SHOULD ARTIFICIAL INTELLIGENCE INTEGRATE WITH DENTAL EDUCATION? AN ASSESSMENT THROUGH THE DENTOMAXILLOFACIAL RADIOLOGY PERSPECTIVE

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ABSTRACT

Introduction: The requirement to adapt dentistry education to the growing knowledge and big data is evident. Future dentists will participate in AI studies as both researchers and users. The main aim was to evaluate the attitudes of undergraduate dental students on artificial intelligence (AI) applications. Secondarily, it was aimed to discuss possible solutions for the integration of AI into education in particular to dentomaxillofacial radiology.

Material and Method: A written survey included 16 questions with a 5-point Likert-scale was designed. The content of the survey included basic knowledge about AI terminology, applications on dentomaxillofacial radiology, and future estimations. One hundred seventy-six students attending the 3rd, 4th, and 5th grades were included. The attitudes of the students were assessed with the total score. The responses were scored as: Strongly disagree: 1, Disagree: 2, Neutral: 3, Agree: 4, Strongly agree: 5. The minimum and maximum possible points were 16 and 80, and 48 was the middle score. The scores were classified as 16-31 (group 1), 32-47 (group 2), 48-63 (group 3), and 64-80 (group 4). Cronbach's alpha reliability coefficient was used to test the internal consistency of the questions. One-way analysis of variance and Chi-square test were used to compare normally distributed data. The Mann-Whitney U test was used to compare the that did not show normal distribution. Statistical significance was evaluated with a 5% Type-I error level.

Results: The Cronbach's alpha reliability coefficient was 0.849. The response rate of the participants was 83.41% (n=176). The mean total scale score was 57.68 ± 0.651. Group 3 had the largest cluster (67.61%; n=119), whereas the group 1 had the smallest (0.56%; n=1). The total scale score showed no statistically significant difference between the academic years.

Conclusion: The attitudes of undergraduate dental students on AI were positive and students are aware of the potential of applications in the field. The conventional dentomaxillofacial radiology curriculum requires an update.

KEYWORDS: Artificial intelligence. Machine learning. Dentistry. Dentomaxillofacial radiology. Undergraduate student.

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INTRODUCTION

Artificial intelligence (AI) applications have the potential to be disruptive in modern medicine. Mainly, the expectation of AI in health is to understand an individual's medical condition and needs by considering many variables together[1]. This prediction anticipates that AI will be a tool that facilitates and improves medicine in the near future. It will be necessary to keep up with these developments in each field of health through a new educational perspective.

Machine learning (ML), a specific field of AI, involves the modelling of algorithms that learn patterns among complex data sets and predict new outputs[2,3]. Diverse and large amounts of data improve the performance of ML algorithms. Inherently, the digital nature of the big data in the radiology allows for the early adoption of AI[1,4]. Similar to the ML process, the decision-making of a radiologist includes analyzing radiographs to recognize patterns, correlating them with clinical findings, generating a differential diagnosis, and selecting the most probable diagnosis[1].

Dentomaxillofacial radiology involves interpreting the intraoral/extraoral plain radiographs and recently cone-beam CT (CBCT) images, and understanding the indications for the advanced imaging such as helical computed tomography (CT), magnetic resonance imaging (MRI) and ultrasonography (USG)[1]. In daily clinical routine, graduated dental students are expected to have developed skills in interpreting plain radiographs and CBCT images[6]. The need for a clear understanding of basic sciences, especially the pathophysiology of disease, is one of the challenges in dentomaxillofacial radiology education[7].

According to the report of Dave and Horner[8], the most common consultation topics from general practitioners and other specialists to dentomaxillofacial radiologists for a second clinical opinion were variations in normal anatomy, chronic periapical periodontitis, idiopathic osteosclerosis, dental caries, and periodontal bone loss. Stated topics are the main dental issues and usually would not be expected to require a second opinion. Considering the technical concordance of the radiographic data to ML studies and the challenges in dentomaxillofacial radiology, it is clear that AI applications will be a precious tool to minimize this imperfection in the coming years. In recent deep learning (DL) research that detected and numbered teeth in intraoral radiographs, Chen et al.[9] concluded that their proposed automatic system performs were very close to the level of a junior dentist.

