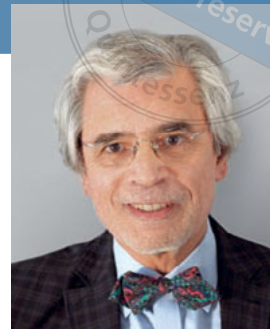


# Artificial intelligence and orthodontics



Ralf J Radlanski

Not so long ago, the question arose in my area of work as to whether the position of chair of orthodontics at a university hospital really needs to be held by a professor of orthodontics. Some (non-orthodontic) colleagues argued that orthodontics could now be handled by artificial intelligence (AI). After all, the current developments in aligner orthodontics suggest that doctors no longer seem to be necessary. Most dental practitioners already offer orthodontic treatment with aligners, and once the scans are taken, the setup is fully automatic.

In a way, some of this is true: we take optical scans and use them to create a digital 3D data set that can be segmented in sophisticated software. We have actually succeeded in separating the teeth and gingiva from each other fully automatically using suitable algorithms; this means the teeth can be moved virtually and a setup with optimal occlusion can be created fully automatically. Guidelines regarding how the teeth should be positioned optimally and correctly in relation to each other can be found in any textbook, and it is not so difficult to write an algorithm for this. This is often practised in the instant simulation in front of the patient.

Machines really do take a considerable amount of our routine work off our hands. Many colleagues hope that automated solutions will one day be available for complicated cases as well, using swarm intelligence.

I have been fortunate enough to be able to teach a seminar on epistemology at the Charité in Berlin for many

decades now. The main aim is to work with the students to raise practical or theoretical questions that we wish to answer using the background of science taught at the university. Of course, the focus is on retrieving and examining studies. As you can imagine, my students have shared an incredible amount of knowledge with me in this way over the last couple of years. This semester, we are focusing on the performance of AI and what the Generative Pre-trained Transformer (GPT) by OpenAI (<https://chat.openai.com/>) has to offer in terms of scientific knowledge relating to our field. Can it answer medical questions so well that everything is correct? We wanted to ask the GPT certain questions and compare its answers with those given in the literature so the students could judge the quality of its responses against the background of their university education. We have all found the seminars extremely exciting!

In the first seminar, some students asked if the GPT knew anything about cephalometry, as a group of them were due to give a presentation on this in another seminar. Indeed, it was very familiar with all the cephalometric points and the definitions it gave were all correct. At the students' request, it even assembled some texts to create a logically structured PowerPoint presentation and added a summary at the end. Some students wanted to know if the GPT could also create some multiple-choice exam questions based on the content of the PowerPoint slides and, at the click of a button, all of the questions came up pretty well, even the



incorrect options for answers. It would have taken me a great deal of time and effort to achieve the same result.

Some other students wanted to present a study on a question they had chosen, and asked the GPT if it could summarise the related content for them so they would not have to read the study themselves. It did, but the summary was very detailed. When the GPT was then asked if it could summarise the most important content in just three sentences, we were positively amazed by the result. Students who were experienced in writing papers then asked the GPT if it could write a 200-word abstract of the study. We compared the abstract it produced with the original study abstract and found it to be pretty good, and I want to point out here that it was not simply a word-for-word copy of that found in the original paper!

These few examples alone show how amazingly and frankly scarily good the GPT can be if asked questions properly. The ubiquity of such technology has been a topic of discussion at the university for months, of course. Some condemn it, whereas others see potential in it. In any case, it is sure to change the way we do research and how we teach and assess students drastically.

Thus, I no longer want to know whether a student wrote an assignment themselves or copied it from a smarter student, or even whether a GPT wrote it for them. Instead, I want to know whether the student has fully understood the text they are presenting, whether they can defend it and how they evaluate it. This creates conditions similar to those of an oral examination, or what I prefer to call a specialist discussion. Oral examinations were phased out gradually during my time as a student and teacher and replaced by multiple-choice examinations. Students could be evaluated faster this way, and it meant that personal bias, sympathies and antipathies could be avoided. From my perspective, however, medicine is not just about passing multiple-choice examinations; it is also about personality. Personal interaction cannot be avoided, and this is certainly an area that requires further discussion.

