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Clinical and educational use of artificial intelligence in oral and maxillofacial surgery: a cross-sectional study

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Abstract:

Background: Artificial intelligence (AI) is increasingly applied in oral and maxillofacial surgery, enhancing diagnostic imaging, treatment planning, and simulation-based training. Its potential to improve accuracy, support complex decision-making, and strengthen educational initiatives is well recognized.

Objective: This study aimed to evaluate the knowledge, attitudes, and practical use of AI among oral and maxillofacial surgeons in both clinical and educational contexts.

Methodology: A descriptive cross-sectional survey was conducted with 150 surgeons from academic institutions and private practices in Karachi between June and December 2024. Participants were recruited through convenience sampling and completed a validated, pilot-tested questionnaire addressing demographics, AI awareness, attitudes, usage, and perceived barriers. Data were analyzed using IBM SPSS Statistics version 26, with descriptive statistics summarizing trends and chi-square tests assessing associations between demographic factors and AI-related knowledge, attitudes, and practices ($p < 0.05$).

Results: Of the respondents, 58% demonstrated moderate understanding of AI in diagnostic imaging and treatment planning, while 40% recognized its role in simulation-based education. Positive attitudes were reported by 62%, yet only 35% actively applied AI tools. Surgeons with more than 10 years of experience exhibited significantly higher knowledge, and academic affiliation correlated with more favorable attitudes. Reported barriers included limited access to technology (48%), lack of formal training (42%), and ethical or legal concerns (38%).

Conclusion: Most surgeons showed moderate awareness of AI in clinical practice, though fewer acknowledged its educational applications. Findings highlight the need for improved access, structured training, and ethical frameworks to support AI integration in oral and maxillofacial surgery.

Keywords: Artificial intelligence, Oral and maxillofacial surgery, Knowledge, Attitudes, Practices

Introduction:

Artificial intelligence (AI) is increasingly transforming healthcare, including dentistry, by enhancing diagnostic accuracy, guiding treatment planning, and supporting educational activities (1,2). Oral and maxillofacial surgery (OMFS) deals with intricate anatomical structures and depends greatly on accurate radiographic analysis. In this context, artificial intelligence can enhance treatment outcomes and promote more consistent and structured training. (3,4). Technologies such as automated image analysis, three-dimensional bone evaluation, and AI-assisted identification of key anatomical landmarks on cone-beam computed tomography (CBCT) scans have demonstrated accuracy comparable to experienced clinicians (5,6). These tools may reduce operator-dependent variability, support preoperative planning, and aid clinical decision-making (7,8). AI is also being integrated into dental and surgical education through simulation platforms and virtual reality environments. These systems provide structured feedback, enhance learner engagement, and standardize skill acquisition, addressing limitations of conventional training methods (9,10). Despite these benefits, AI adoption in routine OMFS practice

remains limited, with barriers including insufficient formal training, ethical and legal uncertainties, restricted access to technology, and unclear clinical responsibility (2,11,12).

While technical research has assessed the effectiveness of AI in imaging and surgical planning, fewer studies have focused on how oral and maxillofacial surgeons view, understand, and apply AI in clinical practice as well as in education. Evaluating their knowledge, attitudes, and practices (KAP) can highlight gaps and guide strategies for safe and effective implementation.

Currently, there is a lack of empirical evidence on the awareness, acceptance, and practical use of AI among OMFS surgeons. Conducting a KAP study will help identify existing knowledge levels, attitudes, and barriers, which can inform educational programs, professional development initiatives, and institutional policies to support broader AI adoption in clinical and training environments.

The objective of this study was to evaluate the knowledge, attitudes, and practical use of AI among oral and maxillofacial surgeons in both clinical and educational settings.

Study design and methodology:

A descriptive cross-sectional study was designed to assess the knowledge, attitudes, and practices of oral and maxillofacial surgeons regarding artificial intelligence (AI), along with the barriers to its use in clinical and educational settings. Data collection was conducted over a seven-month period, from June to December 2024. Oral and maxillofacial surgeons working in both academic institutions and private clinical practices were included in order to capture a broad range of professional experiences and exposure to AI technologies.