The competition and cooperation environment of the modern world demonstrates that future dentists will both benefit and compete with AI applications in many ways. The current conditions clearly force an improvement in the educational content of dentomaxillofacial radiology, as in every field of dentistry and medicine. However, the new wave of AI has given rise to some disagreements, too. Chockley and Emanuel[2] asserted that machine learning algorithms have the potential to replace radiologists as the data grows. On the contrary, Chan and Siegel[10] argued the idea that machines would end radiology damages the radiology profession by discouraging medical students from choosing radiology.

It is well known that dental students are familiar with digital technologies due to the era of digital dentistry. CBCT scans, intraoral scanners, CAD/CAM systems, 3D printing technologies are some instances of the featured digital systems that the students hear from the lectures of different dentistry disciplines[11]. Considering that there are concerns that AI can replace human radiologists in the field of medicine, the main objective of the present study was to evaluate the attitudes of undergraduate dental students on AI applications in dentistry. Secondarily, it was aimed to discuss possible solutions for the integration of AI into education in particular to dentomaxillofacial radiology.

MATERIAL AND METHOD

Study design

A written survey on the subject of AI in dentomaxillofacial radiology was designed. Institutional ethics board approval (115/2) was obtained for the study. The survey included 16 questions with a 5-point Likert-scale. The questions were prepared in the native language (Turkish) of the participants to prevent confusion on the meaning. The survey was piloted by two maxillofacial radiologists. After the recommendations were discussed by the specialists, linguistic and typographic improvements were implemented. The English version of the instructions and the questions was in Table 1. The content of the survey was the basic knowledge about AI terminology, AI applications on dentomaxillofacial radiology and future estimations for the clinical dental practice. Only age and gender were

Table 1. Instructions and the questions of the survey.

Dear Students,

This questionnaire has been prepared to evaluate "the Attitudes of Undergraduate Dental Students to Possible Dentomaxillofacial Radiology Applications of Artificial Intelligence". Your answers will contribute to a scientific study on the given topic. There are 16 questions in this form about AI applications. Answering takes approximately 15 minutes. Your participation in the survey should be voluntary. Your answers will be kept confidential, used only for the research, and your personal information will not be shared with anyone. Therefore, do not write your personal information on the form. If you do not approve, you may not participate or you can stop answering.

Thank you for your time and contribution to the research with your sincere answers.

FIRST PART	1. An artificial intelligence algorithm might detect proximal caries on bitewing radiography. 2. An artificial intelligence algorithm might diagnose periodontitis on periapical radiography. 3. An artificial intelligence algorithm might detect osteoporosis on panoramic radiography. 4. An artificial intelligence algorithm might perform cephalometric analysis. 5. An artificial intelligence algorithm might detect missing teeth on cone beam computed tomography. 6. An artificial intelligence algorithm might detect odontogenic tumors on computed tomography.
SECOND PART	7. Artificial intelligence is the capability of a machine to perform complex tasks such as problem-solving, object and word recognition, and decision making. 8. Machine learning is the modelling of the patterns and relationships among complex data sets and predicting new outputs from different data sets on the basis of those model. 9. Dental radiographs might be reported by deep learning algorithms running with the image processing method. 10. Storing dental radiographs in cloud-based systems instead of local servers makes data access and processing easier and reduces costs. 11. Blockchain technology allows the protection of the privacy of personal dental radiographs of patients.
THIRD PART	12. The use of the clinical photographies and panoramic radiographs in addition to periapical radiographs contribute to the accuracy of the caries diagnosis with an artificial intelligence algorithm on periapical radiography. 13. In order to diagnose a particular pathology by an artificial intelligence algorithm, radiographs that contain both the identified pathology and healthy individuals should be used as input. 14. I think that artificial intelligence will perform the same accuracy with dentists in the radiological diagnosis of a pathology located in the maxillofacial region in 10 years' time. 15. I think that artificial intelligence will be an indispensable supportive tool for dentomaxillofacial radiology specialists in the radiologic diagnosis of a pathology located in the maxillofacial region in 10 years' time. 16. Although the use of digital data in radiological examinations, I think that artificial intelligence cannot completely replace the dentomaxillofacial radiology specialists.

requested; no additional identifying information was asked.

