Efficient Procedure for Precise Bonding of Aligner Attachments

Abstract

Computer-generated attachments, as specified in the ClinCheck® simulation, must be precisely duplicated chair-side on the patient's dentition. This article describes the use of flexible attachment templates for each quadrant. Windows (reliefs) for each specified attachment are filled with composite resin that is bonded on the surface of the teeth. Standard operative procedure, quality control checks, and patient training are reviewed. This article provides step-by-step descriptions and illustrations for efficiently and precisely initiating aligner therapy. This protocol is standard operating procedure at the Beethoven Orthodontic Center. (J Digital Orthod 2020;59:64-73)

Introduction

Attachments are a critical part of clear aligner systems, which are designed to deliver precise and effective control of tooth movement. For most malocclusions, the attachment bonding procedure is the first step in preparing the arches for aligner treatment.[1,2] Precision bonding of the planned attachments is essential for delivering the mechanics required to achieve the planned outcome (*Fig. 1*). The first three "*aligners*" in the series are actually 3D overlays of the digitized dentition that are specific-purpose appliances. The most critical steps in the procedure are well noted (*Latin: nota bene*) for the reader and marked with a NB in bold italics (***NB***).

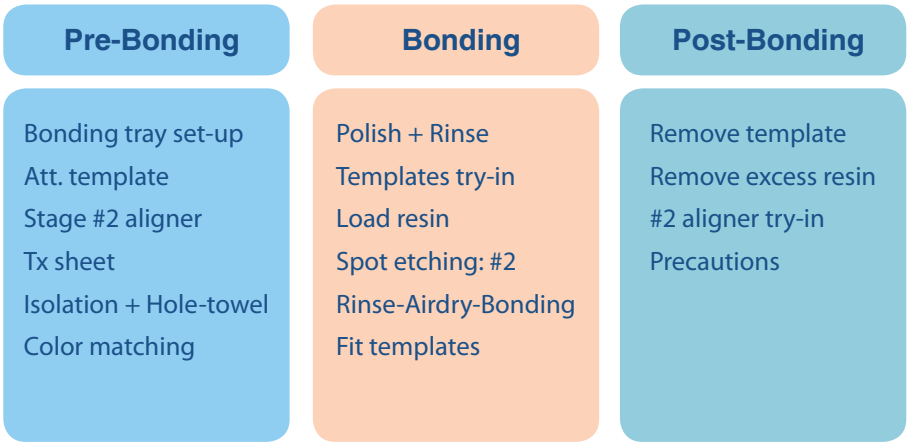
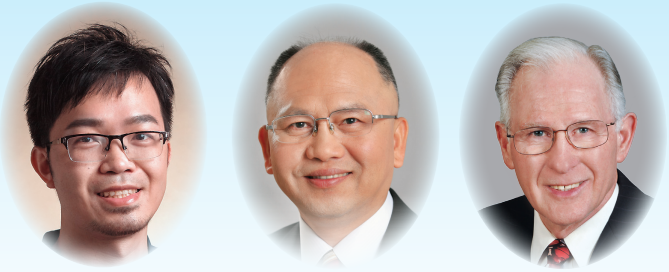


Fig. 1:
There are 3 phases (left to right) for the aligner attachment process. Multiple procedures in sequence are required for each phase. See text for details.

Joshua Lin,
Lecturer, Beethoven Orthodontic Course (Left)
Chris H. Chang,
Founder, Beethoven Orthodontic Center
Publisher, Journal of Digital Orthodontics (Center)
W. Eugene Roberts,
Editor-in-Chief, Journal of Digital Orthodontics (Right)



Introduction to Aligners

The first overlays (*Aligner set #1*) are prepared on the existing dentition. They are designed to engage undercuts to achieve retention, and accustom the patient to activation. Acclimation of the patient for fitting and removing clear aligners is the first objective of treatment. Aligner set #1 is worn all the time except when eating. Objectives are to: 1) fit each device on the entire arch; 2) seat the retention points into the undercuts; 3) continuously retain both appliances on the dentition; and 4) easily remove them when desired. Patients and their parents (*if minors*) are instructed to clean aligners regularly, protect them in the carrier during meals, and keep them stored any time they are not in the mouth. In addition, patients are advised that the first aligners are to prepare them for the very important second stage when the attachments are bonded on the dentition. Most are excited and eagerly await the next visit when the attachments are installed.

