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Artificial intelligence in orthodontics: Where are we now? A scoping review

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Abstract

Objective: This scoping review aims to determine the applications of Artificial Intelligence (AI) that are extensively employed in the field of Orthodontics, to evaluate its benefits, and to discuss its potential implications in this speciality. Recent decades have witnessed enormous changes in our profession. The arrival of new and more aesthetic options in orthodontic treatment, the transition to a fully digital workflow, the emergence of temporary anchorage devices and new imaging methods all provide both patients and professionals with a new focus in orthodontic care.

Materials and methods: This review was performed following the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guidelines. The electronic literature search was performed through MEDLINE/PubMed, Scopus, Web of Science, Cochrane and IEEE Xplore databases with a 11-year time restriction: January 2010 till March 2021. No additional manual searches were performed.

Results: The electronic literature search initially returned 311 records, and 115 after removing duplicate references. Finally, the application of the inclusion criteria resulted in 17 eligible publications in the qualitative synthesis review.

Conclusion: The analysed studies demonstrated that Convolution Neural Networks can be used for the automatic detection of anatomical reference points on radiological images. In the growth and development research area, the Cervical Vertebral Maturation stage can be determined using an Artificial Neural Network model and obtain the same results as expert human observers. AI technology can also improve the diagnostic accuracy for orthodontic treatments, thereby helping the orthodontist work more accurately and efficiently.

KEYWORDS
artificial intelligence, machine learning, orthodontics, review

1 | INTRODUCTION

The last decades have witnessed enormous changes in our profession. The arrival of new and more aesthetic options in orthodontic treatment, the transition to the fully digital workflow, the emergence of temporary anchorage devices and new imaging methods all work to provide both patients and professionals with a new focus in orthodontic care.[1]

To make the diagnostic process more accurate and efficient, the use of Artificial Intelligence (AI) in orthodontics has grown significantly in recent years. This knowledge is fundamental for predicting treatment prognosis. However, the addition of this AI-based knowledge does not change the fact that the health professionals, with their own knowledge gained through specialized education and years of experience, are the ones that ultimately have to diagnose and determine the best treatment plan. Nevertheless, AI can be useful when making specific clinical decisions in a limited time. AI applications can guide clinicians to make better decisions and perform better, because the results obtained from AI are highly accurate and therefore, in some cases, can prevent human errors.[2]

To appreciate the impact of AI on orthodontics, it is first important to discern some key terms related to AI:

- AI's main objective is to offer a machine the ability to have its own intelligence. Put another way, AI aims for a machine to be able to learn through data, to solve problems by itself.
- Machine learning (ML) is the main backbone of AI. It depends on algorithms to predict outcomes based on data sets and draws influence from many research disciplines. Its purpose is to facilitate machines to learn from data so they can resolve issues without human input. The most commonly used techniques of ML include the support vector machine (SVM), logistic regression (LR), naive Bayesian classifier, decision tree (DT), random forest (RF), extreme learning machine (ELM), fuzzy k-nearest neighbour (FKNN) and convolution neural network (CNN).[2,3]
- Neural networks are a set of algorithms that calculate signals through artificial neurons that try to imitate the functioning of human neurons.
- Deep learning is an integral part of ML. It uses networks with different computer layers in deep neural networks to analyse input

data. Its purpose is to build a neural network that can automatically recognize patterns to improve feature detection.[2,3]

- Big data refers to large data sets and/or the combination of all available data points drawn from multiple sources which can be used to recognize patterns that inform a customized experience for different individuals.[1]

Orthodontic treatments are usually long procedures with an average treatment duration of nearly 29 months,[4] which is why orthodontists must become more efficient to adapt to the needs of society. The application of ML techniques can help to solve this issue.