Two hundred eleven students in the 3rd, 4th, and 5th grades of the Faculty of Dentistry in Istanbul Okan University in the 2019-2020 academic year were planned to be included in the survey. The reason for the selection of participants from different academic years was that all of them have taken dentomaxillofacial radiology lectures at different levels. Students that were absent at the time of the survey were excluded from the study to prevent the sharing of opinions. After being given verbal and written instructions, 176 students voluntarily participated in the survey.

The responses were scored as: Strongly disagree: 1, Disagree: 2, Neutral: 3, Agree: 4, Strongly agree: 5. The attitudes of the students were assessed with the total score, not for the individual questions. The minimum and maximum possible points were 16 and 80, and 48 was the middle score. The total scale score was classified into 4 groups as 16-31 group 1, 32-47 group 2, 48-63 group 3, and 64-80 group 4.

Statistical Analysis

The results were analyzed using the Statistical Package for Social Science

(SPSS 21.0) software package (SPSS Inc., Chicago, Illinois, USA). Cronbach's alpha reliability coefficient was used to test the internal consistency of the questions. Means and standard deviations were used to describe the scale because the series of questions was designed to measure a particular trait[12]. The Kolmogorov-Smirnov test was used to test the assumption of normality. One-way analysis of variance and Chi-square test were used to compare normally distributed data. The Mann-Whitney U test was used to compare the data that did not show normal distribution. Statistical significance was evaluated with a 5% Type-I error level.

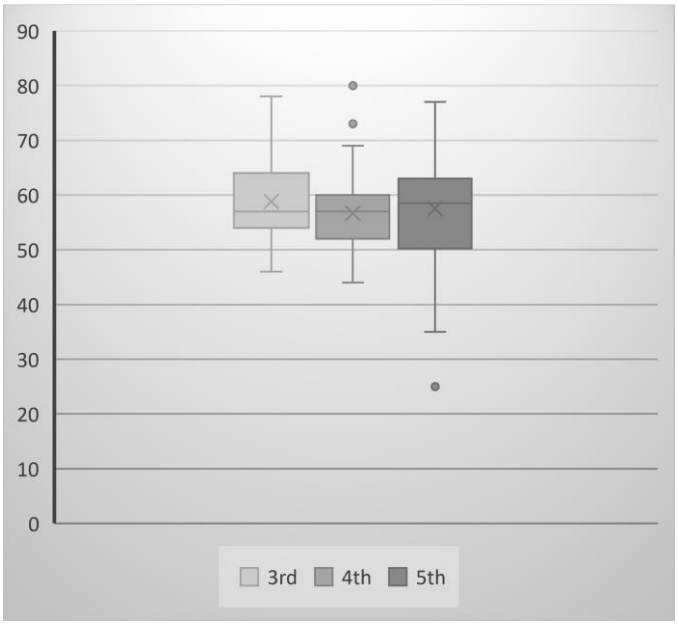
RESULTS

The Cronbach's alpha reliability coefficient was 0.849 (good) for the 16 questions. The response rate of the participants was 83.41% (n=176) for 211 students. The mean age was 22.3 ± 0.87 years. Ninety-one (51.70%) of the students were female and the remainder was male (48.30%; n=85). The minimum score obtained from the survey was 25, and the maximum was 80. The mean total scale score was 57.68 ± 0.651. Means, standard deviations, confidence intervals, and minimum/maximum points of the total scores according to academic years are shown in Table 2. The distribution of total scores between the groups was as follows: group 1, 0.56% (n=1); group 2, 10.22% (n=18), group 3, 67.61% (n=119), and group 4, 21.59% (n=38). Group 3 had the largest cluster. The distribution of total scores between academic years is demonstrated in the box plot graph in Table 3. The total scale score showed no statistically significant difference between the academic years (p=0.398). There was no statistically significant difference in either age or gender with the total survey score (p=0.151 and p=0.087 respectively).

Table 2. The mean, standard deviation (Sd), minimum and maximum points of group scores between academic years (at %95 Confidence Interval).

Academic year	Mean±Sd	95% CI for Mean		Min / Max Points	*p* value
		Lower Bound	Upper Bound		
3rd	58.83±7.612	56.85	60.81	46 / 78	
4th	56.67±7.364	54.71	58.62	44 / 80	0.398
5th	57.52±10.510	54.80	60.23	25 / 77	

Table 3. The distribution of total scores between academic years.



