issn 1868-3207 • Vol. 4 • Issue 1/2025

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aligners

international magazine of aligner orthodontics

case report
Combination of a distaliser and aligners for Class II correction

case report
Treatment of ectopic canines with aligners and the MTA auxiliary

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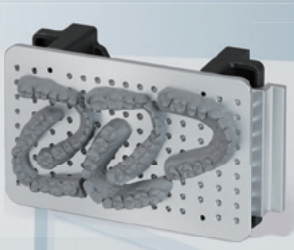

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Dr Rooz Khosravi

The next big thing in aligner orthodontics

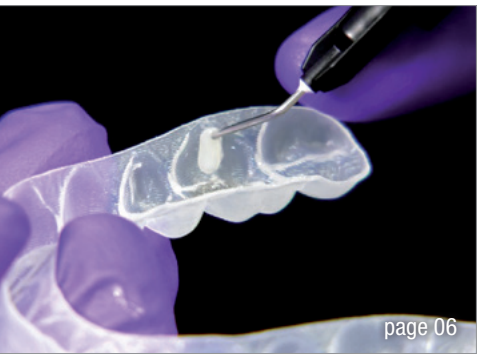
The first 50 years of aligner orthodontics, driven by analogue systems, had a few hallmarks. CAD/CAM technology has elevated aligner orthodontics to a new level in the past two and a half decades. What was once a dream of orthodontic treatment option with no braces for patients with complex treatment needs has now become the norm. From a single aligner system in 1990, we now have over 150 options. Over more than a decade of analysing aligner systems, I have conducted research projects, helped develop aligner software suites and built an in-office aligner system at my practice. I often wonder: what is next for aligner orthodontics? I have heard varying perspectives: clinicians' wish lists differ from those of engineers, and patients' desires contrast with those of clinicians and team members. Collectively, I would categorise the next big things in aligner orthodontics into three areas: software, material and patient preferences.

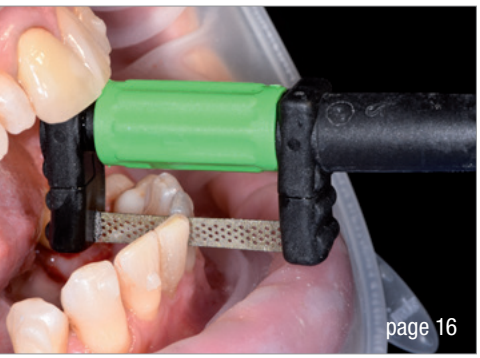
Software — I believe that AI integration in aligner software is next. I am talking about meaningful capabilities, such as 3D pattern analysis that identifies the correct position of teeth in treatment planning powered by AI—this exists today at the level of research and development. Aligner treatment planning software needs fundamental change. You might have heard about treatment planning based on bone data from CBCT. Think bigger. What if tooth movements were designed based on root structure rather than an arbitrary centre of resistance for the teeth? Picture developing an aligner treatment plan with limited root movement—which is what aligners excel at. Most practices use both aligners and fixed appliances. It would be valuable if aligner treatment planning software could handle both treatment modalities—specifically, if it could provide a workflow that assists the clinician in determining the ideal combination. This is not far-fetched; some clunky versions of such software already exist.

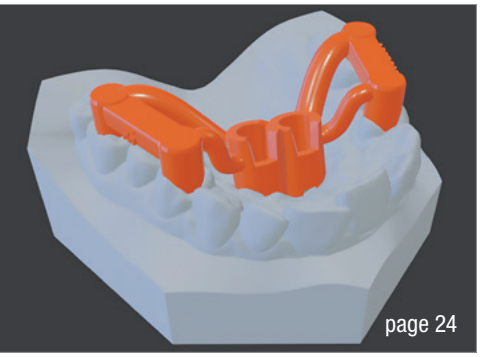
Aligner material — Dental 3D printing has evolved significantly in the last decade. The 3D printing of trays began a few years ago, and those early versions were yellow, brittle and far from ideal. Today, 3D-printed aligners are aesthetically acceptable and have better properties. Despite these improvements, major questions remain unanswered: Is it practical to 3D-print aligners in-office? Would patients prefer 3D-printed aligners to thermoformed ones? Do 3D-printed aligners deliver care more efficiently than thermoformed aligners do? Learning from the past, we know that in-office aligner systems cannot entirely replace mass-produced aligners for every practice. The process of fabricating 3D-printed aligners remains tedious. The force levels produced by 3D-printed aligners are significantly lower than those of thermoformed aligners. Patients are not thrilled about the tendency of 3D-printed aligners to stain and feel rougher in texture. In sum, I am cautiously optimistic about 3D-printed trays and believe that 3D-printed retainers are the entry point.

