Introduction

Since their introduction, clear orthodontic aligners have enabled dentists and orthodontists to provide an increasing number of adult patients with treatments for their misaligned teeth that are more comfortable, hygienic and aesthetic than many traditional fixed orthodontic options. The aligners’ removable nature contributes to patient convenience during activities such as eating, brushing and flossing. Simultaneously, aligner optical properties provide a more aesthetically acceptable treatment for appearance-conscious adults that can produce results comparable to traditional bracket and wire systems.

Because they are fabricated based on CAD/CAM processes, clear aligners empower dentists with digital technologies that enhance the occlusal diagnostic examination, planning of progressive tooth movement, and visualization of the anticipated outcome. In fact, the digital model created from intraoral scans of the patient’s initial condition is the foundation for clear aligners. The same software used to render the digital model also anticipates the tooth movement necessary for achieving the desired outcome and, in the process, the number of aligners required throughout treatment. Once the orthodontist approves the computerized treatment plan, the clear aligners are manufactured via digital processes.
Individual clear aligners typically move teeth an average of 0.2 mm inclination and/or 1 degree rotation, and indications of early generations of clear aligners were limited to correcting mild crowding and spaces between teeth. However, software and material developments, including stronger plastics that withstand tooth pressure and generate requisite forces for precise movement, have enabled orthodontists to use clear aligners to correct a range of conditions. Among the misalignment and occlusal problems that can now be treated with Invisalign, for example, are over- and underbites, crossbites, crowding, open and deep bites, and spacing. Conditions requiring more complex bodily tooth movements—such as incisor torque, premolar derotation and molar distalization—can also be corrected with clear aligners.

The tooth movements required for more complex orthodontic treatments are facilitated by composite attachments placed on the surfaces of specific teeth, which help to better engage the aligners for proper tooth positioning by promoting greater surface area retention, and anchor certain teeth so they remain in place while others move. Attachment shape (e.g., ellipsoid when rotating canines; rectangular for rotating premolars; and beveled) and location are determined when digitally planning progressive tooth movement. Attachments can also facilitate other tooth movements, such as extrusion and intrusion.

**Getting attached to the process**

Because of the need for precise attachment placement to achieve anticipated tooth movement, custom attachment templates are provided to the orthodontist at the time of aligner delivery. Using the templates eliminates discrepancies in shape and location that could otherwise interfere with anticipated tooth movements, in addition to contributing to an efficient aligner delivery appointment.

However, dentists must consider other...
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Factors when attachments are required for clear aligners:

- Because this type of orthodontic treatment is known for offering patients an aesthetic option, the composite used for the attachments must demonstrate aesthetic optical properties that blend invisibly with surrounding natural tooth structure.
- The composite should also demonstrate shade stability over time to accommodate treatments requiring 15–18 months or longer. Additionally, although the attachments will be easily removed from tooth surfaces at the completion of treatment, they do require a sufficiently strong bond capable of withstanding the forces required for planned tooth movement.

**Case presentation**

A 52-year-old patient presented for an orthodontic consultation. A professional dental writer and editor, she was aware of multiple misalignment issues, anticipated undergoing aesthetic restorative dentistry in the future, and predicted needing gingival grafting to correct the health and appearance of recessed areas. Because the patient had three congenitally missing teeth (#4, #20 and #29), she presented with two Maryland bridges placed nearly 30 years earlier, and one three-unit porcelain-fused-to-metal bridge (PFM) that had been in place for 16 years; she was aware that the two Maryland bridges would need to be replaced after orthodontics and was not interested in implants, because the adjacent teeth were already prepared and would require new restorations anyway. The patient reported a history of clenching, bruxism and migraines, and had previously worn a nociceptive trigeminal inhibition (NTI) device until the crowding of her lower anterior teeth made it difficult to place and remove the device.

**Diagnostic evaluation**

An examination was performed that included intraoral and extraoral photographs, intraoral 3D impression scans using an iTero scanner from 3Shape for use in creating...
digital models, and a 3D CBCT scan. A temporomandibular joint (TMJ) examination was also performed; no clicks were evident, and the patient reported no jaw pain. The patient was diagnosed with upper and lower crowding (Fig. 1); an overjet and overbite (Fig. 2); constricted upper and lower arches that resulted in a narrow smile; crossbite of the molars on the left side; gingival recession due to abfractions; and enamel wear on the lower anterior teeth.

**Treatment plan**

The recommended treatment was Invisalign clear aligners to level and align the teeth and upper and lower arches, as well as broaden the arches to create a wider smile. Because of the nature of the tooth movements required, composite attachments on the facial surfaces of teeth #7, #13, #22, #27 and #28, as well as a metal button on tooth number #31 and precision hook at tooth #6 in the aligner to accommodate an interarch elastic band, would be required. The latter would provide the force necessary to move the teeth and align the jaw to correct the overbite and crossbite.

