MANCHESTER 1824
The University of Manchester

The University of Manchester Research

The knowledge, experience, and attitude on artificial intelligence-assisted cephalometric analysis: Survey of orthodontists and orthodontic students

DOI:
10.1016/j.ajodo.2023.07.006

Document Version
Accepted author manuscript

Link to publication record in Manchester Research Explorer

Citation for published version (APA):
Lin, L., Tang, B., Cao, L., Yan, J., Zhao, T., Hua, F., & He, H. (2023). The knowledge, experience, and attitude on artificial intelligence-assisted cephalometric analysis: Survey of orthodontists and orthodontic students. *American Journal of Orthodontics and Dentofacial Orthopedics*. Advance online publication. https://doi.org/10.1016/j.ajodo.2023.07.006

Published in:
American Journal of Orthodontics and Dentofacial Orthopedics

Citing this paper
Please note that where the full-text provided on Manchester Research Explorer is the Author Accepted Manuscript or Proof version this may differ from the final Published version. If citing, it is advised that you check and use the publisher's definitive version.

General rights
Copyright and moral rights for the publications made accessible in the Research Explorer are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

Takedown policy
If you believe that this document breaches copyright please refer to the University of Manchester's Takedown Procedures [http://man.ac.uk/04Y6Bo] or contact uml.scholarlycommunications@manchester.ac.uk providing relevant details, so we can investigate your claim.

OPEN ACCESS

Download date:28. Apr. 2024

The Knowledge, Experience and Attitude Pertaining to Artificial Intelligence-Assisted Cephalometric Analysis: Survey of Orthodontists and Orthodontic Students

Lizhuo Lin [a, b +], Bojun Tang [a, b +], Lingyun Cao [a, b], Jiarong Yan [a, b],

Tingting Zhao [a, b, c], Fang Hua [c, d, e, f *], Hong He [a, b, c *]

a. Hubei-MOST KLOS & KLOBM, School & Hospital of Stomatology, Wuhan University, Wuhan, China.
b. Department of Orthodontics, School & Hospital of Stomatology, Wuhan University, Wuhan, China.
c. Center for Dentofacial Development & Sleep Medicine, School & Hospital of Stomatology, Wuhan University, Wuhan, China.
d. Center for Orthodontics and Pediatric Dentistry at Optics Valley Branch, School & Hospital of Stomatology, Wuhan University, Wuhan, China.
e. Center for Evidence-Based Stomatology, School & Hospital of Stomatology, Wuhan University, Wuhan, China.
f. Division of Dentistry, School of Medical Sciences, Faculty of Biology, Medicine and Health, The University of Manchester, Manchester, UK.

+ These authors contributed equally to this work.

Lizhuo Lin, Email: linlizhuo@whu.edu.cn
Bojun Tang, Email: tangbojun@whu.edu.cn
Lingyun Cao, Email: caolingyun@whu.edu.cn
Jiarong Yan, Email: yanjiarong@whu.edu.cn
Tingting Zhao, Email: zhaott1991@whu.edu.cn

*** Corresponding authors:**
Fang Hua
Associate professor and chair, Center for Orthodontics and Pediatric Dentistry at Optics Valley Branch, School & Hospital of Stomatology, Wuhan University, Luoyu Rd. 237, Wuhan 430079, China. Email: huafang@whu.edu.cn
Hong He
Professor and chair, Department of Orthodontics, School & Hospital of Stomatology, Wuhan University, Luoyu Rd. 237, Wuhan 430079, China. Email: drhehong@whu.edu.cn

ACKNOWLEDGMENTS

We would like to express our sincere gratitude to all the orthodontic professionals that participated in this survey, and Jingyuan Xu, for his contribution to the critical revision of the questionnaire.

Funding

This work was Supported by the Undergraduate Education Quality Construction and Comprehensive Reform Project, Wuhan University (No. 2021ZG328), and the Chinese Stomatological Association COS Basic Research Fund (No. COS-B2021-08).

https://doi.org/10.1016/j.ajodo.2023.07.006

The Knowledge, Experience and Attitude Pertaining to Artificial Intelligence-Assisted Cephalometric Analysis: Survey of Orthodontists and Orthodontic Students

ABSTRACT

Introduction: Artificial intelligence (AI) developed rapidly in orthodontic field and AI-based cephalometric applications have been adopted. This study aimed to assess AI-assisted cephalometric technologies related knowledge, experience and attitude among orthodontists and orthodontic students, describe their subject view of the applications and related technologies in orthodontics and to identify associated factors.

Materials and methods: An online cross-sectional survey based on a professional survey tool (www.wjx.cn) was performed from October 11 to 17, 2022. Participants were recruited with purposive and snowball sampling approach. Data was collected and analyzed with descriptive statistics, chi-square tests and multivariable generalized estimating equations.

Results: A total of 480 valid questionnaires were collected and analyzed. 68.8% of the respondents agreed that AI-based cephalometric applications would replace manual and semi-automatic approaches. Practitioners using AI-assisted applications (87.5%) spent less time in cephalometric analysis than the other groups using other approaches, and 349 (72.7%) respondents considered AI-based applications could assist in obtaining more accurate analysis results. Lectures and training programs (56.0%) were the main sources of respondents' knowledge about AI. Knowledge level was associated with experience in AI-related clinical or scientific projects ($P < 0.001$). Most respondents (88.8%) were interested in future AI applications in orthodontic field.

Conclusions: Respondents are optimistic about the future of AI in orthodontic field. AI-assisted cephalometric applications were believed to be able to make clinical diagnostic analysis more convenient and straightforward for practitioners, and even replace manual and semi-automatic

approaches. The education and promotion of AI should be strengthened to elevate orthodontists' understanding.

Keywords: artificial intelligence, cephalometric analysis, orthodontics, questionnaire, experience

Introduction

Artificial intelligence (AI) is an emerging technology based on computer science to develop machines that mimic intelligent behavior with little assistance from humans.[1,2] In general, AI encompasses various technologies, including machine learning, natural language processing, computer vision, and so on.[3] The development of precision medicine is greatly promoted by the stunning advancements of AI in recent decades.[4-6] Similarly, orthodontic research has become focused on the application of AI, particularly machine learning techniques in diagnosis, treatment planning and decision-making optimization.[7-9] including airway analysis,[10-13] extraction decision,[14-16] orthognathic surgery intervention,[17-19] etc., to improve the efficiency and avoid bias of inexperienced practitioners.[20]

Cephalometric analysis is universally adopted in the clinical process of orthodontic and orthognathic practice.[21] The manual detection of landmarks via conventional and semi-automated approaches on X-ray images is time-consuming and affected by clinicians' experience, resulting in compromised accuracy.[22] Recent studies have shown remarkable progress in AI-based landmark localization. Previous research extensively employed deep learning network models within the domain of machine learning, such as Convolutional Neural Networks (CNN), to successfully accomplish automated cephalometric analysis. [23-26]