The second overlay is a template with voids (*negative relief areas*) on the surfaces of teeth that correspond to the site and shape of each attachment. After the treatment plan is completed and the required attachments are digitally fitted on the dentition, templates are constructed as overlay appliances for the precise installation of attachments. The third overlay set (*Aligners #2*) are appliances designed to fully engage all the attachments and apply about 0.25mm of activation to begin aligning displaced teeth.

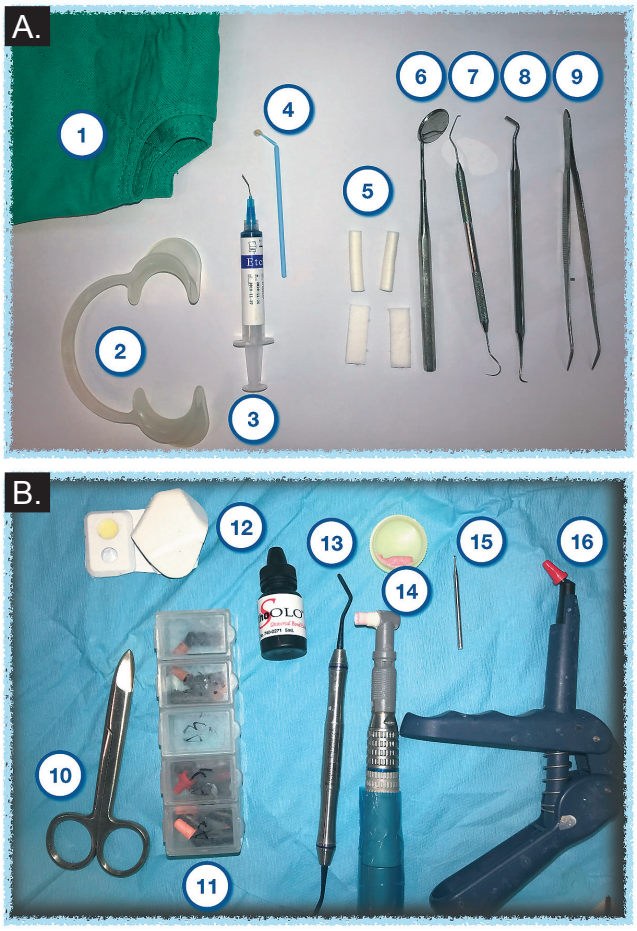


Fig. 2:

A. Doctor's chair-side desktop:

(1) Hole-towel
(2) Retractor
(3) Etching gel
(4) Small cotton wool stick
(5) Cotton rolls
(6) Mirror
(7) Probe
(8) Scaler
(9) Tweezers

B. Assistant's worktable:

(10) Scissors
(11) Differently shaded resin capsules (Tetric N-Ceram®)
(12) Container for the bonding agent (primer): OptiBond® Solo Plus™
(13) Composite resin instrument
(14) Rubber cup and pumice paste
(15) Low-speed round bur (1mm diameter)
(16) Resin feed gun with resin capsule

Attachment Installation

Efficiently bonding attachments is an important step in the treatment process. Precise and efficient bonding of the attachments is a high priority. Beethoven Orthodontic Center developed a standard protocol for achieving attachment goals.[3,4] The purpose of this report is to provide a step-by-step instruction for efficiently bonding attachments on all teeth as needed in about 12-15 minutes. Clinical experience has perfected this important process for beginning aligner treatment.

Pre-Bonding Phase

Once patients have accomplished the acclimation objectives with the first set of aligners, bonding of attachments is the next procedure.