Recent technological innovations in orthodontics, including cone beam computed tomography (CBCT) and 3D visualizations, intraoral scanners, facial scanners, instant teeth modelling software capabilities and new appliance developments using robotics and 3D printing, are changing the face of medical care and are quickly becoming integrated into dentistry.[5] These tools enable a better understanding of the patient's anatomy and are able to create dynamic anatomical reconstructions for the specific patient, and therefore accommodate the possibility of 3D treatment planning. Convolutional neural networks (CNNs) are increasingly applied for medical image diagnostics, most frequently for the detection, segmentation or classification of anatomical structures. Deep learning has also recently been used for geometric feature learning and classification.[6] Machine-learning approaches, which are algorithms trained to identify patterns in large data sets, are ideally suited to facilitate data-driven decision-making.[7]

This scoping review aims to determine the applications of AI that are extensively employed in the field of orthodontics, to evaluate the benefits of AI and to discuss its potential implications in this speciality.

2 | MATERIALS AND METHODS

2.1 | Protocol

This review was performed following the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guidelines.[8] A pilot search of MEDLINE (via

TABLE 1 Description of PICO elements

Study question	What is the applicability of Artificial Intelligence in the field of Orthodontics?
Population	Patients' diagnostic images (orthopantomography, cephalometric radiographs, intraoral radiographs, CBCT[†], clinical images, facial images and 3D model images).
Intervention	Artificial intelligence-based forms of diagnosis and treatment planning.
Comparison	Reference standards and existing literature.
Outcome	Measurable or predictive outcomes such as accuracy, sensitivity and specificity.

Abbreviations: C, Comparison; I, Intervention; O, Outcome; P, Population.
[†]Cone beam computed tomography.

PubMed) was conducted to prepare the study protocol. The data extraction forms were constructed after the initial results of the pilot search.

The search was based on the PICO (problem/patient/population, intervention/indicator, comparison and outcome) elements (Table 1).

2.2 | Literature search

The electronic literature search was performed through MEDLINE/ PubMed, Scopus, Web of Science, Cochrane and IEEE Xplore databases between November 2020 and March 2021.

A specific combination of words was introduced in order to complete a specific and reproducible search (Table 2). No additional manual searches were performed.

2.3 | Eligibility criteria

First, search engine results were evaluated for relevance based on their title and abstract. The studies whose titles or abstracts contained different information that was not related to the study question were excluded. An 11-year restriction was determined, from January 2010 to March 2021, to ensure the review was based on the most up-to-date information. Only fully available articles were considered. Articles focused on AI in the field of orthodontics were included. Only those publications that used some predictive measurable outcomes such as accuracy, sensitivity and specificity, and those with adequate documentation of the data sets they employed, were considered. All relevant publications and studies whose abstracts did not provide enough information to justify an exclusion decision were obtained in full text to determine their eligibility. Articles wrote in any language other than English, Spanish, Portuguese, Italian, German or French were excluded, as well as studies related to non-AI areas.

2.4 | Results extraction

Table 3 depicts how we collected select information from the included studies. The type of ML method, the number and type of images used for testing AI software, the accuracy of the technique, and its benefits to the field of orthodontics were extracted from the articles.

3 | RESULTS

3.1 | Search and study selection

The flowchart of the articles conforming to the PRISMA-ScR and included in this scoping review study selection is shown in Figure 1. The electronic literature search initially returned 311 records, which was reduced to 115 after removing duplicate references. After reviewing the titles and abstracts, all 115 studies were examined in more detail. Two articles were excluded as their full text was not available. Ninety records were excluded because they did not meet the selection criteria, and no additional studies were found by manual reference search. Finally, the application of the inclusion criteria resulted in 17 eligible publications in the qualitative synthesis review. There was a complete consensus among the evaluators on the literature selection process and the classification of the publications.

Of the 17 studies included in this scoping review (Table 3), four publications evaluated the use of AI in the diagnosis of surgery/ non-surgery decision and extraction choice. The determination of cervical vertebrae stages for growth and development periods with ML was evaluated in two publications. Five publications evaluated the accuracy of the automatic detection of anatomical reference points on lateral cephalometric images. The prediction of orthodontic treatment needs with an automatic orthodontic diagnosis was tested in two publications. The accuracy of automatic tooth segmentation was assessed in two publications. One publication analysed the maxillary structure variation in unilateral canine impaction. Lastly, one publication quantified the 3D asymmetry of the maxilla in patients with unilateral cleft lip and palate.