There is no doubt that AI, an emerging but rapidly developing technology, can generate an all-round promotion of orthodontic services.[8] There are already many commercially available cephalometric analyses software utilizing AI-related technologies that are emerging in clinical practice. However, due to the potential technology inaccuracies in diagnosis and clinical decision-making at this stage, the AI-based applications in medical field are still taken cautiously. Data curation and sharing should be further promoted.[27-29]

With the swift advancement of AI technologies in visual object recognition detection, several surveys have investigated the attitudes of medical professionals and students toward AI technologies, especially in the field of radiology.[30-33] However, there is no relevant study in orthodontics. As a powerful assistant tool, is AI-related software likely to replace healthcare workers (HCWs) in performing certain tasks? Considering that AI-assisted cephalometric applications have been used in orthodontic clinical practice, this study focuses on this aspect and aims to investigate related knowledge, experience and attitude of orthodontists and orthodontic students, and describe their

view of AI-based applications as well as associated factors. In addition, the present study was suitably extended to explore their experience and expectations for the future development of AI in the field of orthodontics, to provide suggestions for enhancements to current AI applications and future directions of multidisciplinary research in AI and orthodontics.

Materials and methods

Ethical approval

This study was an anonymous online survey with a convenience sample. Ethical approval was granted by the Ethics Committee of the School & Hospital of Stomatology, Wuhan University (No. 2022-B58). The questionnaire was written based on the CHERRIES (CHEcklist for Reporting Results of Internet E-Surveys), an online survey guideline.[34] The informed consent form in the first section of the questionnaire included the study objectives, the target population and the principle of voluntariness, and includes the contact information of the investigator. The survey was entirely anonymous, with all data stored on one investigator's computer in encrypted form. Participants were specifically informed that there were no rewards or penalties for participating in the survey. They could withdraw anytime and were considered voluntarily participating once submitted.

Survey design

According to previous studies,[30-32] the questionnaire was developed and divided into four sections with total of 37 items **(Supplementary Material 1)**. The first section was about the background information of respondents. Questions regarding pertinent knowledge were set in the second section, which included six items, with one Likert-scale item (#15) assessing individuals' self-perceived familiarity with AI technologies. Five questions pertaining to the fundamental knowledge of AI-assisted cephalometric analysis and other AI-based applications in orthodontics are provided to evaluate the respondents' actual knowledge level (2 single-choice and 3 multiple-choice, #16 to #20). To investigate the experience of respondents, the items in the third section focused on their perceptions of AI-based cephalometric applications. Furthermore, a few questions in the fourth section (#32, #33, #35) were about the behavior with these applications. Other items of the fourth section were about participants' attitude toward their preferences for the use of AI-

based applications in clinical practice and their expectations for future AI development.

The questions were designed to be logically linked in order to make the questionnaire more concise and relevant when actually filled out. Based on the particular options selected by respondents, it is determined whether subsequent specific questions were displayed or skipped. For example, in the question about whether they would like to use AI-assisted cephalometric applications in clinical practice (#26), selecting "yes" or "no" would jump to the question asking for their reasons for this attitude. Before the final release of the questionnaire, it was sent to a panel of 7 orthodontists, 7 orthodontic students and 1 graduate student in computer science for a pilot survey. The intention of pilot survey is to find potential ambiguities and ensure the purpose of every item was clear and there were no flaws in the logic and structure in the questionnaire. In addition, the approximate time required to respond to all items was determined to be five minutes. After the pilot survey, a few items were added or subtracted based on the feedback and the objectives of the survey, and expressions that may have been semantically unclear were revised.

Participant recruitment

The questionnaire was uploaded to an online survey platform (www.wjx.cn), which could ensure the completeness of the submitted questionnaires. The purposive and snowball sampling techniques were used for participant recruitment.[35] The questionnaire link was disseminated on WeChat public platform, which has been China's biggest social media platform. Then the link was sent to orthodontic chat groups and orthodontic practitioners were required to invite their students and friends engaging in orthodontics to fill out the questionnaire.

The distribution of this survey was from October 11 to 17, 2022. The questionnaire was accessed only through WeChat and could only be submitted once from each account. Questionnaires with apparent errors such as contradictory answers and abnormal age, and anomalous response times (<2 min or more than 30 min) were excluded.[36]

Statistical analysis

The collected data were all downloaded from the online platform and coded by two authors independently, and as planned a priori, invalid data were excluded. All discrepancies were resolved by discussion. For the knowledge section (#16 to #20), each question was worth 1 point if answered

correctly. Then the total knowledge score was calculated (score range: 0 to 5).

The general information of respondents and the answers to each question were described by descriptive statics. For all Likert-scale items, the score ranged from 1 (completely disagree) to 5 (completely agree). Information related to respondent demographic characteristics and AI-related scientific experience and behaviors were described in frequencies and percentages. Chi-square tests and Kruskal-Wallis tests were used to analyze categorical data and skewed data, respectively.

To explore the associated factors to the self-perceived level of familiarity with AI and AI-based applications and total knowledge score, generalized estimating equations (GEE) regression analyses were performed. To detect multicollinearity, predictors with tolerance <0.1 or VIF (variance inflation factor) > 10 were removed from the final model. $P < 0.05$ was regarded statistically significant.

Results

Within the set survey period, 498 questionnaires were collected. 18 invalid questionnaires were excluded according to the previously developed exclusion inclusion criteria, and finally 480 valid questionnaires were included for analysis. The questionnaires came from 32 of China's 34 provincial-level administrative regions. **Table I** shows the demographic information of the respondents. The 480 respondents ranged in age from 22-64 years, with a mean age of 32.5 (SD = 8.9), of which 317 were females (66.0%) and 163 were males (34.0%).

For the professional attributes of the respondents, orthodontists accounted for more than half (62.1%), and the proportion of orthodontic students was 34.0%. The majority of the respondents (97.7%) reported that they routinely used cephalometric analysis in their clinical practice, with 62.0% using semi-automated cephalometric tracing most frequently, followed by AI automated tracing (22.2%). Only 22.1% of the participants considered themselves familiar with AI technologies, while those who had never engaged in AI-related clinical or scientific projects accounted for 88.5% of the overall respondents.

Of the 584 participants who routinely used cephalometric aids in orthodontic clinical practice, the proportion of those who took less than 5 minutes to perform lateral cephalometric tracing was 55.9%. As shown in **Table II**, the proportion of respondents who traced a lateral cephalogram for less than 5 minutes differed significantly between the groups using different tracing approaches.