DISCUSSION

Adapting to new technology is always a compelling issue. In every field of medicine, it is necessary to develop strategies for both investigating the potential of AI and defining the required scientific, educational, and ethical issues. The purpose of this study was to discuss the game-changing potential of AI applications, in particular for education, by evaluating the views of undergraduate dental students. To our knowledge, there is no such research in the literature evaluating the opinions of dental students about AI.

The present series of questions was designed systematically to measure the perception of dental students on the integration of the ascending AI technologies in dentomaxillofacial radiology. The capability of AI algorithms in imaging modalities used in dentomaxillofacial radiology was examined in the first six questions. The purpose of this part was to help to score the perception of students from different academic years who have varied dentomaxillofacial radiology knowledge. An advancing scale from the evaluation of proximal caries on bite wing radiographs to the detection of odontogenic tumors on computed tomography was built. Each of the mentioned radiology tasks had already been studied with AI[17,18,20,23]. The second part of the survey (7th to 11th questions) investigated the knowledge of the basic terminology about AI and ML, and the possible applications of image processing, cloud systems, and blockchain in the field of dentomaxillofacial radiology. This part was aimed to measure the understanding of students about the implementations of AI. The last part of the questionnaire (12th to 16th questions) was about the future predictions on AI utilization and human practitioners.

Using the Likert scale method, the sum of the scores allowed the evaluation of awareness level and the attitudes of the participants with an inclusive approach. Based on this content, it might be assumed that the students in group 1 (0.56%) represented the most pessimistic individuals about AI, whereas group 4 (21.59%) represented the most optimistic students. On the other hand, group 2 (10.22%) and group 3 (67.61%) might exemplify skeptics in negative and positive ways, respectively. In addition, when groups 3 and 4 were evaluated together, it was seen that 89.2% of the participants responded above the average score. Moreover, thanks to gender equality in education, as expected gender did not significantly differ in the total score rates. The high score rates might be interpreted as the awareness level of the participants on the subject is obvious and they agree with the idea that AI will be an essential part of dentomaxillofacial radiology.

Collado-Mesa et al.[13] conducted a survey at their diagnostic radiology residency program and reported that there was a lack of awareness of AI implications on radiology among both attending radiologists and trainees. The prominently different results of the present study may be a reflection of how the perception of AI in medicine has improved in a short three-year time period. In another recent study conducted with undergraduate medical students, Pinto Dos Santos et al.[14] stated that students agreed that AI would likely revolutionize radiology. Moreover, they emphasized that most students disagreed with the idea that AI applications would replace human radiologists. It is not possible to compare individual answers between the studies because of methodologic differences, Pinto Dos Santos et al. [14] used a Likert-type questionnaire, whereas the present study used a Likert scale survey. However, it is clear that the idea of task replacement between human practitioners and machines remains a poor prediction and not a certainty in the foreseeable future.

AI systems offer opportunities for population health, early detection of disease, and improvements in quality, efficiency, and cost-effectiveness of healthcare services[3]. Specific to radiology, AI implementations may assist in detecting pathologies, improving image interpretation time and accuracy, and the prioritization of cases[15]. Some promising AI assistant medical tools have been introduced recently. Chester is a recent inclusive system designed to be an aiding tool for diagnosing chest X-rays, promising to use minimal computational power while maintaining patient privacy[16]. There are also some studies intended to solve specific dentomaxillofacial radiology tasks on different imaging modalities. Lee et al.[17] demonstrated a DL algorithm for assessing the diagnosis and predictability of periodontally compromised teeth on periapical radiographic images. Poedjiastoeti and Suebnukarn[20] structured an algorithm that detects ameloblastomas and keratocystic odontogenic tumors on digital panoramic radiographic images. They reported their results may aid in screening for these benign tumors in a substantially shorter time than oral and maxillofacial surgeons. Orhan et al.[18] recently developed a deep convolutional neural network method to detect

periapical pathosis in CBCT images for clinical application. Kise et al.[19] introduced a DL system for the detection of Sjögren's syndrome on CT as a diagnostic support tool. The reported diagnostic accuracies of the DL algorithms using the above-mentioned dentomaxillofacial radiology studies ranged from 76.7% to 96% (17-20). The promising diagnostic accuracy scores of these pilot studies are an indication of the practical benefits that AI applications will offer to dentistry in the near future.