1. Bonding Tray Set-Up

- ***Doctor's Chair-Side Desktop:*** Hole-towel, retractor, etching gel, bonding agent, cotton rolls, mirror, probe, scaler, and tweezers (*Fig. 2A*)
- ***Assistant's Work Area:*** Scissors, shaded resin capsules (*Tetric N-Ceram®, Invoclar Vivadent AG, Füstentum, Liechtenstein*), bonding agent (*OptiBond® Solo Plus™, Kerr Corp., Brea CA*), composite resin instruments, rubber cup, pumice paste, low-speed round bur, and resin feed gun with resin capsule (*Fig. 2B*)

2. Marking Templates and Stage 2 Aligners

Referring to the Invisalign® Treatment Overview sheet,[5,6] assistants confirm the location and specifications for each attachment, and mark the outer surfaces of the template with an indelible pen to correspond to each attachment (*Figs. 3 and 4*). Then each attachment template is cut in half, between the central incisors, resulting in four templates: upper right (*UR*), upper left (*UL*), lower right (*LR*), and lower left (*LL*) (*Fig. 5*). After this segmentation procedure, an assistant again compares the attachments for each quadrant template to the treatment overview (*Fig. 4*). Attachment locations are similarly marked on the post-bonding set of aligner trays (*Aligners #2*) to confirm the type and size of each attachment prior to the bonding procedure. The doctor then tries in the post-bonding set of aligner trays (*#2*) in patient's mouth to check attachment positions relative to the treatment plan (*Fig. 4*). In effect, there are three checks of aligner positions and specifications according to the treatment overview: two by the assistant(*s*) and one by the doctor (*Figs. 3-5*). These multiple checks reduce chair time and mistakes by ensuring that all templates are correctly configured.

3. Isolation and Color-Matching

After explaining the attachment bonding process to the patient, the hole-towel and retractor are applied to isolate the teeth and reduce saliva contamination. The shade for the attachment composite is selected under ambient light conditions by the doctor using the color matching tabs (*shade guides*) (*Fig. 6*).

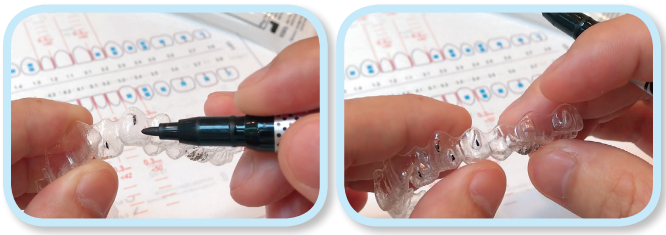


Fig. 3:
Marking the outer surface of each attachment window with a black marker pen