The study included oral and maxillofacial surgeons who were actively engaged in either clinical practice, academic work, or both during the study duration. Surgeons were eligible for inclusion regardless of their years of professional experience, provided they agreed to participate in the study. Participants were recruited from hospitals, dental colleges, and private practices to ensure representation from different practice settings and levels of technological adoption. Dentists from other specialties, surgeons who were not actively practicing, individuals who declined participation, and respondents who returned incomplete questionnaires were excluded from the final analysis. The sample size was determined using the standard formula for cross-sectional studies:

$$n = Z^2 \times p\,(1 - p) / d^2$$

where **n** represents the required sample size, **Z** corresponds to the standard normal value for a 95% confidence level (1.96), **p** represents the estimated prevalence of awareness or use of artificial intelligence among oral and maxillofacial surgeons, and **d** indicates the margin of error, set at 5%.

In the absence of dependable regional data on AI use among oral and maxillofacial surgeons, a prevalence of 50% was assumed to calculate the largest possible sample size. Based on this assumption, the minimum calculated sample size was 138 participants. To compensate for potential non-response or incomplete survey submissions, the final target sample size was increased to 150 participants. This sample size was considered sufficient to achieve approximately 80% statistical power for detecting potential associations between demographic variables and levels of knowledge or attitudes toward AI.

A non-probability convenience sampling strategy was used for participant recruitment. Eligible surgeons were approached through professional networks, institutional affiliations, and dental professional groups. The questionnaire was distributed both electronically and in printed form to facilitate broader participation and enhance the response rate.

Instrument Development and Validation

Data was collected using a structured, self-administered questionnaire developed after a comprehensive review of published literature on artificial intelligence applications in dentistry and healthcare. The survey instrument was designed to collect information across several domains, including demographic characteristics (age, gender, years of experience, and practice setting), awareness

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and knowledge of AI applications in oral and maxillofacial surgery, attitudes toward the adoption of AI technologies, current patterns of AI use in clinical or educational activities, and perceived barriers to the implementation of AI.

The initial questionnaire was evaluated by a panel of experts, including oral and maxillofacial surgeons, dental faculty members, and researchers experienced in digital health technologies. The panel assessed the questionnaire for clarity, relevance, and content validity. Based on their recommendations, modifications were made to improve the wording and overall structure of the survey items.

A pilot study was carried out with 15 oral and maxillofacial surgeons who were excluded from the final study sample. The pilot study was undertaken to evaluate the clarity, feasibility, and reliability of the instrument. Feedback obtained during this phase resulted in minor revisions to enhance the comprehensibility of the questionnaire. The internal consistency of the instrument was assessed using Cronbach's alpha coefficient, which yielded a value greater than 0.70, indicating acceptable reliability.

Data collection:

Approval was obtained from the Institutional Ethics Committee, and the study was conducted in compliance with established ethical guidelines. Data was collected through a structured self-administered questionnaire given to 150 practicing oral and maxillofacial surgeons. The tool was developed to obtain detailed information on demographics, awareness of AI applications, attitudes toward its use, current clinical and educational adoption, and perceived barriers to implementation. Participation in the study was entirely voluntary, and respondents were assured of confidentiality and anonymity to encourage honest and unbiased responses.

Statistical analysis:

The collected responses were coded and analyzed using statistical analysis software SPSS 26.0. Descriptive statistics were applied to summarize demographic variables, levels of awareness, attitudes, and patterns of artificial intelligence usage, and were presented as frequencies and percentages. Inferential analysis was performed to examine the relationship between participants' characteristics, including years of experience and practice setting, and their knowledge and attitudes toward AI, using the Chi-Square test. Statistical significance was set at a p-value of less than 0.05. Key findings were illustrated using tables and figures to enhance clarity and interpretation.

Results:

Participants' Demographics:

A total of 150 oral and maxillofacial surgeons completed the survey. The majority were male (n = 102, 68%) and aged 36–45 years (n = 64, 43%). Clinical experience ranged from <5 years (n = 25, 17%), 5–15 years (n = 84, 56%), to >15 years (n = 41, 27%). Most participants were affiliated with academic institutions (n = 90, 60%), while 40% (n = 60) practiced exclusively in private or clinical settings (Table 1).

Table 1. Demographic Characteristics of Participants (n = 150)

Characteristics	Frequency (n)	Percentage (%)
Gender		
Male	102	68
Female	48	32
Age (years)		
28-35	45	30
36-45	64	43
46-60	40	27
Years of experience		
<5	25	17
5-15	84	56
>15	41	27
Institution type		
Academic	90	60
Private/ Clinical practice	60	40

Knowledge of AI Applications

Awareness of AI was categorized as **low (≤33%)**, **moderate (34–66%)**, and **high (≥67%)** based on correct responses to knowledge-related questions. Overall, 58% (n = 87) exhibited moderate awareness, particularly regarding AI in diagnostic imaging and treatment planning. Awareness of AI in educational simulations and virtual training platforms was reported by 40% (n = 60).