What does the power of AI mean for practitioners? Automation will increase. Most people think this is a good thing, as boredom will decrease and we will be able to focus more on what interests us. We will have more time to dedicate to personal interactions with our patients, and thus more time for the patient as a person in general. AI can also make suggestions for diagnostics and therapy and offer solutions.

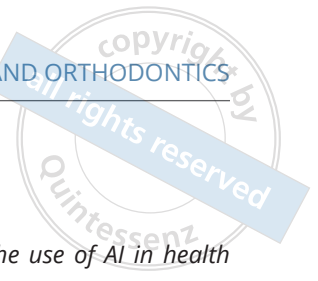
Ultimately, however, it is we who have to decide what is right for the patient. Humans must decide because machines think differently (if indeed they think at all), and doctors must not think like machines, although some may wish they did. We could imagine a health care system in which physicians are reduced to mere providers of a list of prefabricated diagnoses and the relevant therapies. The effort required, treatment durations and fees would then only need to be retrieved and processed using AI; however, anyone who has ever been a patient before would not wish to fall ill if such a system existed. Rather, the doctor needs to know the patient and vice versa. Every patient has their own story, medical history and desired outcomes. Patients should understand their treatment, comply with it, and share their personal treatment goals.

While writing this, it occurred to me that I should ask the GPT for its opinion. I will now share the question I asked and the answers the GPT gave so that you, dear readers and colleagues, can see if it convinces you. I asked: "Is it possible that AI will be able to replace orthodontists one day, as we have so many automated procedures for creating setups using algorithms, like for instant simulation with Invisalign? Please give arguments for and against."

The GPT responded as follows:

*"The potential for AI to automate certain aspects of orthodontic procedures, such as tooth alignment, has indeed been explored and implemented to some extent. However, whether AI can fully replace orthodontists is a complex question that involves various factors. Let's consider arguments both in favour of and against the possibility of AI replacing orthodontists. The arguments in favour of AI replacing orthodontists are as follows:*

1. *Efficiency and speed: AI algorithms can process large amounts of data quickly, enabling faster analysis and treatment planning. This could potentially reduce treatment time and increase efficiency.*
2. *Consistency: AI systems can provide consistent results by following predetermined algorithms and guidelines. This may minimise human errors or variations that can occur during manual procedures.*
3. *Access to expertise: AI systems can potentially provide access to orthodontic expertise in areas with limited availability of orthodontists. This can be particularly beneficial for underserved regions or areas with a shortage of specialised health care professionals.*



4. *Cost reduction: If AI systems can effectively perform certain orthodontic procedures, it could potentially lower the overall cost of treatment, making it more accessible to a larger population.*

*The arguments against AI replacing orthodontists are as follows:*

- 1. Complex decision-making: Orthodontic treatment involves complex decision-making processes that require clinical judgement, patient communication and customisation to individual needs. AI algorithms may struggle to replicate the human ability to consider various factors and adapt treatment plans accordingly.*
- 2. Patient interaction and empathy: Orthodontists not only diagnose and treat dental conditions but also interact with patients, address their concerns and provide emotional support. The human element of care, including empathy and communication, is vital in the health care field and may be challenging for AI to replicate.*
- 3. Unforeseen challenges: Orthodontic treatment may present unexpected complications or variations that require immediate adjustments. The ability to adapt to such scenarios and make real-time decisions based on visual and tactile feedback is currently better suited to human orthodontists.*

4. *Legal and ethical considerations: The use of AI in health care raises legal and ethical questions regarding liability, accountability and the potential for errors. The responsibility of patient care and the associated legal implications are significant factors to consider.*

*In summary, while AI has shown the potential to enhance certain aspects of orthodontic procedures, completely replacing orthodontists is unlikely in the foreseeable future. The field of orthodontics requires a combination of clinical expertise, patient interaction and adaptability, which are currently best fulfilled by human professionals. AI may continue to play a supportive role, aiding orthodontists in diagnosis and treatment planning, and enhancing efficiency, but human oversight and intervention will likely remain critical."*

I had been talking a lot with the GPT for months prior to this, so maybe it had got to know me a little. Regardless, the answer it gave aligned exactly with what I had in mind even before I asked my question. I have nothing more to add. I advocate the text that the GPT presented and could also expand on the answers it gave, but I guess there is no need to do so...

*R. J. Radlani*