Patient preferences — Aligner treatment is evidently not suitable for all patients, particularly regarding adherence to full-time wear. Combining fixed appliances and aligners to reduce the treatment time for which aligners must be worn could provide an alternative for partially compliant patients. Currently, transitioning between these two appliances is tedious. Along with the notion of universal treatment planning software, imagine a platform where the clinician can choose aligners as needed—an on-demand aligner system. I have used my in-office aligner system this way for years and this concept has proved successful. The next big thing in aligner orthodontics starts with the patient's needs and ends with the provider's imagination.

Dr Rooz Khosravi







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The power of precision—3M Clarity Precision Grip Attachments

Dr David Cinader, Dr Michael K. Domroese & Nick Poeschl, US

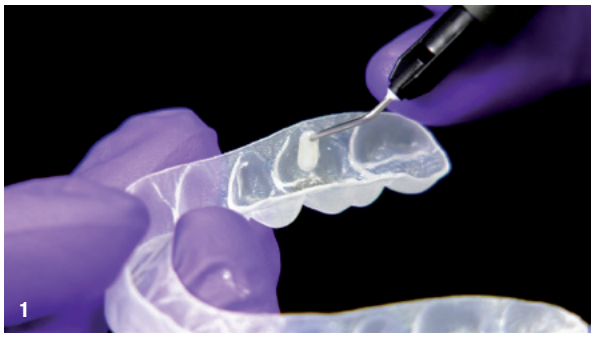


Fig. 1: Dispensing a flowable composite into an attachment template.

Fig. 2: Poorly formed attachments and flash around attachments.

Precision in attachments

Soon after the mass adoption of clear aligners, it became apparent that a plastic shell did not provide sufficient purchase on the teeth for all movements. Attachments, or polymerised bumps of composite directly bonded to the teeth, were developed to provide a grip for these movements. Presumably, attachments provide better engagement between the teeth and aligner. A technique for producing these attachments was developed in which a mould of the dental arch, or template, is used to form attachments directly on the teeth (Fig. 1). It is typically accomplished by injecting a small amount of composite into each of the attachment pockets in the template. This method enabled a great deal of customisation because many sizes and shapes of attachment may be produced, and there is wide choice regarding their position and orientation.

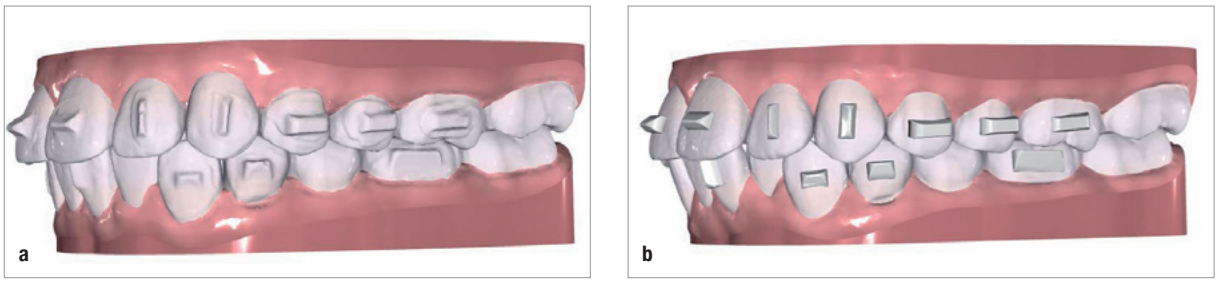
However, the procedure is complicated by the difficulty in dispensing the ideal amount of composite into the template. Too little composite results in the risk of bond failure or creation of an attachment with voids. In addition to affecting the ability of the aligner to engage the tooth and attachment, voids may cause discomfort because the craters left by bubbles may have sharp edges. Too much composite results in a significant excess, or flash, around the attachment perimeter (Fig. 2). Flash may attract stains, harbour plaque and inhibit the ability of the aligner to fully engage the attachment.[1] All of these depend on the mould-filling technique, which can be difficult to standardise.