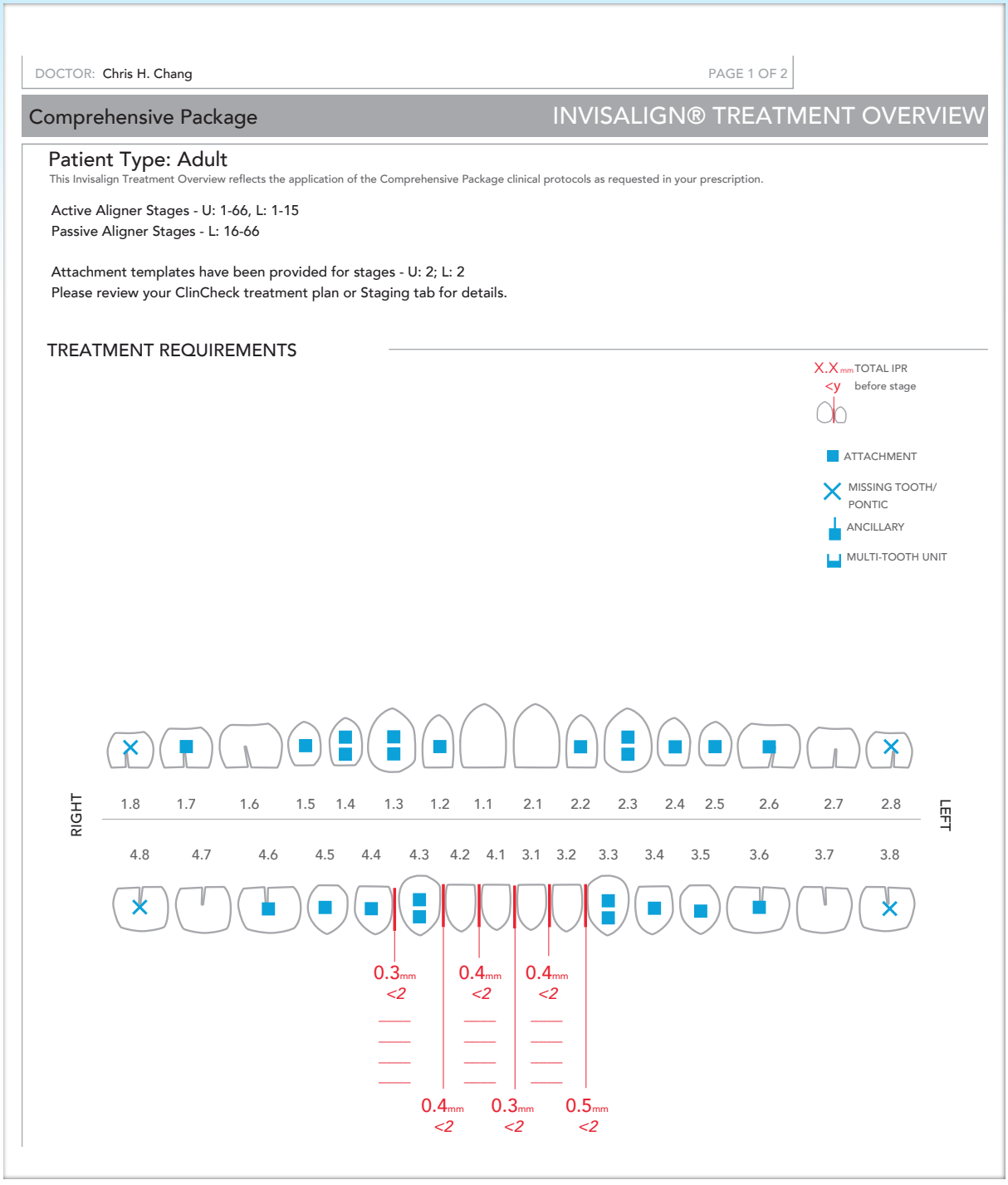


Fig. 4: Invisalign® Treatment Overview

The document is downloaded from the Invisalign ClinCheck®. It summarizes the position, type, size, and shape of each attachment, as well as the location and quantity for interproximal reduction (IPR).

"Active Aligner Stages" are the stages in which there is active force to the dentition. Every active aligner is a little different in shape to the previous aligner. Therefore, patient can feel the force when replacing an active aligner with a new one. In this figure, the active aligner stages of upper dentition is from stage #1 to the last stage of #66, whereas the active aligner stages of lower dentition is from stage #1 to #15. "Passive Aligner Stages" are the stages in which there is no force to the dentition. Passive aligners are for retention purpose only, and patient cannot feel any force when wearing passive aligners. In this figure, there is no passive aligner stage prescribed to the upper dentition and the passive aligner stages of lower dentition is from #16 to #66.

When the doctor prescribes the use of "power arm", the Treatment Overview sheet will show a symbol "Ancillary" on the corresponding tooth.

Fig. 5:
Prior to try-in, templates for bonding each arch are sectioned at the midline which results in four quadrant trays that are more convenient for clinical use.

Fig. 6:
Color-matching with shade guides helps produce inconspicuous attachments.

Bonding Phase

(1) Polish all enamel surfaces in both arches with pumice paste and rinse thoroughly.

(2) Try in the respective template for each quadrant. Ensure that they snap into place and fit properly. Fitting and retention problems may occur in the most crowded areas resulting in displacement on either end of the template. Note any fitting problems (*Fig. 7*) so they can be addressed at the time of bonding by applying pressure with a finger or instrument to achieve an optimal fit. Also, try in the post-attachment aligners (#2) to ensure a proper fit.

Fig. 7:
Fitting problem (yellow arrow) of the UL template occurs in the central incisor area which is the most crowded and irregular aspect of the arch.

NB: During this step, the doctor must again check the specification and location for each attachment by comparing template marks to the Treatment Overview sheet (*Fig. 3*). After triple-checking the templates (*twice by the assistant and once by the doctor*), the assistant then fills the attachment windows (*reliefs*) with composite resin.