3.2 | Outcome domains of included studies

Considering the selected articles, a total of 472 lateral cephalometric radiographs were used in two of the studies to analyse the accuracy of using neural network ML to decide whether to use extractions to reduce discrepancy in different orthodontic malocclusions.[7,9] Jung et al (2016)[7] reported an accuracy of 84%-93% and Choi et al (2019)[9] noted an intra-class correlation coefficient of 0.97-0.99.

One study evaluated the use of a CNN in automatic cephalometric analysis. It demonstrated an accuracy of 88.43% for a total of

TABLE 2 Electronic literature search strategy

Database	Keywords	Time frame	Filters in database	Result	Included articles
MEDLINE/ Pubmed	('Orthodontic*') AND ('machine learning' OR 'unsupervised Machine Learning'	November 2020—March 2021	Full text Since 2010	91	17
Scopus	OR 'supervised Machine Learning'			104	
IEEE Xplore	OR 'artificial intelligence'			22	
Cochrane	OR 'Artificial life' OR 'deep learning')			3	
Web of Science				91	

TABLE 3 Summary of the included studies

Author Origin Year	Aim	Major Method (Algorithm)	No. of images for testing	Type of image for testing	Accuracy	Benefits to Orthodontics
Jung et al[7] Korea 2016	Diagnosis of extractions using neural network machine learning.	2-LNN	156	Lateral Cephalometric Radiograph	93% - 84%	The AI expert system could be a reference for less-experienced practitioners to evaluate the need for extractions.
Choi et al[9] Korea 2019	Diagnosis of surgery/non-surgery decision and extraction determination.	2-LNN	316	Lateral Cephalometric Radiograph	ICC: 0.97-0.99	The AI model using neural network machine learning could be applied for the diagnosis of orthognathic surgery cases.
Kim et al[10] Korea 2020	Automatic cephalometric analysis.	CNN	400	Lateral Cephalometric Radiograph	88.43%	The AI expert system could be used to automatically identify cephalometric landmarks with high accuracy immediately.
Dobratulin et al[11] Russia 2020	Automatic detection of anatomical reference points on radiological images of the head profile.	CNN (U-Net)	100	Lateral Cephalometric Radiograph	92%	It solves the problem of detecting anatomical reference points on a radiological image of the head in a lateral projection.
Lee et al[12] Korea 2020	Automatic location of cephalometric landmarks with confidence regions.	BN	400	Lateral Cephalometric Radiograph	90.11%	It provides cephalometric landmarks and their confidence regions, which could be used as a computer-aided diagnosis and educational tool.
Kim et al[13] Korea 2021	Automated landmark identification for posteroanterior (PA) cephalometric landmarks.	CNN	430	CBCT images	80.4%	Automated identification for CBCT-synthesized PA cephalometric landmarks shows better consistency than manual identification, although does not adequately achieve the clinically acceptable error range of less than 2 mm.
Kök et al[14] Turkey 2019	Determination of cervical vertebrae stages for growth and development periods.	K-NN, NB, Tree, ANN, SVM, RF, LR	300	Lateral Cephalometric Radiograph	77.02%	AI algorithms can be used for diagnostic purposes in orthodontics where growth development needs to be determined.
Amasya et al[15] Turkey 2020	Cervical vertebral maturation (CVM) analysis.	CDSS	647	Lateral Cephalometric Radiograph	58.3%	Automatic classification of CVM with AI may replace conventional evaluation methods.