The largest percentage used AI-automated tracing (87.5%), followed by semi-automatic tracing (48.1%) and manual tracing (32.6%).

Knowledge, experience and attitude

The self-evaluation score for AI familiarity was 2.89 (SD 0.94, score range: 0 to 5), while the mean total knowledge score was 1.54 (SD 1.193). As shown in **Figure 1**, lectures and training programs (56.0%) and academic conferences (55.6%) are the main sources of knowledge for the respondents, followed by journal literature (43.5%), websites (35.6%), people around (35.6%), social media (30.6%), undergraduate or graduate courses (33.8%) and books (26.0%).

Table III presents the results of GEE regression analyses for the self-evaluation level for AI technologies familiarity and total knowledge score. Results indicated that self-perceptions were associated with workplace setting and AI-related clinical or scientific projects experience. Respondents who had never been involved in AI-related projects (B = -0.685, 95%CI: -0.949 to -0.421, P < 0.001) had significantly lower self-perceptions of AI technology familiarity. In contrast, those whose workplaces were private (P = 0.009) had significantly higher self-ratings. According to GEE regression analyses, the total knowledge score of AI and AI-assisted cephalometric analysis was only significantly lower among the participants who had no experience in AI-related clinical or scientific projects (B = -0.676, 95%CI: -1.058 to -0.294, P <0.001).

Several AI-assisted cephalometric analysis applications have been adopted by orthodontic professionals in the orthodontic clinic. The majority of the respondents (96.5%) had heard of AI automated cephalometric applications and had experience with different software (79.2%). However, less than two-thirds (63.3%) were aware of the cost. Of the several automatic cephalometric applications listed in **Supplementary Table I**, the one that most participants had heard of, used and informed about the cost was iOrtho (86.3%, 60.6%, 41.7%), followed by Uceph (66.5%, 48.5%, 42.1%) and Digident (50.6%, 26.9%, 27.7%). A total of 426 (88.8%) respondents were interested in the future AI applications in orthodontic field, and they believed future direction should be aided decision-making, treatment protocol design, and orthodontic outcome prediction. **Table IV** shows the related attitudes and behaviors of respondents grouped by profession. Orthodontists paid more attention to the future application of AI technologies in orthodontics than orthodontic students (P = 0.002), and the latter were less in agreement that AI-assisted software could reduce the time to

perform cephalometric analysis ($P = 0.001$). 68.8% of the respondents agreed that AI-based software would replace manual and semi-automatic cephalometric approaches in the near future ($P < 0.001$).

Regarding the most desirable advantages of automated cephalometric analysis, **Figure 2** showed that accurate results (81.0%) and usability (72.7%) were the two dimensions most valued by participants. As indicated in **Supplementary Table II**, the majority (96.0%) of respondents in the survey were willing to use AI-assisted cephalometric analysis, with 83.8% considering additional time savings and 50.0% being sufficiently satisfied with the accuracy of the automatic landmark localization. In addition, 3.3% of the respondents were hesitant to use automatic landmark detection because of their perception of the lack of accuracy, and only 1.0% considered the high prices of the software. According to 84.6% of respondents, AI cephalometric applications should be charged for, and more than half (59.2%) stated a reasonable price set at $137 (RMB 1000) or less. Among those with experience in using AI-assisted cephalometric applications, only 3.9% never made adjustments to the AI landmark localization.

Discussion

AI technologies have been developed rapidly in recent years and have progressively been applied in clinical visual data processing, auxiliary diagnosis, and prognosis assessment. Landmark detection and analysis of cephalometric measurements was presently one of the most extensive applications of AI technologies in orthodontic practice,[7,37] and it could be highly accessible and offer convenience for orthodontic practitioners.[38] There was no research on the perception and experience of AI-assisted cephalometric applications among orthodontic practitioners, despite the fact that many researchers have undertaken to explore the possibility of AI technologies to assist in orthodontic clinical practice. This was the first survey on the knowledge, experience and attitude of orthodontists and orthodontic students towards AI-assisted cephalometric analysis and related technologies and applications. A 37-item questionnaire based on WeChat public platform and online survey tool was conducted, to provide a valuable reference for the current situation of AI-assisted cephalometric applications and the future direction of AI technologies in the orthodontic field.

As one of the most crucial tools for orthodontic diagnosis and decision-making, cephalometric measurements continue to maintain a unique role.[21] By automating the measuring process, semi-automatic cephalometric analysis programs have substantially increased the efficiency and usability,

largely replacing the traditional manual approach that involved using a viewing box and acetate tracing paper.[39] Currently, there are several commercial AI automatic cephalometric software or platforms available. The results of this study indicated that around one-fifth of participants frequently utilized the AI-based cephalometric approach, a more recent innovation, while the other three-fifths were still habituated to semi-automatic cephalometric measures.

The results also revealed that time-saving was a big advantage of utilizing AI technologies for cephalometric analysis, which was the primary motivation for the majority of users to adopt this technology. However, for the accuracy of AI-assisted cephalometric applications, although the overall tendency was satisfactory, there was still potential for improvement. Only a tiny fraction (3.9%) of respondents did not perform manual calibration after employing AI applications, with the possible reason that the inaccuracy of the AI applications is influenced by the selection of AI models, the sharpness of medical radiographs and the developing model that expert detection, machine-learning.[40-42] On the one hand, machine learning is not optimally consistent, on the other, there are differences in landmark localization from one R&D team to another and they lack an adequate data basis for their applications. Users may frequently not fully be convinced by the results of automated detection due to their own experience. Therefore, sharing, interoperability and standardization management of huge volumes of data may be key strategies to leapfrog the landmark detection accuracy challenge. The top three brands applied by respondents (iOrtho, Uceph, Digident) were all locally owned in China, which might be influenced by racial disparities, marketing access, the accessibility to after-sales services, publicity and data security.

Despite the surging of AI-related research in the field of orthodontics, orthodontic practitioners still lack knowledge of AI and AI-based cephalometric applications related fundamental principles and classifications, which was consistent with the results of other studies,[32,43] and high levels of related knowledge were significantly associated with having participated in AI clinical or scientific research projects. A possible explanation is that most respondents have only used the applications and never acquired a better comprehension of AI's underlying principles and associated information. Despite the research and application of AI technologies in orthodontics were proliferating, it is frequently conducted in partnership between orthodontic practitioners and programmers. In the future, cultivating multidisciplinary abilities in orthodontics and computer science may be a contributing factor to the orthodontic-AI field advancement.