(3) Use the marked post-attachment aligners and the doctor's chair-side laptop computer to identify areas of enamel requiring etching. Spot etch only the area to be bonded with a 37% phosphoric acid gel for enamel, or hydrofluoric acid for porcelain (*Fig. 8*). Thoroughly rinse with water and dry. The etched areas should have a frosty appearance (*Fig. 9*). Insert cotton rolls between the teeth and tongue for saliva control. Apply the bonding agent (*primer*): OptiBond® Solo Plus™, but do not apply the curing light.

(4) Load the shade-matched composite into the windows of the attachment template, slightly overfilling each area (*Fig. 10*).

Fig. 8:
Acid-etching according to the marked areas on the template is accomplished for natural enamel with 37% phosphoric acid gel for 30 seconds, and for porcelain surfaces with hydrofluoric acid for 60 seconds.

Fig. 9:
After rinsing with water and air drying, an etched enamel surface has a frosty (satin) appearance.

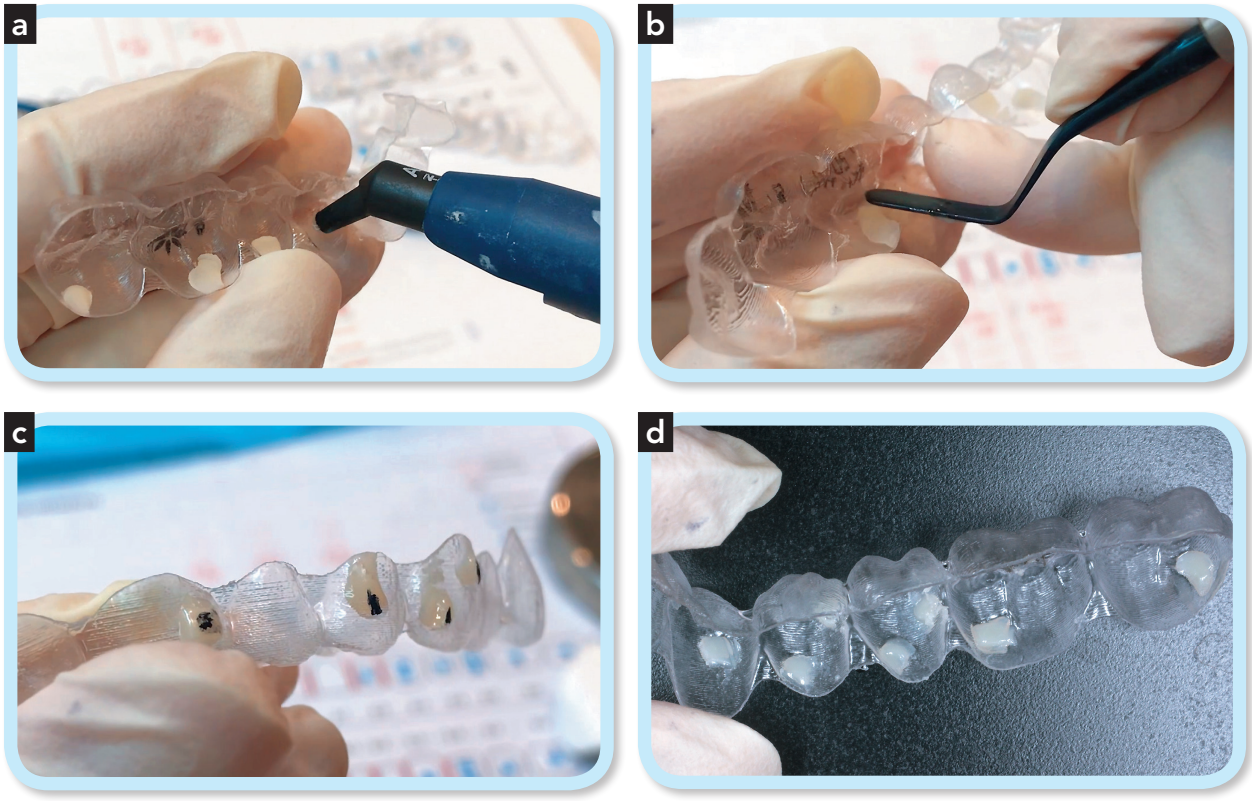


Fig. 10:
(a) Load composite resin into each attachment relief (window) with a resin-feeding gun.
(b) Adapt the resin into each window with a composite spatula.
(c) Check the buccal surfaces of the template to confirm a complete fill for each window.
(d) The lingual surface for each filled window should be slightly overfilled (convex).