Bivariate analysis showed a significant association between years of clinical experience and AI knowledge ($\chi^2 = 6.92$, df = 2, p = 0.03, Cramer's V = 0.21). Multivariable logistic regression, controlling for age and institutional affiliation, confirmed that surgeons with >10 years of experience were more likely to have moderate-to-high AI knowledge (OR = 2.41; 95% CI: 1.12–5.17; p = 0.024) (Figure 1).

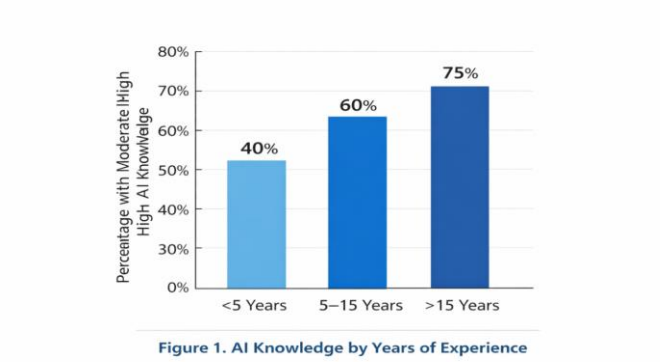

Figure 1. AI Knowledge by Years of Experience

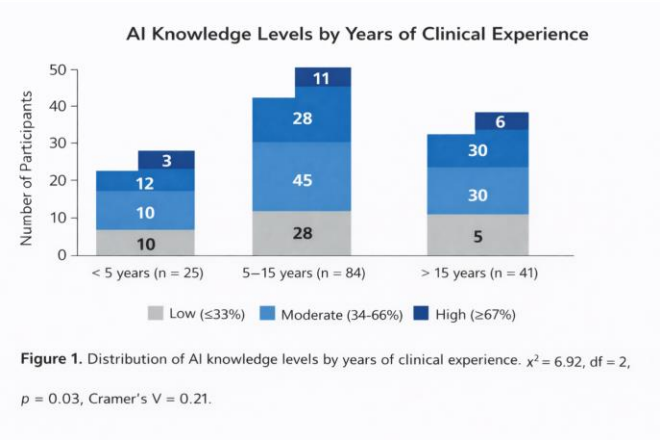

Figure 1. Distribution of AI knowledge levels by years of clinical experience. $x^2 = 6.92$, df = 2, $p = 0.03$, Cramer's V = 0.21.

Attitudes Toward AI

Overall, 62% (n = 93) reported a positive attitude toward AI integration. Academic affiliation was significantly associated with favorable attitudes ($\chi^2 = 5.45$, df = 1, p = 0.02, Cramer's V = 0.19). In multivariable analysis adjusting for age and experience, academic surgeons were more likely to express positive perceptions of AI (OR = 1.87; 95% CI: 1.03–3.39; p = 0.039).

Practices and Perceived Barriers

Despite moderate awareness and positive attitudes, only 35% (n = 53) actively used AI tools in clinical or educational settings. Reported barriers included Limited access to AI tools: n = 72 (48%), Lack of formal training/workshops: n = 63 (42%), Ethical or legal concerns: n = 57 (38%)

Table 2. Knowledge, Attitudes, Practices, and Barriers toward AI (n = 150)

Domain	Response/Observation	Frequency (n)	Percentages (%)
Knowledge of AI applications	Moderate awareness	87	58
	Use in imaging and treatment planning	87	58
	Use in educational simulations	60	40
Attitudes toward AI	Positive attitude	93	62
Practice / Use of AI tools	Actively using AI	53	35
Barriers to AI implementation	Limited access to AI tools	72	48
	Lack of formal training	63	42
	Ethical/legal concerns	57	38