Previous research among other medical specialties found that respondents regarded the work of HCWs as irreplaceable by AI technologies.[32,44,45] Medical interactions require trust, communication and empathy,[44,46,47] particularly for a positive patient-physician relationship required in orthodontics, which needs to be maintained over time. Several aids such as cephalometric analysis may be substituted which does not require physicians to use them in the presence of patients, rather than clinical practice from start to finish. The results of this survey show that a large percentage of orthodontic practitioners were optimistic about the possibility of AI-assisted automatic cephalometric analysis replacing manual and semi-automatic cephalometric measurements in the near future. This indicates that they recognized the liberation of productivity brought about by technological advances, and the improved accuracy and stability of progressive development of AI technologies. Orthodontic students were less likely to agree with the potential revolutionary effects of AI, possibly due to their lack of experience distinguishing the effectiveness and accuracy of AI-based applications, as evidenced by their less agreement that AI software can reduce the amount of time spent on cephalometric analysis. They might require extra time to determine whether the outcomes of automated landmark detection were objectively accurate, as well as to make trade-offs and adjustments if they disagreed with the applications.

Individuals who had participated in AI-related clinical or scientific research and those whose workplace setting was private rated themselves as more familiar with AI technologies. The high self-perception of those groups might be influenced by curiosity and interest in new technologies, a more flexible private enterprise model, and comparatively less stringent access rules. Respondents' main sources of AI information were lectures and training programs, followed by academic conferences, while very few came from undergraduate and graduate courses. This was different from the results in other surveys, which showed the main source was social media.[32,44] The majority of respondents were enthusiastic about the future application of AI in orthodontics, as indicated by the findings. Therefore, further academic presentations and lectures focused on AI technologies can be considered to assist practitioners in comprehending the most recent industry developments. Meanwhile, related content could be incorporated into undergraduate and graduate education to stimulate interest, cultivate inter-disciplinary talents, and advance the industry's growth, as previous studies suggested.[2,45,48]

The route AI technologies in orthodontics would take in the future was a topic of increasing interest to many respondents. This survey was conducted from the viewpoint of orthodontic practitioners, or users of AI-based applications, and their expectations mainly focused on assisting treatment decisions and design, and orthodontic result prediction and presentation. However, details of orthodontic clinical practice are influenced by personalized orthodontic treatment plans, aesthetic diversity, and various operating technique levels. The design of applications that match these needs and are widely applicable would face the challenge of robustness, comparability, and generalizability of the results, which might necessitate even more data support, standardization of medical data administration, and perhaps international cooperation.[27] In addition, the survey reveals that respondents were willing to pay for the use of AI-assisted cephalometric applications, which was a positive sign from a health economics perspective for future AI research and development, achieving clinical translation, and commercialization. The development prospect of AI technologies in orthodontics is still broad, and this survey undoubtedly provides a valuable reference for research direction.

There were also limitations in this survey. First, as with previous surveys, although the number of valid questionnaires returned in this survey was sufficient for data analysis, selection bias should still be considered and the results be interpreted with caution. Second, the sample size of certain groups of the population might not be fully representative of the aggregate in which they are located. Even so, the sample of this study covered almost all provincial administrative regions in China, which was comprehensive enough. This is the first survey to investigate the knowledge, perception, experience, attitudes, and behaviors of orthodontic practitioners towards the application of AI-based cephalometric analysis and related technologies in orthodontics, which can assist orthodontic colleagues and researchers in understanding the current situation and providing valuable references for the future development of disciplinary crossover.

Conclusion

More than half of the respondents agreed that AI-assisted cephalometric analysis would replace manual and semi-automatic cephalometric approaches in the near future. AI-assisted cephalometric applications are believed to make clinical diagnostic analysis more convenient and straightforward for practitioners, and to benefit orthodontists more in their clinical practice. The majority of the

respondents are optimistic about the future of AI technologies in orthodontic field, while AI-related education should be strengthened to elevate orthodontists' understanding, and to further promote the cultivation of cross-disciplinary talents. The broad adoption of aided decision-making, treatment protocol design, and orthodontic outcome prediction are probably where AI applications in orthodontics will head in the future.

Declarations

Ethical approval and consent to participate

This study was reviewed and approved by the Ethics Committee of School & Hospital of Stomatology, Wuhan University (No. 2022-B58). Informed consent was obtained from all individual participants included in the study.

Competing interests

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Availability of data and materials

The data underlying this article will be shared on reasonable request to the corresponding author.

References

1. Mohammad-Rahimi H, Nadimi M, Rohban MH, Shamsoddin E, Lee VY, Motamedian SR. Machine learning and orthodontics, current trends and the future opportunities: A scoping review. Am J Orthod Dentofacial Orthop 2021;160:170-192 e174.

2. Hamet P, Tremblay J. Artificial intelligence in medicine. Metabolism 2017;69s:S36-s40.

3. Greco M, Caruso PF, Cecconi M. Artificial Intelligence in the Intensive Care Unit. Semin Respir Crit Care Med 2021;42:2-9.

4. Kermany DS, Goldbaum M, Cai W, Valentim CCS, Liang H, Baxter SL et al. Identifying Medical Diagnoses and Treatable Diseases by Image-Based Deep Learning. Cell 2018;172:1122-1131.e1129.

5. Garcia-Vidal C, Sanjuan G, Puerta-Alcalde P, Moreno-García E, Soriano A. Artificial intelligence to support clinical decision-making processes. EBioMedicine 2019;46:27-29.

6. Schwendicke F, Samek W, Krois J. Artificial Intelligence in Dentistry: Chances and Challenges. J Dent Res 2020;99:769-774.

7. Schwendicke F, Chaurasia A, Arsiwala L, Lee JH, Elhennawy K, Jost-Brinkmann PG et al. Deep learning for cephalometric landmark detection: systematic review and meta-analysis. Clin Oral Investig 2021;25:4299-4309.

8. Khanagar SB, Al-Ehaideb A, Vishwanathaiah S, Maganur PC, Patil S, Naik S et al. Scope and performance of artificial intelligence technology in orthodontic diagnosis, treatment planning, and clinical decision-making - A systematic review. J Dent Sci 2021;16:482-492.

9. Bichu YM, Hansa I, Bichu AY, Premjani P, Flores-Mir C, Vaid NR. Applications of artificial intelligence and machine learning in orthodontics: a scoping review. Prog Orthod 2021;22:18.

10. Zhao T, Zhou J, Yan J, Cao L, Cao Y, Hua F et al. Automated Adenoid Hypertrophy Assessment with Lateral Cephalometry in Children Based on Artificial Intelligence. Diagnostics (Basel) 2021;11.

11. Liu JL, Li SH, Cai YM, Lan DP, Lu YF, Liao W et al. Automated Radiographic Evaluation of Adenoid Hypertrophy Based on VGG-Lite. J Dent Res 2021;100:1337-1343.

12. Ryu S, Kim JH, Yu H, Jung HD, Chang SW, Park JJ et al. Diagnosis of obstructive sleep apnea with prediction of flow characteristics according to airway morphology automatically extracted from medical images: Computational fluid dynamics and artificial intelligence approach. Comput Methods Programs Biomed 2021;208:106243.

