

Aligners, digital transformation, artificial intelligence, companies and the future of orthodontics: embracing the reality

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Similar to many other fields, developments in digital technology and artificial intelligence have reached exciting levels within the orthodontic profession. However, it is predicted that certain branches of medicine, such as radiology, pathology and dermatology, may either 'fall victim' to the rapid advancements in artificial intelligence or undergo significant transformations. In this context, how will the digital transformations that excite orthodontists and the increasing integration of artificial intelligence in orthodontics impact the future of the profession? What long-term effects will these rapid advancements in artificial intelligence, in particular, have on orthodontics? This article seeks to stimulate a range of perspectives among orthodontists regarding the future of their profession by examining the recent developments in digital technologies, aligners, and artificial intelligence. (Aust Orthod J 2025; 41: 155 - 159. DOI: 10.2478/aoj-2025-0011)

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Introduction

Digital technologies are increasingly becoming integral to orthodontic practices, and are noted as advancements in digital cephalometric measurements, digital appliance designs, and digital orthognathic surgery planning.¹⁻³ It is clear that digital transformation is enhancing orthodontic practice which is further amplified by the support of artificial intelligence (AI). For example, there is no longer a need to manually mark points on digital cephalometric radiographs, as AI has proven to be highly effective in automatically determining landmarks.⁴

Currently, orthognathic planning software requires the manual identification of separation lines; however, in the near future, AI-supported software may automatically identify separation lines when given computerised tomography images. The software could also be capable of performing three-dimensional cephalometric measurements and

adjusting the jaws to normalise cephalometric values that deviate from the accepted range. Additionally, AI may be able to generate alternative treatment plans, which could reduce the active role of orthodontists in the planning process.

Similarly, aligner treatments, which are increasingly simplifying orthodontic care, do not require a clinician's involvement to the same extent as traditional wire-based treatments. This raises the question regarding the role of orthodontists, who currently play an active role in the initial planning of aligner treatments, could eventually be reduced by AI as digital technologies rapidly advance? While the human brain can evaluate a maximum of 5 to 9 variables simultaneously,⁵ AI has the capacity to process a far greater number of variables in a comprehensive manner. It is certain that this development will have significant implications for orthodontic clinical practice and the role of orthodontists in the foreseeable future.

Aligners, orthodontists and Indian farmers

Initially, aligners were primarily used to treat mild and moderate cases, but with advancement, more complex cases are being successfully addressed using aligner therapy.⁶ As the market for aligners has grown, companies have increasingly targeting a broader customer base. In an effort to expand their exposure, aligner companies are encouraging, not only orthodontists, but also general dentists to become 'aligner providers' in a strategy aimed at attracting a larger pool of patients.⁷ To further this objective, some companies have opened clear aligner scanning stores and are directing customers to the nearest dentist or orthodontist who are loyal to their brand.⁸ This creates a situation in which orthodontists are provided incentives to remain loyal to specific companies.

In addition, aligner companies often sell intraoral scanners at discounted prices to clinicians who commit to administering a predetermined number of aligner treatments. Special discounts are also offered to orthodontists or general dentists who promise to treat a specific number of patients. To maintain eligibility for these discounts, clinicians are encouraged to direct more patients toward aligner treatments, which in turn increases their dependence on the provider companies.

This arrangement is also reflected in the way orthodontists use social media.⁹ Rather than promote their own practices, clinicians often advertise the aligner companies in an attempt to attract more patients and enhance their professional standing.¹⁰ In addition to offering discounts, companies reinforce brand loyalty by awarding orthodontists with titles such as 'elite', 'platinum', or 'apex' based on the number of patients treated. However, the qualifications for these titles are not based on the clinical complexity or quality of the cases treated, nor are they evaluated using objective criteria such as the American Board of Orthodontics (ABO) standards. These titles are essentially marketing tools, given to orthodontists simply for the number of patients they have seen, without regard to the clinical outcomes.

As a result, orthodontists are becoming increasingly dependent on the companies, leading to what Batista refers to as 'company-driven orthodontists'.¹¹ This dependence on external aligner companies may shift the focus from patient-centred care to fulfilling corporate incentives, ultimately altering the way that orthodontic professionals operate within their field.