(Continues)

TABLE 3 (Continued)

Author Origin Year	Aim	Major Method (Algorithm)	No. of images for testing	Type of image for testing	Accuracy	Benefits to Orthodontics
Guo et al[16] China 2021	To estimate human age based on a sample of dental orthopantomographies.	CNN	10,257	Orthopantomograms	94.15%	CNN models can surpass humans in age classification.
Li et al[17] China 2020	Automatic tooth root segmentation algorithm of CBCT axial image based on deep learning.	CNN (RNN)	361	CBCT images	95.8% - 95.3%	The automatic segmentation of individual tooth root has potential to improve the segmentation efficiency and accuracy.
Sun et al[18] China 2020	Automatic and accurate segmentation and identification of individual teeth from digital dental casts.	CNN	100	3D digital dental casts	97%	It achieves performance improvements compared with the state-of-the-art in both tooth segmentation and identification tasks.
Thanathornwong et al[19] Thailand 2018	Predicting the need for orthodontic treatment in patients with permanent dentition.	BN	1000	Data sets	93% - 95%	It achieved a high degree of accuracy in classifying patients into groups needing and not needing orthodontic treatment.
Murata et al[20] Japan 2017	Automatic orthodontic diagnostic imaging system.	CNN	704	Facial photographs	64.8%	It reduces doctor's assessment workload. It improves the accuracy in diagnosis and also increases the number of facial parts to be assessed.
Shin et al[21] Korea 2021	Predicting the need for orthognathic surgery of skeletal malocclusion using cephalogram.	RNN	840	Lateral and frontal Cephalometric Radiograph	95.4%	A deep learning program can determine the need for orthognathic surgery with relative accuracy, helping oral, maxillofacial surgeons, orthodontists, and general dentists to make standardized decisions.
Lin et al[22] Korea 2021	To determine the cephalometric predictors of the future need for orthognathic surgery in patients with repaired unilateral cleft lip and palate (UCLP).	XGBoost	56	Lateral Cephalometric Radiograph	87.4%	At the age of 6 years, it is possible to predict the future need for surgery to correct sagittal skeletal discrepancy in UCLP.

TABLE 3 (Continued)

Author Origin Year	Aim	Major Method (Algorithm)	No. of images for testing	Type of image for testing	Accuracy	Benefits to Orthodontics
Wang et al[23] China 2021	Quantify the 3D asymmetry of the maxilla in patients with unilateral cleft lip and palate.	CNN (U-Net)	60	CBCT images	ICC >0.90	The deep learning-based protocol could automatically segment the maxilla. Significant hypoplasia of the maxilla on the cleft side exists in the pyriform aperture and alveolar crest area near the defect.
Chen et al[29] Pekin 2020	Assessment of maxillary structure variation in unilateral canine impaction.	RF	60	CBCT images	ICC: 0.994 - 0.999	Fast and efficient CBCT image segmentation will allow large clinical data sets to be analysed effectively.

Note: Use of machine learning in orthodontics.

Abbreviations: 2-LNN: 2-layer Neural Network; ANN: Artificial Neural Network; BN: Bayesian Network; CDSS: Clinical Decision Support System; CNN: Convolutional Neural Network; ICC: Intraclass Correlation Coefficient; K-NN: K-nearest neighbours; LR: Logistic Regression; NB: Naïve Bayes; RF: Random Forest; RNN: Residual Neural Network; SVM: Support Vector Machine; Tree: Decision Tree; XGBoost: Extreme Gradient Boosting.

400 lateral cephalometric radiographs.[10] Following the same line of research, 500 radiological images of the head profile were used in two articles to study the viability of automatic detection of anatomical reference points on radiological images using a CNN (U-Net)[11] and Bayesian network.[12] The accuracies reported in these studies were 90.11% and 92%, respectively.[11,12] Kim et al (2021) performed the same analysis but used 430 CBCT images instead, and concluded that automated identification was more consistent than manual identification.[13]

There were two studies that evaluated the Cervical Vertebral Maturation (CVM) analysis using AI algorithms. Kök et al (2019)[14] reported a mean accuracy of 77.02%, whereas the accuracy reported by Amasya et al (2020)[15] was 58.3%. Another way to estimate the age of a person is to focus on the dental age, which Guo et al (2021) did in their study, with an accuracy of 94.15%,[16] finding that CNN models were able to surpass humans in age classification.