13. Shujaat S, Jazil O, Willems H, Van Gerven A, Shaheen E, Politis C et al. Automatic segmentation of

the pharyngeal airway space with convolutional neural network. J Dent 2021;111:103705.

14. Evangelista K, de Freitas Silva BS, Yamamoto-Silva FP, Valladares-Neto J, Silva MAG, Cevidanes LHS et al. Accuracy of artificial intelligence for tooth extraction decision-making in orthodontics: a systematic review and meta-analysis. Clin Oral Investig 2022.

15. Xie X, Wang L, Wang A. Artificial neural network modeling for deciding if extractions are necessary prior to orthodontic treatment. Angle Orthod 2010;80:262-266.

16. Jung SK, Kim TW. New approach for the diagnosis of extractions with neural network machine learning. Am J Orthod Dentofacial Orthop 2016;149:127-133.

17. Shin W, Yeom HG, Lee GH, Yun JP, Jeong SH, Lee JH et al. Deep learning based prediction of necessity for orthognathic surgery of skeletal malocclusion using cephalogram in Korean individuals. BMC Oral Health 2021;21:130.

18. Choi HI, Jung SK, Baek SH, Lim WH, Ahn SJ, Yang IH et al. Artificial Intelligent Model With Neural Network Machine Learning for the Diagnosis of Orthognathic Surgery. J Craniofac Surg 2019;30:1986-1989.

19. Tanikawa C, Yamashiro T. Development of novel artificial intelligence systems to predict facial morphology after orthognathic surgery and orthodontic treatment in Japanese patients. Sci Rep 2021;11:15853.

20. Topol EJ. High-performance medicine: the convergence of human and artificial intelligence. Nat Med 2019;25:44-56.

21. BROADBENT BH. A NEW X-RAY TECHNIQUE and ITS APPLICATION TO ORTHODONTIA: The Introduction of Cephalometric Radiography. Angle Orthod 1981;51:93-114.

22. Miloro M, Borba AM, Ribeiro-Junior O, Naclério-Homem MG, Jungner M. Is there consistency in cephalometric landmark identification amongst oral and maxillofacial surgeons? Int J Oral Maxillofac Surg 2014;43:445-453.

23. Yu HJ, Cho SR, Kim MJ, Kim WH, Kim JW, Choi J. Automated Skeletal Classification with Lateral Cephalometry Based on Artificial Intelligence. J Dent Res 2020;99:249-256.

24. Nishimoto S, Sotsuka Y, Kawai K, Ishise H, Kakibuchi M. Personal Computer-Based Cephalometric Landmark Detection With Deep Learning, Using Cephalograms on the Internet. J Craniofac Surg 2019;30:91-95.

25. Lee JH, Yu HJ, Kim MJ, Kim JW, Choi J. Automated cephalometric landmark detection with

confidence regions using Bayesian convolutional neural networks. BMC Oral Health 2020;20:270.

26. Hwang HW, Park JH, Moon JH, Yu Y, Kim H, Her SB et al. Automated identification of cephalometric landmarks: Part 2-Might it be better than human? Angle Orthod 2020;90:69-76.

27. Shan T, Tay FR, Gu L. Application of Artificial Intelligence in Dentistry. J Dent Res 2021;100:232-244.

28. Hosny A, Parmar C, Quackenbush J, Schwartz LH, Aerts H. Artificial intelligence in radiology. Nat Rev Cancer 2018;18:500-510.

29. Schwendicke F, Golla T, Dreher M, Krois J. Convolutional neural networks for dental image diagnostics: A scoping review. J Dent 2019;91:103226.

30. Pinto Dos Santos D, Giese D, Brodehl S, Chon SH, Staab W, Kleinert R et al. Medical students' attitude towards artificial intelligence: a multicentre survey. Eur Radiol 2019;29:1640-1646.

31. Huisman M, Ranschaert E, Parker W, Mastrodicasa D, Koci M, Pinto de Santos D et al. An international survey on AI in radiology in 1,041 radiologists and radiology residents part 1: fear of replacement, knowledge, and attitude. Eur Radiol 2021;31:7058-7066.

32. Yuzbasioglu E. Attitudes and perceptions of dental students towards artificial intelligence. J Dent Educ 2021;85:60-68.

33. Coppola F, Faggioni L, Regge D, Giovagnoni A, Golfieri R, Bibbolino C et al. Artificial intelligence: radiologists' expectations and opinions gleaned from a nationwide online survey. Radiol Med 2021;126:63-71.

34. Eysenbach G. Improving the quality of Web surveys: the Checklist for Reporting Results of Internet E-Surveys (CHERRIES). J Med Internet Res 2004;6:e34.

35. Tyrer S, Heyman B. Sampling in epidemiological research: issues, hazards and pitfalls. BJPsych Bull 2016;40:57-60.

36. Hua F, Qin D, Yan J, Zhao T, He H. COVID-19 Related Experience, Knowledge, Attitude, and Behaviors Among 2,669 Orthodontists, Orthodontic Residents, and Nurses in China: A Cross-Sectional Survey. Front Med (Lausanne) 2020;7:481.

37. Oh K, Oh IS, Le VNT, Lee DW. Deep Anatomical Context Feature Learning for Cephalometric Landmark Detection. IEEE J Biomed Health Inform 2021;25:806-817.

38. Jianbin MA, Chaoran XUE, Ding BAI. Progress on application of artificial intelligence technology in orthodontic diagnosis and treatment. Journal of Prevention and Treatment for Stomatological Diseases

2022;30:278-282.

39. Erkan M, Gurel HG, Nur M, Demirel B. Reliability of four different computerized cephalometric analysis programs. Eur J Orthod 2012;34:318-321.

40. Sayinsu K, Isik F, Trakyali G, Arun T. An evaluation of the errors in cephalometric measurements on scanned cephalometric images and conventional tracings. Eur J Orthod 2007;29:105-108.

41. Hwang HW, Moon JH, Kim MG, Donatelli RE, Lee SJ. Evaluation of automated cephalometric analysis based on the latest deep learning method. Angle Orthod 2021;91:329-335.

42. Song Y, Qiao X, Iwamoto Y, Chen Y-w. Automatic Cephalometric Landmark Detection on X-ray Images Using a Deep-Learning Method. Applied Sciences 2020;10:2547.

43. Waymel Q, Badr S, Demondion X, Cotten A, Jacques T. Impact of the rise of artificial intelligence in radiology: What do radiologists think? Diagn Interv Imaging 2019;100:327-336.