In the 1970s, Indian farmers were provided with both heirloom wheat and genetically modified (GMO) seeds to increase their crop yields.¹² However, the GMO seeds could only be planted once, thereby requiring farmers to purchase new seeds every year. To do so, they had to turn to the companies that sold the seeds, which also provided the necessary pesticides for crop growth. As a result, farmers became increasingly indebted, and those unable to repay their debts tragically began to commit suicide. Between 1995 and 2018, an estimated 400,000 farmers took their lives, an average of 48 suicides per day. While a similar outcome is not predicted for orthodontists, the emphasis is on the potential pressure corporate dependency can place on professional groups, as well as the negative and unpredictable consequences that may arise from business pressures.^{12,13}

In-house aligner production might be immediately considered as a way to avoid corporate dependency. However, the long-term widespread adoption of in-house production, which requires additional personnel and equipment, seems unlikely. Moreover, the material quality of in-house aligners currently does not match the standards set by large companies that manufacture aligners at scale.

Human versus AI in chess and human versus AI in aligner planning

Orthodontic treatment planning is undoubtedly a crucial stage of orthodontic care. Every decision made at the outset of treatment, as well as during interim sessions, involves formulating new strategies in response to the dental and occlusal reaction to the established treatment plan.¹⁴ In essence, this is similar to a chess game. Therefore, by examining the world of chess, parallels can be drawn to predict the potential trajectory of the orthodontist-AI relationship in the future.

In 1997, the defeat of world chess champion Garry Kasparov by IBM's Deep Blue caused significant unrest.¹⁵ However, in the years that followed, software began to play chess at such a high level that a computer defeating a human was no longer considered a groundbreaking event. In 2017, Google's AlphaZero defeated Stockfish 8, the 2016 chess champion, which had access to a century of grandmaster knowledge and decades of computational experience. Stockfish 8 could analyse up to 70 million moves per second. In contrast,

AlphaZero could evaluate only 80,000 moves per second. What is truly remarkable is that AlphaZero had not been explicitly taught any chess strategies by human instructors; instead, it was designed to teach itself. It took AlphaZero just four hours to master the game of chess.^{16,17}

Representatives and marketers of aligner companies often emphasise that orthodontists can determine their 'clinical preferences' in advance and make adjustments to a treatment plan as needed. For example, removing or repositioning an attachment can give the orthodontist a greater sense of control over the treatment process. However, in reality, the orthodontist is making changes to the preferences of an artificial intelligence (AI) trained on data from millions of patients.¹⁸ To date, no orthodontic study has compared outcomes obtained without altering the initial ClinCheck treatment plan to those in which orthodontists intervene. However, when an AI system with the capacity to process millions of moves per second is trained on sufficient data, it raises the question of how likely is it that a human could outperform AI in treatment planning?

In cases in which AI has not correctly planned a treatment, the system is continually updated through changes made by orthodontists. Over time and with more data, AI algorithms will likely approach perfection. Given this, new questions arise: 'What will be the role of the orthodontist in a system in which they do not control production and need less involvement in planning? A possible answer is that orthodontists will focus primarily on bonding attachments, performing stripping, and reviewing cases.

In orthodontic clinics with high patient volumes, dental assistants are already applying attachments and performing enamel stripping. While it could be argued that these procedures should be performed by orthodontists, another question is raised: how much expertise do these procedures truly require? It is conceivable that a general dentist could also perform attachment bonding and stripping, especially in a system in which these tasks are streamlined and standardised.

Will the role of orthodontists change during treatment?

In conventional orthodontic treatment, which involves brackets and archwires, the orthodontist plays

an active role beyond the initial treatment planning stage. This includes overseeing the mechanics of the established plan, adjusting strategies, and developing new moves at each session in response to the dental reactions to treatment.

However, in aligner treatments:

1. Planning is primarily performed by artificial intelligence, with the orthodontist evaluating the differences between their envisaged plan and the plan suggested by AI. The orthodontist can make adjustments as needed.
2. If the patient complies well, there is no need to review or modify the planned movements during each review session, as is required during conventional treatments.
3. The orthodontist's role involves evaluating discrepancies between enamel stripping, patient compliance, and the virtual planning, as well as assessing the clinical outcomes between appointments.
4. The orthodontist's focus shifts to motivating patients regarding treatment compliance during review sessions.