An automatic tooth root segmentation algorithm for CBCT axial images based on deep learning was studied by Li et al (2020)[17] and Sun et al (2020)[18] with an accuracy of 97%[18] and 95.8%–95.3%.[17] Both studies used a CNN. Li et al (2020)[17] worked with CBCT images to test the algorithm whereas Sun et al (2020)[18] used 3D digital dental casts.

Alternatively, Thanathornwong et al (2018)[19] and Murata et al (2017)[20] created automated diagnostic systems for orthodontic treatment. Thanathornwong et al (2018) worked with data sets whereas Murata et al (2017) worked with facial photographs. The accuracy of their respective methods was reported as 93%-95%[19] and 64.8%.[20] Similarly, Shin et al (2021)[21] and Lin et al (2021)[22] concluded, with an accuracy of 95.4%[21] and 87.4%,[22] respectively, that a deep learning program can be used to determine the need for orthognathic surgery. The latter publication also determined that it is possible to predict the future need for surgery to correct sagittal skeletal discrepancy in patients with repaired unilateral cleft lip and palate at the age of 6 years.[22] For those patients with unilateral cleft lip and palate, AI can be also useful to segment the maxilla and quantify its 3D asymmetry, as was demonstrated by Wang et al (2021)[23] with an intra-class correlation coefficient (ICC) greater than 0.90. Using a CNN, they also determined the existence of significant maxillary hypoplasia on the cleft side of those patients.

4 | DISCUSSION

With the aim of achieving successful orthodontic treatments, having detailed diagnoses, accurate treatment plans and accurate outcome predictions is crucial. The research surveyed here has demonstrated that AI technology helps the orthodontist to work more efficiently and therefore to be more adapted to the needs of society.

To decide whether extractions are necessary prior to orthodontic treatment, it would be useful to have a decision-making expert system based on an artificial neural network (ANN). Xie et al (2010)[24] used an ANN system to determine whether an extraction or non-extraction treatment was best for malocclusion patients between 11

FIGURE 1 PRISMA-ScR flowchart of search strategy and selection of articles
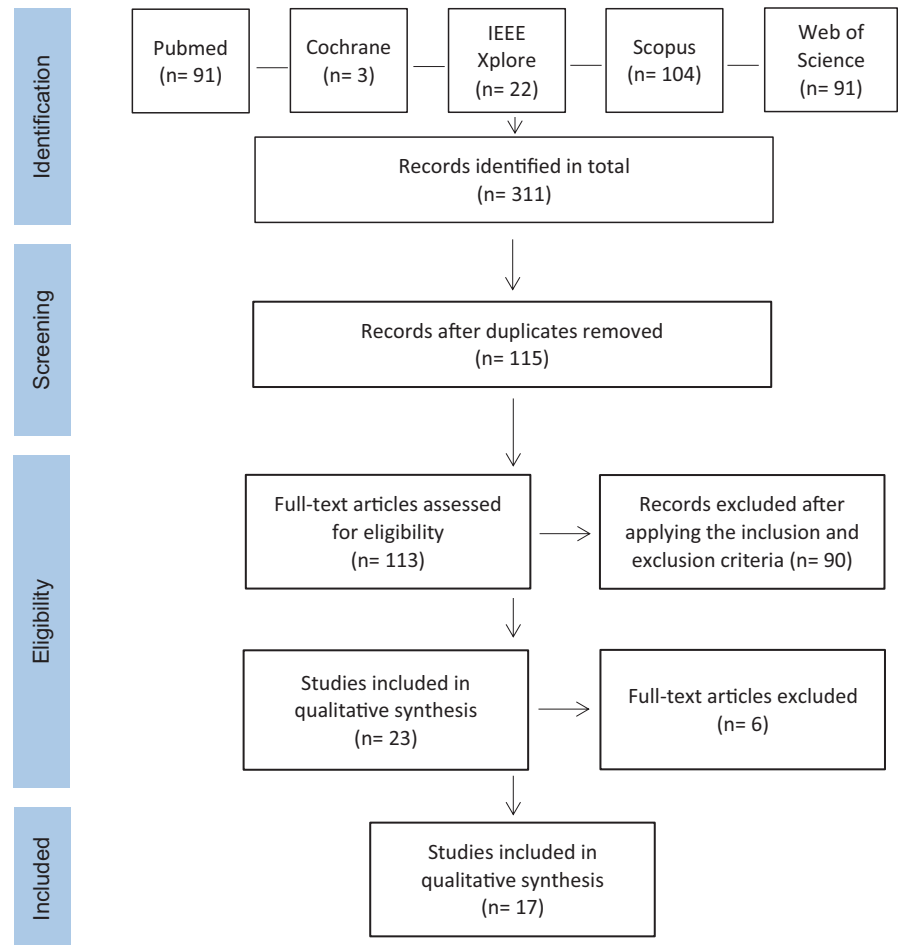
and 15 years old, and found the ANN worked with 80% accuracy. These results were similar to the studies by Jung et al (2016)[7] and Choi et al (2019).[9]