44. Bisdas S, Topriceanu CC, Zakrzewska Z, Irimia AV, Shakallis L, Subhash J et al. Artificial Intelligence in Medicine: A Multinational Multi-Center Survey on the Medical and Dental Students' Perception. Front Public Health 2021;9:795284.

45. Pinto Dos Santos D, Giese D, Brodehl S, Chon SH, Staab W, Kleinert R et al. Medical students' attitude towards artificial intelligence: a multicentre survey. Eur Radiol 2019;29:1640-1646.

46. Inkster B, Sarda S, Subramanian V. An Empathy-Driven, Conversational Artificial Intelligence Agent (Wysa) for Digital Mental Well-Being: Real-World Data Evaluation Mixed-Methods Study. JMIR Mhealth Uhealth 2018;6:e12106.

47. Blease C, Kaptchuk TJ, Bernstein MH, Mandl KD, Halamka JD, DesRoches CM. Artificial Intelligence and the Future of Primary Care: Exploratory Qualitative Study of UK General Practitioners' Views. J Med Internet Res 2019;21:e12802.

48. Pauwels R, Del Rey YC. Attitude of Brazilian dentists and dental students regarding the future role of artificial intelligence in oral radiology: a multicenter survey. Dentomaxillofac Radiol 2021;50:20200461.

Figure caption

Fig 1. The sources of AI-related knowledge among respondents (semi-open question, #21) (n = 480).

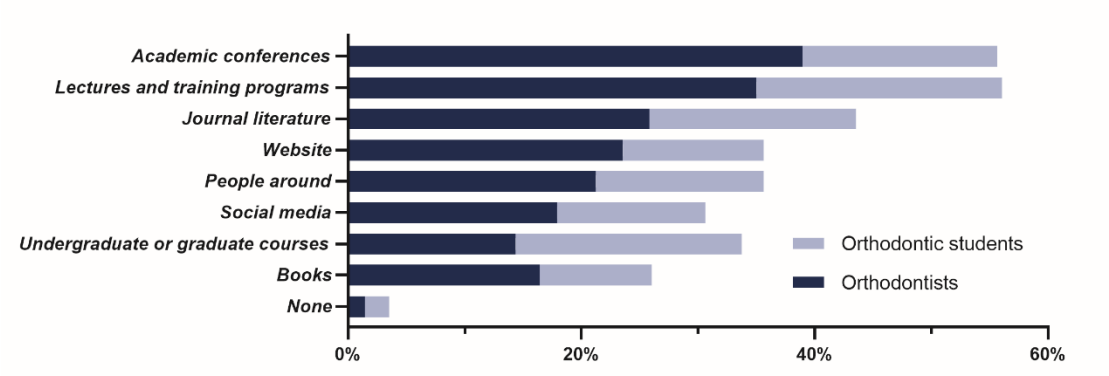

Fig 2. The most important strengths that respondents consider an AI-assisted cephalometric applications should possess (semi-open question, #36) (n = 480).

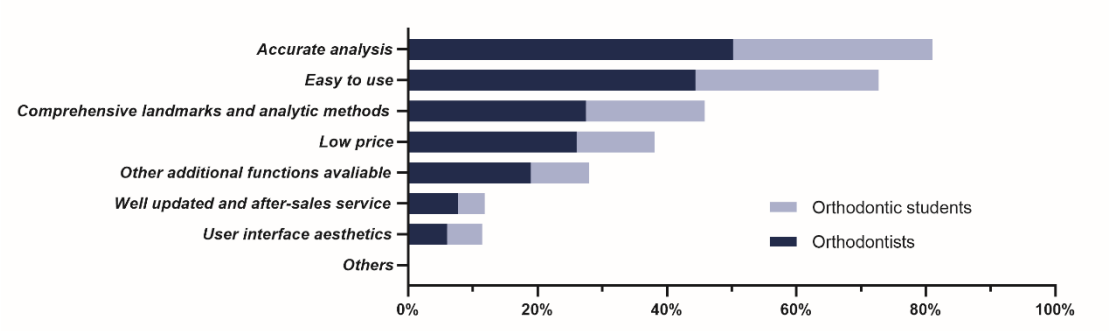

Table I. Demographic and workplace information of the respondents to this survey

Characteristics	N	%
Demographics		
Age §	32.5±8.9	22-64
Gender		
Female	317	66.0
Male	163	34.0
Profession		
Orthodontists	298	62.1
Orthodontic student	182	37.9
Years of orthodontic practice		
≤ 5 years	259	54.0
5-10 years	111	23.1
11-20 years	58	12.1
> 20 years	52	10.8
Highest academic degree		
PhD	89	18.5
Master	296	61.7
Bachelor	90	18.8
Junior college and Technical secondary school	5	1.0
Workplace information		
Setting		
public	367	76.5
private	113	23.5
Having experience in AI related subjects		
Yes	55	11.5
No	425	88.5
Routinely used lateral cephalometric radiographs clinically		
Yes	469	97.7
No	11	2.3
Routinely used cephalometric analysis methods (N=469)		
Direct observation	31	6.6
Manual tracing	43	9.2
Semi-automated tracing	291	62.0
AI automated tracing	104	22.2
Self-evaluation of familiarity with AI		
Completely unfamiliar	45	9.4
Unfamiliar	90	18.8
Neither familiar nor unfamiliar	239	49.8
Familiar	87	18.1
Completely familiar	19	4.0

§ Displayed as mean ± SD, and range.

Table II. Time spent by respondents with different approaches to cephalometric analysis

Personal experience §	Total (n=438)	Manual tracing (n=43)	Semi-automated tracing (n=291)	AI automated tracing (n=104)	P value
Time/min					
< 5	245 (55.9)	14 (32.6) [a]	140 (48.1) [a]	91 (87.5) [b]	
6 to 10	115 (26.3)	10 (23.3) [a, b]	95 (32.6) [b]	10 (9.6) [a]	<0.0001
11 to 15	45 (10.3)	10 (23.3) [a]	33 (11.3) [a]	2 (1.9) [b]	
> 15	33 (7.5)	9 (20.9) [a]	23 (7.9) [b]	1 (1.0) [c]	

§ Displayed as N (%).

a, b, c: groups with the same letters in the same row are not statistically different ($P > 0.05$) according to *post hoc* tests.