Given these developments, it can be predicted that the active role of orthodontists in clinical practice will undergo transformation. In the long term, as some practitioners shift exclusively to aligner treatments and move away from conventional fixed appliance methods, their involvement in direct, hands-on treatment will likely decrease.

What impact can the convenience brought by digitisation and artificial intelligence have on orthodontics?

It is an undeniable that digitisation and artificial intelligence (AI) have greatly simplified orthodontic routines.¹⁹ While these advancements make orthodontic practice more efficient, they may also reduce the skill differences between highly experienced and less experienced practitioners. Techniques such as wire bending, including complex loops that once required mastery, experience, and talent, are slowly losing their place in orthodontic practice.

While this increased convenience appears to benefit orthodontists, it has also sparked the interest of general dentists who were previously reluctant to

perform orthodontic treatments due to complex treatment protocols and planning requirements. With the easing of treatment complexity, general dentists are now encouraged to offer orthodontic care. As a result, orthodontists may no longer hold exclusive authority over future treatment plans. This shift in authority could have significant financial implications, potentially leading to lower earnings for orthodontists.

Furthermore, as orthodontics becomes less specialised and more accessible to a wider range of practitioners, the field may lose its current appeal to newly trained dentists, who may be less inclined to pursue orthodontics as a specialty.

How AI diminishes the orthodontist role?

The application of artificial intelligence in orthodontics is expanding rapidly and AI algorithms are now outperforming their early iterations.²⁰ The impact of artificial intelligence on orthodontics can be categorised into several key areas:^{21–23}

1. *Diagnostic applications:* These include cephalometric analysis, the determination of skeletal maturation stages, dental analyses such as the Bolton analysis, the Hayce Nance analysis, molar relationship detection, facial analysis, airway evaluation, and the estimation of unerupted tooth size.²⁴
2. *Treatment planning:* This encompasses decision-making regarding tooth extractions, orthognathic surgery, and the prediction of treatment outcomes.
3. *Clinical practice:* AI contributes to practical guidance, remote care, clinical documentation, and patient co-operation estimation.^{25,26}
4. *Natural Language Processing:* Tools such as ChatGPT (OpenAI, San Francisco, CA, USA), Gemini (Google DeepMind, London, England), and Copilot (GitHub, San Francisco, CA, USA) serve as patient information consultants.^{27–29}

The rapid and successful development of artificial intelligence in orthodontics may, over time, reduce the role of orthodontists in aspects of their practice. However, it is important to recognise that AI will ultimately enhance and facilitate orthodontic treatment rather than replace orthodontists. This is particularly true as orthodontics requires meticulous, personalised, and precise care, especially in situations that demand human judgment, empathy, and hands-on treatment.

What precautions can be taken?

It is an undeniable reality that technological advancements, the increasing effectiveness of aligner treatments and the integration of artificial intelligence (AI) will play an increasingly significant role in orthodontic practice. These developments will undoubtedly simplify orthodontic procedures and reduce the need for specialised skills, such as wire bending, analytical thinking and treatment planning that were once essential for orthodontic care. Given these changes, what measures can be taken in the long term?

- **Designing a System that Ensures Orthodontists Retain Control:** It is crucial to develop a system in which control remains with the orthodontist rather than with aligner companies, ensuring that orthodontists are not directed nor influenced by external sources. Raising awareness of both current and newly trained orthodontists about this issue is essential.
- **Discouraging Orthodontists from Advertising Specific Aligner Brands:** Orthodontists should be discouraged from promoting specific aligner companies on their social media platforms. This can be regulated by the professional societies and associations to which orthodontists belong and helping to maintain ethical standards within the profession.
- **Securing Legal Protections for Orthodontists and Associations:** Efforts must be made to ensure that the rights of orthodontists and orthodontic associations regarding treatment practices are legally protected. This may include advocating for legal restrictions on orthodontic treatments performed by general dentists or other dental specialties.

Conclusion

With the advancements in digital technology and artificial intelligence, it is inevitable that some professions will experience a reduction in employment opportunities or financial earnings. While it is challenging to predict whether the rapid developments in orthodontics will lead to such outcomes, it is clear that in order for orthodontists to maintain their role in the evolving landscape, both individual and collective actions must be taken. These steps should include both personal initiatives and legal measures to safeguard the future of the orthodontic profession.

Conflict of interest

The authors declare that there is no conflict of interest.

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