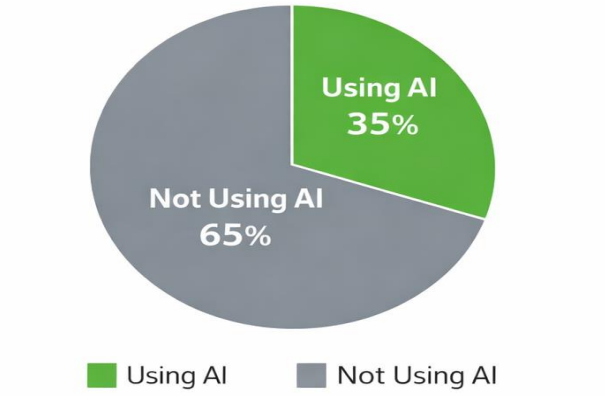

Figure 2. *Use of AI in Clinical and Educational Settings*

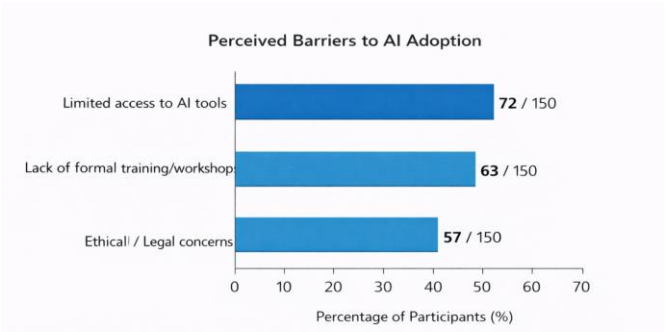

Figure 2. Perceived barriers to AI adoption among oral and maxillofacial surgeons (n = 150).

The proportion of missing responses was <5% for all variables. Missing data was handled via listwise deletion. Sensitivity analyses showed that removing incomplete responses did not significantly change the overall findings. Although oral and maxillofacial surgeons have a moderate level of awareness and generally favorable attitudes toward AI, its practical use is still relatively low.

Experience and academic affiliation were significant predictors of knowledge and attitudes, respectively. Key barriers included restricted access, insufficient training, and ethical concerns must be addressed through targeted education, resource provision, and

ethical guidelines to promote effective integration of AI in clinical and educational practice.

Discussion:

The findings of this study showed that 58% of oral and maxillofacial surgeons had a moderate level of awareness about AI in clinical and educational use, while 62% held favorable views toward its adoption. However, only 35% reported actively using AI-based tools in practice. These results highlight a clear gap between awareness, favorable perceptions, and practical implementation. Surgeons with more than 10 years of experience demonstrated higher AI knowledge, suggesting that clinical exposure and accumulated procedural expertise may facilitate understanding and interest in new technologies. Additionally, those affiliated with academic institutions exhibited more positive attitudes compared to private practitioners, likely due to greater access to resources, exposure to emerging technologies, and involvement in educational initiatives.

Our findings align with previous research demonstrating that AI is increasingly recognized as a valuable adjunct in OMFS education and practice (1,2,3). Deep learning algorithms have shown promise in 3D segmentation of craniofacial structures, enhancing preoperative planning and surgical precision (4,5). AI-assisted image analysis has been shown to enhance diagnostic precision and minimize variability between clinicians in identifying maxillofacial fractures and other related conditions. (6,7,14,15). However, the limited routine use of AI observed in our study mirrors broader trends, where clinicians cite barriers such as restricted access to AI tools, insufficient training, and ethical or legal concerns (8,9,25).

The predominant barriers identified—restricted availability of AI tools (48%), lack of formal training (42%), and ethical concerns (38%)—underscore the need for structured educational programs and institutional support to facilitate adoption. Prior studies have highlighted that integrating AI into training platforms, virtual simulations, and adaptive learning systems can increase engagement and competency among trainees (10,13,18,20). Similarly, explainable AI (XAI) frameworks can foster trust by allowing surgeons to understand algorithmic recommendations, which is crucial for clinical decision-making (22,23).

Overall, while OMFS professionals generally perceive AI positively, our results emphasize that practical adoption is constrained by resources, training, and ethical factors. Addressing these barriers through accessible AI platforms, structured workshops, and clear clinical guidelines is essential to bridge the gap between awareness and routine use, enhancing both patient care and surgical education (24,25).

Conclusion:

Oral and maxillofacial surgeons acknowledge the advantages of artificial intelligence, with 58% showing moderate awareness and 62% expressing favorable attitudes; however, only 35% currently apply it in clinical practice. Surgeons with greater experience had higher knowledge, and those in academic settings showed more favorable attitudes. Key barriers included limited access to AI tools, lack of formal training, and ethical or legal concerns. Addressing these challenges through structured training programs, improved access to technology, ethical guidance, and explainable AI platforms is essential to promote safe and effective integration of AI in both clinical practice and surgical education.

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Dr. Momil Nadeem Sheikh: Conception, Designing and Manuscript drafting
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