Table III. Results of multivariable generalized estimating equations (GEE) regression analyses for self-evaluation and total knowledge score of AI

Variable	Self-evaluation of familiarity with AI			AI-related knowledge score		
	B	95% CI	P value	B	95% CI	P value
Demographics						
Age	-0.005	(-0.036, 0.026)	0.741	-0.037	(-0.070, -0.004)	0.027
Gender			0.114			0.115
Male	Reference			Reference		
Female	-0.138	(-0.309, 0.033)	0.114	-0.172	(-0.387, 0.042)	0.115
Profession			0.238			0.341
Orthodontic specialists	Reference			Reference		
Orthodontic residents	-0.184	(-0.491, 0.122)	0.238	-0.193	(-0.590, 0.204)	0.341
Years of orthodontic practice			0.822			0.352
≤ 5 years	Reference			Reference		
5-10 years	0.127	(-0.157, 0.412)	0.380	-0.238	(-0.534, 0.953)	0.246
11-20 years	0.056	(-0.440, 0.552)	0.826	0.035	(-0.535, 0.604)	0.905
> 20 years	-0.013	(-0.730, 0.704)	0.971	0.210	(-0.639, 0.164)	0.580
Titles			0.937			0.164
Students	Reference					
Residents	0.058	(-0.249, 0.365)	0.709	-0.378	(-0.778, 0.023)	0.065
Attending physician	0.108	(-0.291, 0.506)	0.597	-0.119	(-0.656, 0.417)	0.663
Associate chief physician	0.267	(-0.346, 0.880)	0.393	0.068	(-0.665, 0.801)	0.856
Chief physician	0.172	(-0.583, 0.928)	0.655	0.312	(-0.576, 1.200)	0.491
Highest academic degree			0.826			0.247
PhD	Reference			Reference		
Master	0.076	(-0.151, 0.304)	0.512	-0.329	(-0.649, -0.009)	0.044
Bachelor	0.138	(-0.150, 0.426)	0.348	-0.274	(-0.655, 0.106)	0.158

Junior college and Technical secondary school	0.098	(-1.002, 1.198)	0.862	-0.106	(-1.150, 0.937)	0.842
Workplace information						
Setting			0.009			0.769
Public	Reference			Reference		
Private	0.283	(0.070, 0.496)	0.009	0.041	(-0.231, 0.313)	0.769
Having experience in AI-related subjects			<0.001			0.001
Yes	Reference			Reference		
No	-0.685	(-0.949, -0.421)	<0.001	-0.676	(-1.058, -0.294)	0.001

Table IV. Respondents' attitude and behaviors towards AI and AI cephalometric applications by profession

Questions about attitude and behaviors	Total	Orthodontists (N=298)	Orthodontic students (N=182)	P value
24. I am interested in the future application of AI in the field of orthodontics.	5 (4 - 5)	5 (4 - 5)	4 (4 - 5)	0.002
29. AI cephalometric applications reduce the time required to perform cephalometric analysis.	4 (4 - 5)	5 (4 - 5)	4 (4 - 5)	0.001
30. AI cephalometric applications can help me to get more accurate analysis results.	4 (3 - 5)	4 (3 - 5)	4 (3 - 4)	0.041
37. AI cephalometric applications will replace manual and semi-automatic cephalometric analysis in the near future.	4 (3 - 5)	4 (4 - 5)	4 (3 - 4)	< 0.001

#24, #29, #30, #37: Displayed as median (25th percentile – 75 percentile). Likert scale, ranging from 1 (completely disagree) to 5 (completely agree).

Supplementary Material 1

The Knowledge, Experience and Attitude Pertaining to Artificial Intelligence-Assisted Cephalometric Analysis: Survey of Orthodontists and Orthodontic Students

We are inviting you to participate in a questionnaire survey entitled "The Knowledge, Experience and Attitude Pertaining to Artificial Intelligence-Assisted Cephalometric Analysis: Survey of Orthodontists and Orthodontic Students". The study protocol has been approved by the Ethics Committee of School & Hospital of Stomatology, Wuhan University ([2022] NO. B58).

Before deciding whether to participate in this study, please read the Informed Consent via the following link. **The submission of this questionnaire will be regarded as your consent to participate.**

【Informed Consent：http://qr61.cn/o26pmL/qHGlf0b **】**

This survey is anonymous and takes about **5 minutes** to complete.

Section 1

This section is mainly about your personal background information. The information will be used for this survey only.

1. Age [blank filling question] *

_____

2. Gender [single-choice question] *

○Man

○Female

3. Profession [single-choice question] *

○Orthodontists

○Orthodontic students

4. Years of orthodontic practice (including postgraduate education period) [single-choice question] *

○≤ 5 years

○6~10 years

○11~20 years

○ > 20 years

5. Your current position [single-choice question] *

○Students

○Resident in orthodontist

○Attending orthodontist

○Associate chief of the orthodontic department/ Associate professor

○Chief of the orthodontic department/Professor

6. Highest academic degree [single-choice question] *

○PhD

○Master

○Bachelor

○Junior college

○College degree

○Technical secondary school

7. Location of your workplace: [blank filling question] *

_____

8. Setting of your workplace [single-choice question] *

○Hospital of Stomatology (Public)

○Hospital of Stomatology (Private)

○Department of Stomatology of General Hospital (Public)

○Department of Stomatology of General Hospital (Private)

○Community dental clinic (Public)

○Dental clinics (Private)

9. Are you working on or have you completed an AI-related clinical/scientific research project? [single-choice question] *

○Yes

○No

10. In my daily practice of orthodontics, I routinely take a lateral cephalometric film. [single-choice question] *

○Yes

○No

11. In the last two years of orthodontic practice, the kinds of techniques I use most frequently for cephalometric analysis: [single-choice question] *

○Direct observation

○Traditional hand-tracing methods

○Computer-based semi-automated software（Dolphin, etc.）

○AI cephalometric programs

Dependent on option 1 in question 10

12. The average time it takes me to complete a cephalometric analysis by traditional hand-tracing methods is： [single-choice question] *

○≤5mins

○6~10 mins

○11~15 mins

○⩾15mins

Dependent on option 2 in question 11

13. The average time it takes me to complete a cephalometric analysis by computer-based semi-automated software is： [single-choice question] *

○≤5mins

○6~10 mins

○11~15 mins

○≥15mins

Dependent on option 3 in question 11

14. The average time it takes me to complete a cephalometric analysis by AI cephalometric programs is： [single-choice question] *

○≤5mins

○6~10 mins

○11~15 mins

○≥15mins

Dependent on option 4 in question 11

Part 2

This section is about your level of knowledge about artificial intelligence.