NB: To improve efficiency, the doctor performs the etching procedure (*Fig. 8*) at the same time the assistant loads composite into the template windows (*Fig. 10*).

(5) After air blowing the uncured primer to a thin layer on each tooth, the UL and LL templates loaded with composite resin are seated in sequence. Then the patient bites on a cotton roll to seat the templates, i.e. tightly adapt the templates to the surfaces of the teeth (*Fig. 11*).

NB: Particularly for severely crowded incisors, a gap between the template and the surfaces of the teeth may occur after the patient bites on the cotton roll (*Fig. 11*). The problem is best resolved by pressing the fingers or an instrument to seat as much as possible the distorted section of the template prior to applying the curing light (*Fig. 12*).

(6) After the bonding procedure is completed for all four quadrants, additional irradiation with the curing light from all angles is necessary to ensure that primer and composite resin are completely cured.

Fig. 11:
After coating each etched attachment area with primer, the resin-filled trays are seated on the two left quadrants, and the patient bites on a cotton roll to ensure a good fit to tooth surfaces.

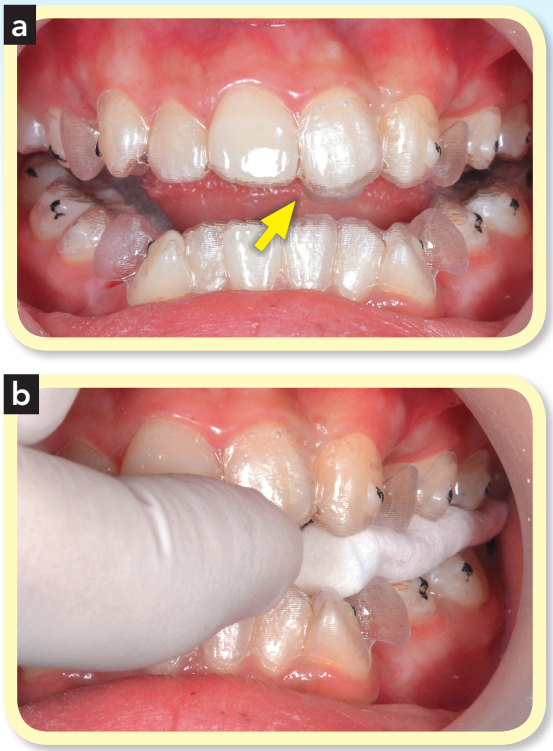


Fig. 12:
(a) A problem with the fit of the UL template was noticed at the try-in (yellow arrow). It must be corrected with finger or instrument pressure prior to curing the resin.
(b) The patient continues to bite on a cotton roll, while an instrument or finger is used to press the ill-fitting area so that it conforms properly to the surfaces of the teeth prior to utilizing the curing light.

Post-Bonding Phase

(1) After curing is complete, use a large hook-type scaler to dislodge the distal ends of the template on the lingual surface, and then carefully remove it to the buccal to avoid damaging the template or attachments (*Fig. 13*). The templates are removed sequentially and properly stored. They may be needed when replacing or repairing an attachment(s) during treatment.

NB: Keep the templates in the patient's Invisalign® treatment box. The attachment templates should never be given to the patient.

