*. 2020;30(1):48–54.
21. Hosny A, Parmar C, Quackenbush J, Schwartz LH, Aerts HJ. Artificial intelligence in radiology. *Nat Rev Cancer*. 2018;18(8):500–10.
22. Rajkomar A, Hardt M, Howell MD, Corrado G, Chin MH. Ensuring fairness in machine learning to advance health equity. *Ann Intern Med*. 2018;169(12):866–72.
23. Obermeyer Z, Emanuel EJ. Predicting the Future - Big Data, Machine Learning, and Clinical Medicine. *N Engl J Med*. 2016;375(13):1216–9.
24. Brall C, Schröder-Bäck P, Maeckelberghe E. Ethical aspects of digital health from a justice point of view. *Eur J Public Health*. 2019;29(S 3):18–22.
25. Holzinger A, Langs G, Denk H, Zatloukal K, Müller H. Causability and explainability of artificial intelligence in medicine. *WIREs Data Min Knowledge Discov*. 2019;9(4). doi:10.1002/widm.1312.
26. Loperfido A, Celebrini A, Marzetti A, Bellocchi G. Current role of artificial intelligence in head and neck cancer surgery: a systematic review of literature. *Explor Target Antitumor Ther*. 2023;4(5):933–40.

Author's biography

Shallu Bansal, Professor and HOD https://orcid.org/0000-0002-3316-9174

Anil Managutti, Professor and HOD https://orcid.org/0000-0003-4958-8346

Aishwarya Babhulkar, Resident

Neha Patel, Resident

Cite this article: Bansal S, Managutti A, Babhulkar A, Patel N. Artificial intelligence in oral and maxillofacial surgery: A road ahead. *J Oral Med, Oral Surg, Oral Pathol, Oral Radiol* 2024;10(4):254-260.