The Maryland bridges would be sectioned (i.e., distal to tooth #4 and distal to tooth #28) before initiating treatment. Minor interproximal reduction would also be required at specific stages of treatment, which was anticipated to take between 15 and 18 months.

This orthodontic treatment would be effective in correcting the patient’s misalignment and occlusal problems, as well as protect her teeth against clenching and bruxing. The patient’s overjet was contributing to the wear, chipping and craze lines of her anterior teeth, and orthodontic appliances have proven effective in resolving misalignment that leads to these conditions. Her crossbite was also a contributing factor to the tooth wear and chipped teeth, as well as the abfractions. Orthodontic treatment has been effective in resolving alignment issues associated with these problems, as well as correcting dental crowding through extrusion or other movement. The clear aligners would also enable incorporation of an anterior stop that would prevent her clenching and help to relieve her headache pain symptoms.

**Aligner fabrication**

The patient accepted the treatment plan and, based on the consultation and records obtained, a digital treatment plan was finalized and forwarded to Invisalign. The digital 3D software illustrated and planned how proper tooth alignment would be achieved, as well as the shape and location of the attachments required to facilitate tooth movements. Interproximal reduction was also prescribed for specific anterior mandibular teeth to enhance alignment, and proper tooth movement staging was determined.

For the first batch of aligners, treatment was staged with weekly aligner changes over 32 aligner stages. Attachments were placed during Stage 1 on teeth #7, #13, #22, #27 and #28. Interproximal reduction was prescribed at Stage 7 at the contacts between teeth #23 and #24, and #25 and #26. Additional interproximal reduction would also be necessary at later stages between teeth #26 and 27, #24 and #25, and #22 and #23.

**Attachment placement protocol**

During the delivery appointment, isolation was established to reduce salivary contamination, after which the prefabricated Invisalign attachment templates were tried in the patient’s mouth to ensure proper fit, then removed. Similarly, the first set of aligners was tried in so an intimate fit could be confirmed, and they were then removed.

The attachment template was air-dried with an air/water syringe, and the enamel on the teeth to receive attachments was acid-etched according to the manufacturer’s instructions, keeping the etch shape and location consistent with that of the planned attachments. The teeth were rinsed for 15 seconds and dried until the surfaces exhibited a frosted appearance. Subsequently,
Adhese Universal from Ivoclar Vivadent—a single-component, light-cured adhesive compatible with all etching techniques—was applied to the etched surfaces for 20 seconds to enhance bond strength, air-dried, then light-cured for 10 seconds each.

To create the attachments, Tetric EvoCeram nanohybrid composite from Ivoclar Vivadent in shade A1 was selected. The material was first loaded into the wells of the maxillary attachment template, using the padded end of an OptraSculpt Pad dental tool to press the composite into the wells; care was taken not to over- or underfill the wells. The template was then fully seated onto the patient’s maxillary teeth, and a dental spatula was used to gently apply pressure around each attachment to ensure complete adaptation. Any excess composite was squeezed away from the etched area, after which the template was light-cured using a Bluephase Style 20i LED curing light from Ivoclar Vivadent. The template was then carefully removed, leaving only the bonded attachments on the tooth surfaces.

The same process was repeated for the mandibular attachment template, after which finishing stones were used to remove excess flash, and interproximal areas were flossed. The patient then examined the appearance of the five attachments, noting that they were practically invisible and an excellent match to her natural tooth shade. She was also asked to feel the attachments with her tongue to ensure they weren’t too sharp, and the attachments were then polished using a rubber tip and low-speed polisher.

The button required on tooth #31 was also placed.

Once the patient was comfortable with her new clear aligners, the next appointment was scheduled for six weeks later. At that time, the patient’s bite and alignment were checked, as well as the aesthetics and durability of the attachments (Figs. 3 through 6). The patient reported having no problems with the attachments, and that she was pleased with how their color continued to match and blend invisibly with her natural teeth.

Interproximal reduction was performed as planned between teeth #23 and #24, and #25 and #26, and the patient received the next 18 sets of clear aligners. Another appointment was scheduled for six weeks later.

**Conclusion**

In this case, the ability to quickly, easily, and predictably place aesthetic composite
attachments has helped to facilitate the necessary tooth movement required for this patient’s clear aligner treatment. Certainly the Invisalign attachment template was invaluable for ensuring procedural efficiency and attachment placement precision. However, the handling characteristics of the Tetric EvoCeram nanohybrid composite selected for creating the attachments also contributed to ideal and predictable chairside protocol. Equally important, the composite attachments demonstrate an ideal, seamless shade match with the patient’s surrounding natural tooth structure, thereby complementing the aesthetic appearance of clear aligner treatments. ■

References