However, it is important to remember that there is no singularly correct answer for the diagnosis of extractions.[7] Generally, most orthodontists decide whether an extraction is necessary based on their experience and knowledge by analysing data from their patients' clinical evaluation, photographs, dental casts and radiographs. One problem is that this often causes intra- and inter-clinician variability in the treatment planning process.[25] By mimicking the decision-making of human experts, an AI expert system could be developed based on various philosophies of diagnosis to assist the decision-making process.[7] Nevertheless, the final decision will always belong to the clinicians.

Various studies have been conducted to demonstrate the efficacy of AI applications in identifying cephalometric landmarks. The diagnostic value of the analysis depends on the accuracy and the reproducibility of landmark identification. In orthodontic practice, lateral cephalometry has been widely used for skeletal classification and treatment planning. The incorporation of a CNN can provide an accurate and robust skeletal diagnostic system.[12] Park et al (2019)[26] compared two of the latest deep learning methods in their study: You-Only-Look-Once version 3 (YOLOv3) and the Single Shot Multibox Detector (SSD). YOLOv3 showed higher diagnosing

accuracy and demonstrated a more isotropic form of detection errors than did SSD. Hwang et al (2020)[27] concluded that AI cephalometric landmarks identification is as accurate as human examiners. In the same way, Kim et al (2020),[10] Dobratulin et al (2020)[11] and Lee et al (2020)[12] determined, with an accuracy between 88% and 92%, that the AI expert system could be used to automatically identify cephalometric landmarks. Guo et al (2021)[16] also concluded that a deep learning technique without human interference can effectively overcome the limitations associated with manual methods of identification.

AI has also been used to automatically identify and classify skeletal malocclusions from 3D CBCT craniofacial images. In 2020, Kim et al proposed a method that aimed to assist orthodontists in determining the best treatment path for the patient, be it orthodontic treatment, surgical treatment, or a combination of both.[28] Fast and efficient CBCT image segmentation would allow for large clinical data sets to be analysed effectively.[29] ML can help to determine the cephalometric predictors of the future need for orthognathic surgery, as in patients with repaired unilateral cleft lip and palate (UCLP).[30] Thus, the use of AI definitely reduces doctor assessment workload and improves diagnostic accuracy.[20]

The assessment of bone age and skeletal maturity and its comparison to chronological age is an important task for the diagnosis of paediatric endocrinology, orthodontics and orthopaedic disorders.

Because this assessment is a time-consuming activity that may be affected by inter- and intra-rater variability, the use of methods that can automate it, like ML techniques, can be of great value.[31] Growth and development can be determined by cervical vertebrae stages (CVS), which can be predicted/classified using different AI algorithms. Kök et al (2019)[14] compared seven AI algorithms that are frequently used in the field of classification: K-nearest neighbours (k-NN), Naive Bayes (NB), decision tree (Tree), artificial neural networks (ANN), support vector machine (SVM), random forest (RF) and logistic regression (LR) algorithms. They concluded that k-NN and LR algorithms had the lowest accuracy values, whereas SVM-RF-Tree and NB algorithms had variable accuracy values, and the ANN would be the preferred method for determining CVS.[14] Amasya H. et al (2020)[15] developed an ANN model to determine skeletal age. The developed ANN model performed close to, if not better than, human observers in CVM analysis. Repeatability and reproducibility of the ANN model were in the range of human observers.[15] Guo et al (2021)[16] concluded that deep learning techniques, without human interference, can effectively overcome limitations of the manual method in age classification based on panoramic images. Their CNN program focused on low-density features around the teeth, instead of using the dental morphological traits that are typically used by humans for age classification.[16]