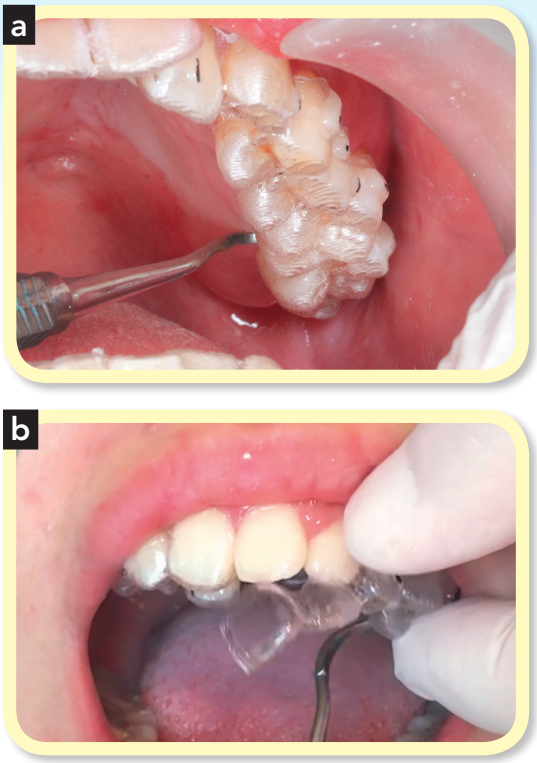


Fig. 13:
(a) After the composite is completely cured, use a large scaler to dislodge the palatal or lingual posterior surface of each template.
(b) Protect the cheeks and lips with the operator's fingers when the attachment template is gently rotated to the buccal and removed from the mouth.

(2) Clean all excess flash and residual bonding resin from around the attachments with a small round bur in a straight handpick (*Fig. 14*). Dental floss is effective for removing excess resin or composite from interproximal areas.

NB: Rotate the bur at a slow speed with blown air to clear excess resin as it is removed. To more easily distinguish the margin of each attachment, avoid water irrigation. Never touch the active surfaces of optimized attachments (*Fig. 15*) because their shape and orientation are critical for the planned treatment objectives.

Fig. 14:
Clean flash and residual bonding resin around each attachment with an 1mm diameter round bur in a straight handpiece. Avoid water-cooling to better visualize the margins of the attachments. Remove excess interproximal resin with dental floss.

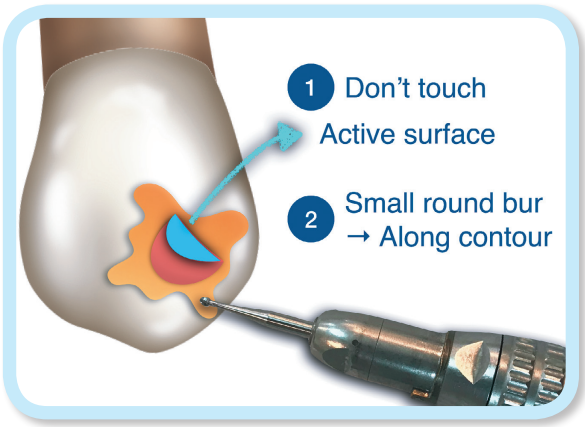


Fig. 15:
Avoid contacting the active surfaces of optimized attachments.

(3) Instruct the patient to completely engage all attachments when the post-attachment aligners are seated. Emphasize proper hygiene for the aligners and all enamel surfaces (*Fig. 16*). White spots are much less common for aligner compared to fixed appliance treatment, but placing aligners over teeth coated with plaque can result in generalized decalcification.[7]

Discussion

Precise placement of attachments helps ensure optimal tooth movement as prescribed in ClinCheck®. This is probably the most important step for achieving desired outcomes.[8] The standard bonding procedure for attachments at Beethoven Orthodontic Center involves multiple checks by different personnel (*Figs. 3, 5-7*) to ensure adherence to the specification for each attachment: shape (*type*), shade, relative prominence, and location. Furthermore, excessive humidity (*moisture contamination*) is controlled with cheek and lip retraction and lingual cotton rolls to isolate the tongue. These are important steps for achieving optimal polymerization, bond strength, and desired dimensions for each attachment.[9]

Conclusions

Attachments bonded with this established procedure facilitate the patient and dental team to enjoy a highly effective and relatively comfortable treatment experience. A full-mouth attachment bonding procedure can be accomplished in 12-15 minutes. This approach for rapidly and precisely bonding all attachments optimizes the efficiency of treatment to reduce chair time and improve outcomes.[10]

Acknowledgements

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Fig. 16:
An upper panel of three intra-oral photographs reveals the original malocclusion. A similar lower panel shows the dentition after attachments are bonded and Aligner set #2 are seated to activate alignment.

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