It has been recognised that clinical outcomes may be undermined by the lack of correspondence between the digital representation of the planned attachment and the actual attachment when bonded to the tooth.[2,3] This lack of correspondence may be the result of voids, flash or distortion of the attachment template (Fig. 3). We have used finite element analysis simulations to show that both composite flash and displacement may have deleterious effects on the direction of applied force. It is important for attachments to be accurately positioned and precisely shaped (Fig. 4).

Customisation through 3D printing

In order to deliver accuracy and precision, an improved process was needed. Ideally, the attachment templates could be delivered preloaded with composite. The tiny dimensions and custom shapes of attachments make precise filling of the pockets difficult. It is also difficult to judge the amount of material required to adapt to the curvature of the tooth surface; it must be estimated from the surrounding surface of the template.

To address this, we leveraged 3D printing as a solution. This technology offers the ability to efficiently produce custom articles with complex shapes and intricate detail. In this case, it is used to deliver to the clinician



Figs. 3a & b: Poorly formed attachments and flash around attachments.

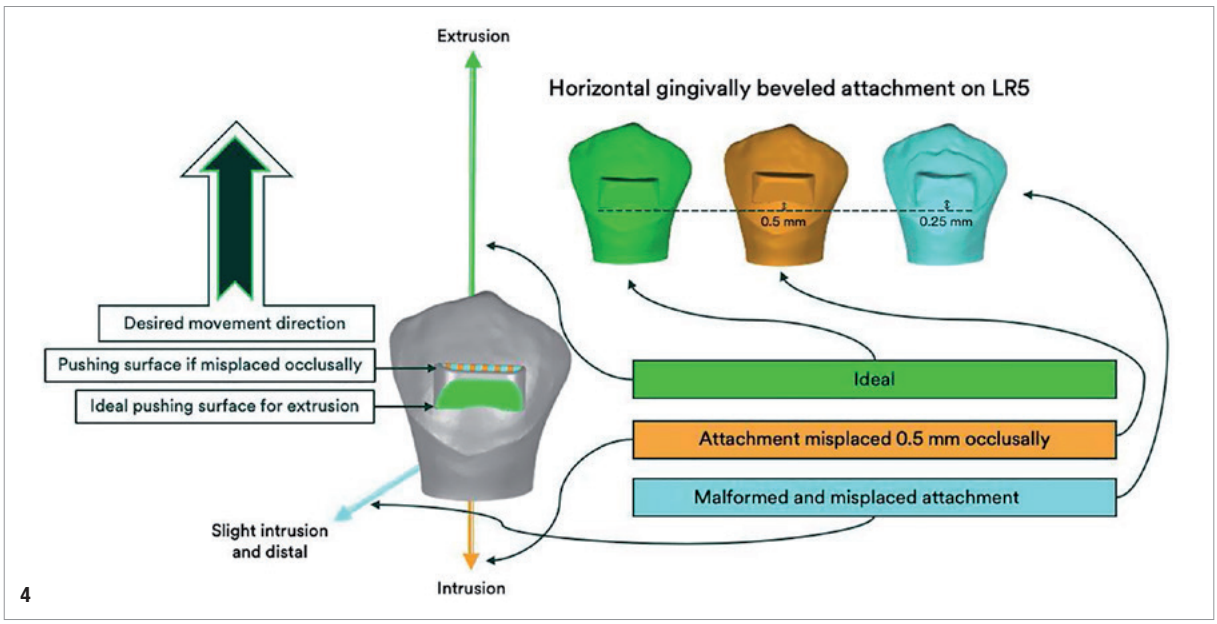
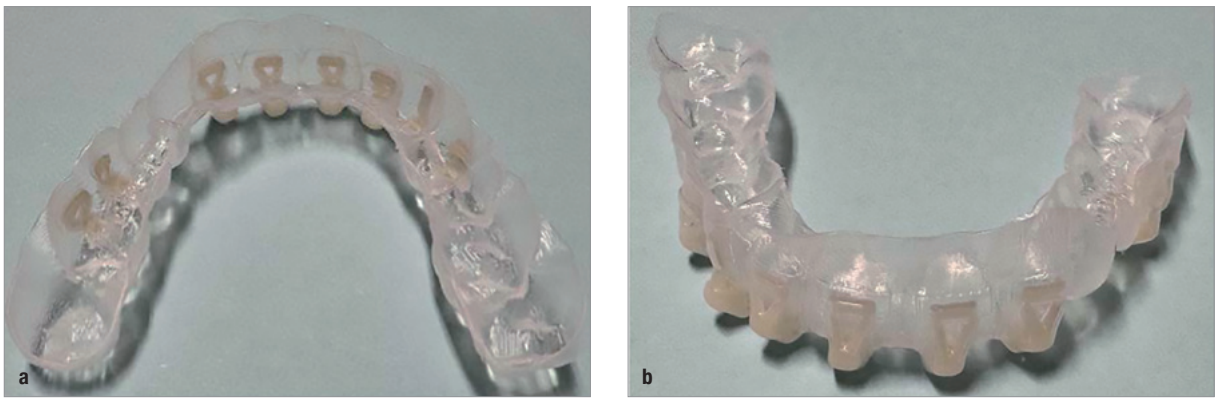