Dental segmentation is one of the key steps in computer-assisted orthodontic technology and its accuracy is closely related to treatment outcome. This procedure requires precise positioning and extraction of tooth shapes on the patient's 3D digital dental cast (or intraoral scan). ML using a CNN-based model for tooth segmentation and identification achieved performance improvements when compared with the state-of-the-art general mesh segmentation method for both tooth segmentation and identification tasks.[18]

Deep learning systems work in distinct areas of orthodontics. Orthodontists can use AI systems as an ancillary tool for increasing the accuracy of diagnosis, treatment planning and for predicting treatment outcomes. Automated systems can save a lot of time and increase the efficiency of the clinicians. For example, the use of automated cephalometric points identification or automated teeth segmentation to enable a treatment preview outcome helps reduce orthodontic treatment planning times.[5,10-13] Additionally, with deep learning techniques it is possible to eliminate the subjectivity associated with human decision-making; traditional manual methods are likely to incorporate a relatively higher degree of intra- and inter-observer errors due to that subjectivity, which can lead to an increase in the prediction error.[32] Likewise, these systems can be used for secondary opinions, in order to improve the accuracy of diagnosis. Nevertheless, clinicians should always trust their clinical judgment above all.

AI could become a valuable tool to use in those procedures that require high precision and are more time consuming, such as indirect bonding, precise Bolton Analysis or wire bending, in order to increase the quality of the treatments we offer to our patients.

4.1 | Limitations

This review presents two main limitations:

First, being a scoping review, the review question has to be more generally defined when compared to a systematic review. Whereas scoping reviews assess where consolidated knowledge ends and additional research is needed, systematic reviews clarify whether existing knowledge is reliable.[33] AI embraces many different fields and applications, and therefore, it adjusts with the aim of a scoping review, which is to provide an overview of the evidence.

Second, the search was limited to the last 11 years, because the authors agreed that it would be more useful to describe only the latest applications of AI in orthodontics, rather than making an historical review and thereby including obsolete technologies.

Despite these limitations, the authors expect this to be a useful overall introduction to understand the recent past of AI and the actual present (as well as the near future) of its applications in orthodontics. There is no doubt that there is still a long road ahead. Many of the results published in the papers used in this scoping review must be thoroughly and carefully analysed. However, those who are already used to work with intraoral scanners and facial-driven smile designs know exactly how limited and at the same time how useful all these new technologies are. Therefore, all the tools available to the clinicians are of great value, and AI is one of them.

Nevertheless, the authors truly believe that despite all the future advancements in AI, it will never substitute human reasoning; however, it will definitely help.

5 | CONCLUSIONS

The analysed studies demonstrated that CNNs can be used for the automatic detection of anatomical reference points on radiological images. For growth and development areas, the CVM can be determined using an ANN model and obtain the same results as human observers. AI technology can also help improve the accuracy of diagnoses for orthodontic treatment, therefore, helping orthodontists work more efficiently. However, although the improvement of AI is definitely a great help for orthodontists and other health professionals, the final decisions on health matters will always be the clinicians' responsibility.

CONFLICT OF INTEREST
The authors declared no conflict of interest.

AUTHOR CONTRIBUTIONS
Monill-González A. and Rovira-Calatayud L performed equally with the study selection, data extraction and data presentation. They also

completed the initial manuscript draft and data analysis. d'Oliveira NG conceptualized the study and resolved disagreements in study selection. He analysed all data and prepared the presentation of the final manuscript. Ustrell-Torrent JM supervised the research activity and provided the necessary resources to conduct the review. All authors contributed to critical revision of the article. All authors read and approved the final manuscript.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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