15. I think the level of familiarity I have with artificial intelligence is: [single-choice question] *

○Completely unfamiliar ○Unfamiliar ○Neither familiar nor unfamiliar ○Familiar ○Completely familiar

16. What is the relationship between the following nouns with each other? [single-choice question] *

○Artificial Intelligence > Machine Learning > Deep Learning

○Artificial Intelligence > Deep Learning > Machine Learning

○Machine Learning > Artificial Intelligence > Deep Learning

○Artificial Intelligence > Machine Learning = Deep Learning

○Artificial Intelligence = Machine Learning = Deep Learning

17. Supervised learning is one of the artificial intelligence learning models that generates a function for predicting outcomes accurately. As input data is fed into the model, it adjusts its weights until the model has been fitted appropriately. [single-choice question] *

○Yes

○No

○Don’t know

18. Which of the following are classical deep learning models or methods? [Multiple-choice question] *

□Convolutional Neural Networks, CNN

□Recurrent Neural Network, RNN

□Generative Adversarial Networks, GANs

□Reinforcement Learning, RL

□None of the above

□Don’t know

19. What belongs to the application of artificial intelligence image recognition in the field of dentistry? [Multiple-choice question] *

□Cephalometric analysis

□Measurement of crowding

□Measurement of 3D model

□Measurement of P-A film

□Segmentation of teeth and gingiva

□None of the above

□Don’t know

20. In addition to cephalometry, In addition to cephalometry, AI-related research/software applications have been produced in the following aspects： [Multiple-choice question] *

□Cervical vertebra maturation, CVM

□Adenoids and/or tonsils hypertrophy

□Extraction decision

□Visual treatment objective, VTO

□Orthognathic surgery intervention decision

□None of the above

□Don’t know

Part 3

This section is about your perception of AI technology applications.

21. The sources of your knowledge about the application of artificial intelligence in the field of orthodontics include: [Multiple-choice question] *

□Undergraduate or graduate courses

□Lectures and training programs

□Academic conferences

□Books

□Journal literature

□Websites

□Social media

□People around

□Other (free text) *

□None

22. The following AI cephalometric software that I have heard about include: [Multiple-choice question] *

□Uceph

□Digident

□WebCeph

□Audax

□iOrtho

□KOOA

□DentaliQ

□Other (free text) *

□None

23. I know the cost of the following AI cephalometric software: [Multiple-choice question] *

□Uceph

□Digident

□WebCeph

□Audax

□iOrtho

□KOOA

□DentaliQ

□Other (free text) *

□None

Part 4

This section is about your attitude and behavior toward the application of AI technology.

24. I am concerned about the application of artificial intelligence in the field of orthodontics. [single-choice question] *

○Completely disagree	○Disagree	○Neither agree nor disagree	○Agree	○Completely agree

25. I think the most important direction for AI in the field of orthodontics in the future is: [blank filling question] *

(Free text)

Dependent on options 4、5 in question 24

26. Are you willing to use AI cephalometric software in clinical practices routinely? [single-choice question] *

○Yes

○No

27. The reason that I am willing to use AI cephalometric software in clinical practices routinely include: [Multiple-choice question] *

□Automated landmark detection is accurate enough

□ time-saving

□Other (free text) *

Dependent on option 1 in question 26

28. The reason that I am NOT willing to use AI cephalometric software in clinical practices routinely include: [Multiple-choice question] *

□Automated landmark detection is not accurate

□High prices

□Other (free text) *

Dependent on option 2 in question 26

29. I think AI cephalometric software can reduce the time for cephalometric analysis in clinical practices. [single-choice question] *

○Completely disagree	○Disagree	○Neither agree nor disagree	○Agree	○Completely agree

30. I think AI cephalometric software can help to get more accurate analysis results. [single-choice question] *

○Completely disagree	○Disagree	○Neither agree nor disagree	○Agree	○Completely agree

31. I think the reasonable charge below per year for AI cephalometric software is: [single-choice question] *

○For free

○¥1~1000

○¥1000~3500

○¥3500~7000

○≥ ¥7000

32. The following AI cephalometric software that I have used include: [Multiple-choice question] *

□Uceph

□Digident

□WebCeph

□Audax

□iOrtho

□KOOA

□DentaliQ

□Other (free text) *

□None

33. The frequency of my manual correction to the AI landmark localization when using the above AI cephalometric software is: [single-choice question] *

○Never

○Sometime

○Often

○Always

Dependent on option 1;2;3;4;5;6;7;8 in question 32

34. The platform that I prefer to use for the above AI applications is: [single-choice question] *

○Website

○App

○Computer software

○Other (free text) *

○All of above

Dependent on option 1;2;3;4;5;6;7;8 in question 32

35. How many orthodontists at your hospital/dental clinic are using AI cephalometric software? [single-choice question] *

○All of the orthodontists

○Most of the orthodontists

○A few orthodontists

○None of the orthodontists

○Don’t know

36. The most important advantages that an AI cephalometric software should possess: [Multiple-choice question] *

□Easy to use

□User interface aesthetics

□Low price

□Accurate analysis

□Comprehensive landmarks and analytic methods

□Other additional functions available

□Well update and after-sales service

□Other (free text) *

37. I believe that artificial intelligence cephalometric software will replace manual and semi-automatic cephalometric measurements in the near future. [single-choice question] *

○Completely disagree	○Disagree	○Neither agree nor disagree	○Agree	○Completely agree

Supplementary Table I. Respondents' personal experience with AI cephalometric application

Personal experience §	Heard about	Used	Know the cost
Names			
Uceph	319 (66.5)	233 (48.5)	202 (42.1)
Digident	243 (50.6)	129 (26.9)	133 (27.7)
WebCeph	100 (20.8)	43 (9.0)	29 (6.0)
Audax	14 (2.9)	3 (0.6)	5 (1.0)
iOrtho	414 (86.3)	291 (60.6)	200 (41.7)
KOOA	22 (4.9)	6 (1.3)	7 (1.5)
DentaliQ	24 (5.0)	13 (2.7)	7 (1.5)
Others	13 (2.7)	18 (3.8)	2 (0.4)
None	17 (3.5)	100 (20.8)	176 (36.7)

§ Displayed as N (%).

Supplementary Table II. Respondents' attitude and behaviors about AI cephalometric applications

Questions	N	%
27. Willing to use AI cephalometric applications (N=461)		
Accurate automatic detection	240	50.0
Less time spent	402	83.8
Others	11	2.3
28. Unwilling to use AI cephalometric applications (N=19)		
Inaccurate automatic detection	16	3.3
High price	5	1.0
Others	2	0.4
31. Suitable annual charge for AI cephalometric applications (N=480)		
0	74	15.4
1~1000	284	59.2
1000~3500	97	20.2
3500~7000	20	4.2
>7000	5	1.0
33. Frequency of manual adjustment using AI cephalometric applications (N=383)		
Never	15	3.9
Sometimes	222	58.0
Often	109	28.5
Always	37	9.7
34. Platforms that prefer to use AI applications (N=383)		
Website	99	25.8
Phone App	34	8.9
PC standalone App	198	51.7
Above all	52	13.6
35. Current use of AI cephalometric applications at your institution (N=480)		
All colleagues are using	50	10.4
Most colleagues are using	158	32.9
A few colleagues are using	175	36.5
No colleagues are using	34	7.1
Don't know	63	13.1