Fig. 4: Simulations of the force vectors obtained when horizontal gingivally bevelled attachments on tooth #45 are misplaced or malformed and misplaced. The green attachment achieves the desired force vector (green arrow). The orange attachment is misplaced 0.5 mm occlusally, resulting in a force vector in the opposite direction (orange arrow) of the desired force vector. The teal attachment is misplaced and has significant flash, resulting in a force vector in the incorrect direction (teal arrow).

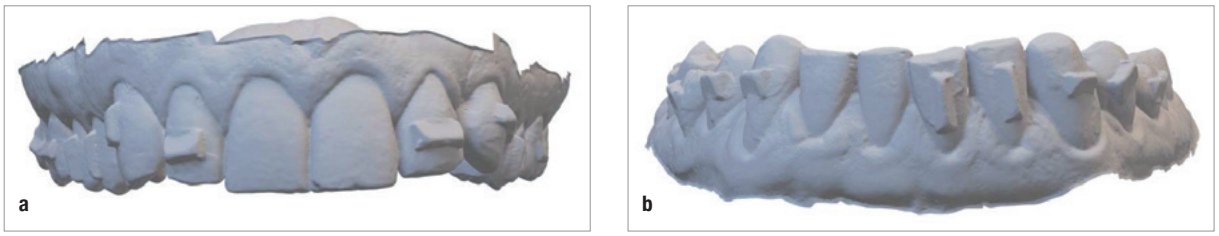


Figs. 5a & b: Clarity Aligners Precision Grip Attachments in the attachment tray.

pre-hardened customised attachments. The fully polymerised, pre-hardened Clarity Precision Grip Attachments are delivered in a thermoformed attachment tray that relies on an intuitive bonding procedure (Fig. 5).

The bonding procedure begins with the application of a bonding agent (3M Transbond XT Light Cure Adhesive Primer, Solventum) to the tooth-facing surfaces of the Clarity Precision Grip Attachments. The teeth are cleaned

Fig. 6: Clarity Precision Grip Attachments bonded in the mouth.



Figs. 7a & b: Post-bonding scan of the Clarity Precision Grip Attachments in the case demonstrated.