The requirement to adapt dentistry education to the growing knowledge and big data is evident. Taking into account the survey scores, students seem ready to cooperate with the changing environment. One of the questions that the present study looked for the answer was how AI technologies should be integrated into dentistry education. When the researchers of the afore-mentioned dentomaxillofacial radiology studies were compared, it was remarkable that two-dimensional (2D) imaging studies were conducted with dental specialists (a periodontologist [17] and an oral and maxillofacial surgeon[20]), whereas 3D imaging studies had mathematicians or engineering partners along with the dental specialists (a dentomaxillofacial radiologist[18,19] and an endodontist[18]). The varying professions of current researchers are noteworthy as a projection for AI-based dentistry studies. Future dentists will participate in AI studies as both researchers and users. In light of such an assumption, improving their awareness and knowledge will be inevitable. The undergraduate dental curriculum might be updated by focusing on understanding the basic concept of AI rather than the mathematical substructure in the first step.

Transformation in dentistry will also affect the specialty preferences of candidate dentists. Among the dentistry branches, dentomaxillofacial radiology, which stands out especially with its compatibility with image processing methods, is a considerable candidate to contribute to developing the curriculum. Although it may vary between countries, an undergraduate student mainly studies radiation physics, basic and advanced radiographic techniques, and image interpretation in dentomaxillofacial radiology classes[21]. In the faculty that the survey has been conducted, theoretical dentomaxillofacial radiology classes are divided into 3 academic years. The radiation physics, image formation, and digital imaging lectures are given in the 2nd grade. The normal radiographic anatomy, CBCT imaging, and the advanced imaging systems are described in the 3rd grade. In the 4th grade, radiographic interpretation of the specific pathologies and the generation of differential diagnosis are introduced. 5th-grade students have no theoretical radiology classes. Moreover, students in the 3rd, 4th, and 5th grades attend the clinical practice as interns under the observation of professors. The outcomes of the study revealed that the perception of students showed no significant difference between the academic years. This might be caused by the lack of AI content in the current dental curriculum yet. It might be suggested that lectures introducing AI could be spread over the academic years. In line with the curriculum flow, students may be introduced gradually to radiographic images as a component of big data, the rationale of AI algorithms, and the possible implementations of AI in dentomaxillofacial radiology and dentistry.

The construction of standardized dental public datasets is one of the main necessities for clinical practice of AI in the field of dentistry[22]. In a systematic review on the use and performance of AI applications in dentomaxillofacial radiology, Hung et al.[23] stated that the diagnostic performance of AI models still needed to be verified in terms of the generalizability and reliability of these models before clinical application. The existing challenges entail the development of the specialty curriculum in dentomaxillofacial radiology, too. For a qualified and rapid improvement, dentomaxillofacial radiology specialty education might be enriched by the training of complex tasks such as the standardization of the storage of patient records and radiographs with cloud systems, anonymization of these data or encryption by blockchain technologies, and processing them with AI models.

There are some limitations of the present study. One is the questionnaire was conducted in a single institution with a student sample that originated from similar socio-economic conditions. Different populations may affect the outcomes of the research. Another limitation is that neither the dentomaxillofacial radiology nor the other dentistry branches yet had AI content in their curricula in the faculty, so the basic framework of the survey might not be sufficient to generalize the concept. Additionally, the exclusion of postgraduates and specialists from the study is a restrictive factor for the extent of the research. A comprehensive assessment of the views of undergraduates, postgraduates, and specialists together will help to form a

roadmap to progress the educational concept. Furthermore, to assess the alterations in the specialty preferences of students, long-term studies should be conducted.

CONCLUSION

There is no doubt the use of AI promises to improve patient care and reduce public health costs in many ways. The outcomes of the study indicate that the attitudes of undergraduate dental students on AI applications were positive and the students are aware of the potential of AI in the field. The conventional dentomaxillofacial radiology curriculum requires an update to introduce AI applications. It is essential to discuss the methodologic approaches for AI adaptation to dental education and make an effort to work interdisciplinary and multi-centrally.

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Conflict of Interest

There is no conflict of interest to declare.

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