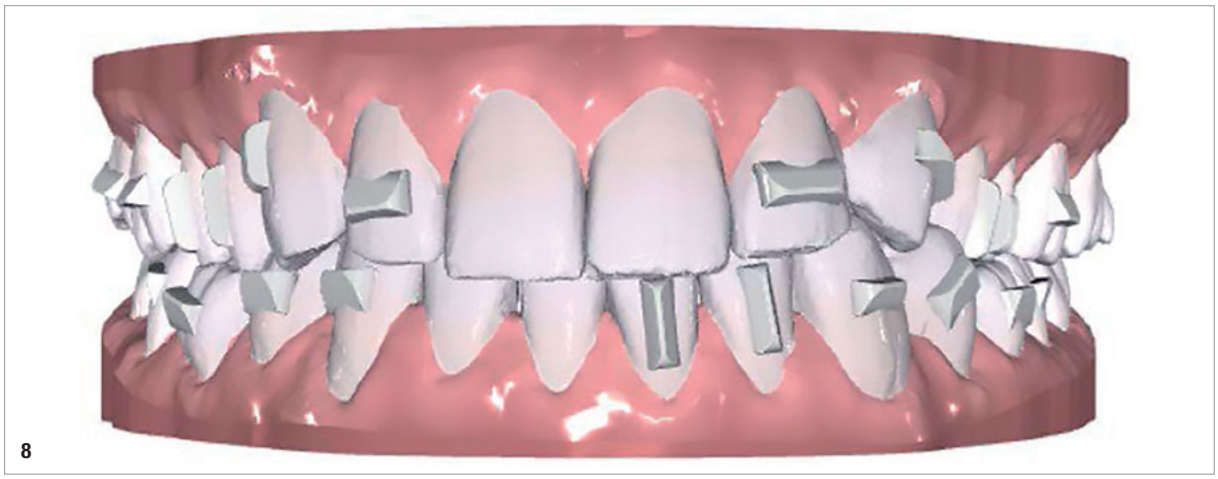
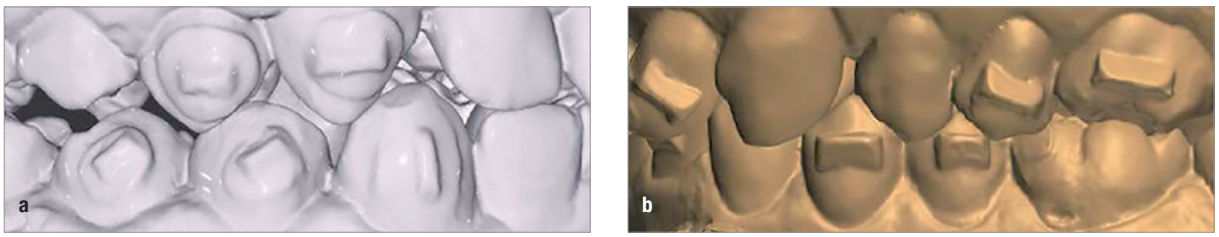
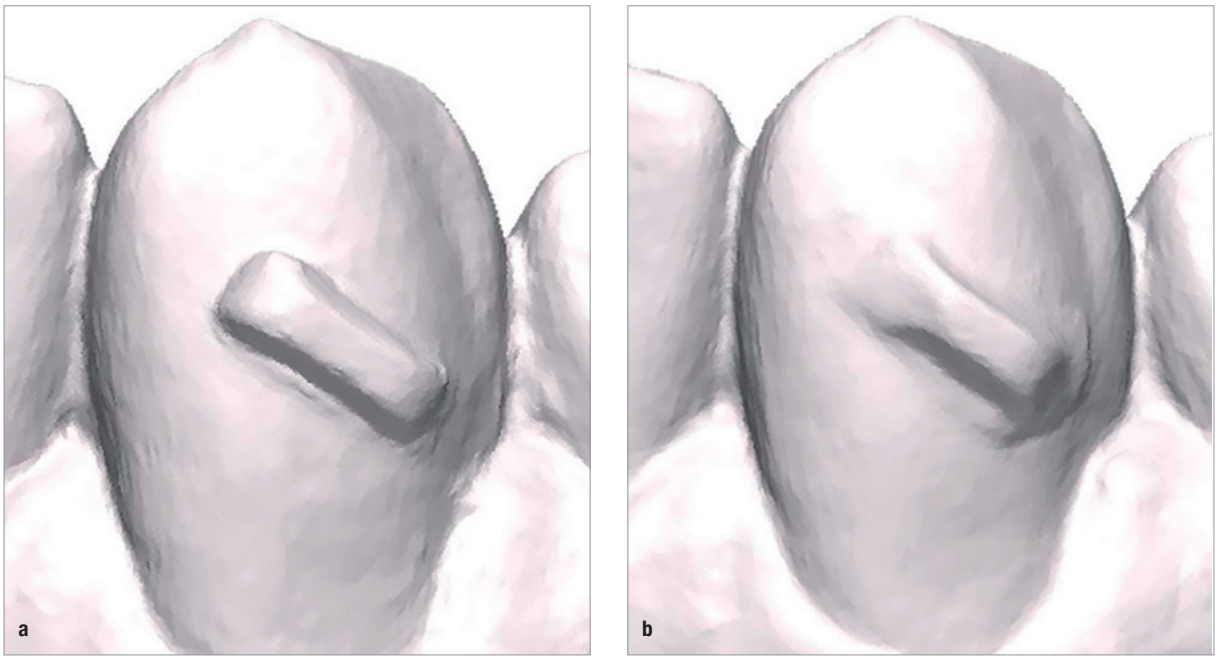


Fig. 8: Plan (3D set-up) of the attachments and their placement for the case demonstrated.



Figs. 9a & b: (a) Scan of conventionally moulded attachments and (b) of Clarity Precision Grip Attachments. Both scans were taken prior to any flash removal.



Figs. 10a & b: Scans of individual teeth with bonded attachments. (a) Clarity Precision Grip Attachment and (b) conventionally moulded attachment.

with a prophylaxis paste or etched and then prepared with a different bonding agent (3M Transbond Plus Self Etching Primer). The tray is fitted on to the teeth, and the bonding agents are polymerised by a 6-second exposure to an 3M Ortholux Luminous Curing Light or a 10-second exposure to a 3M Elipar curing light directly over each attachment. The tray is then removed from the mouth.

The attachments produced in this fashion are very well defined and free of composite flash after bonding (Figs. 6 & 7). The case shown demonstrates that the post-bonding results of Clarity Precision Grip Attachments closely mirror the precise shape and virtual placement in the digital plan (Fig. 8). To achieve optimal outcomes, it is crucial that the clinical reproduction of the attachments closely mirrors their virtual placement.

A comparison between attachments created via a conventional attachment template and Clarity Precision Grip Attachments shows that the 3D-printed attachments are cleanly defined and have less flash than the conventional attachments (Fig. 9). A direct comparison between a Clarity Precision Grip Attachment and a conventional attachment of the same planned shape and position, placed in the same patient and bonded by the same clinician demonstrates the defined edges of the Clarity Precision Grip Attachment (Fig. 10).

Engagement between aligner and attachment is also improved with attachments that are more precise (Fig. 11). In a comparison between a Clarity Precision

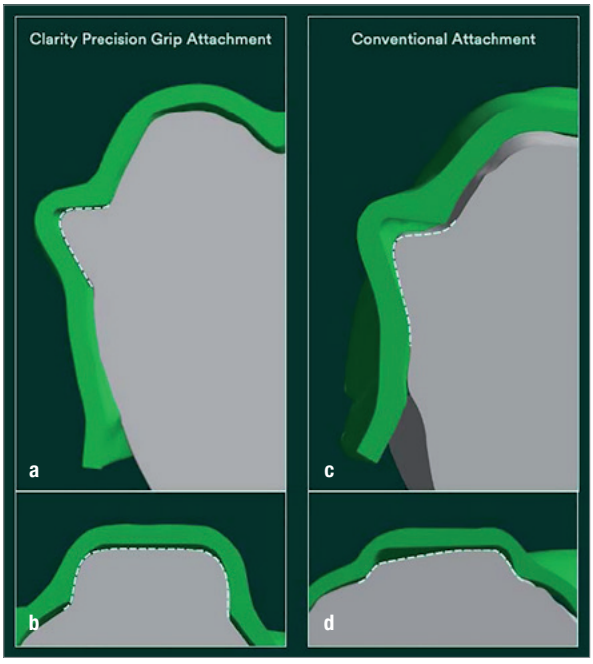


Fig. 11a–d: Cross-sectional views of bonded attachments. (a & b) More precise fit of the Clarity Precision Grip Attachment and (c & d) morepronounced gap and misalignment of the conventionally moulded attachment.