Invisalign Case Report

by Jonathan Nicozisis, DMD, MS

Chief Concern:

"I don't like the way my teeth look. I'll do braces, but would rather not."

Highlights of This Case:

Invisalign used to correct an anterior crossbite with favorable extraoral soft tissue response and intraoral gingival margin alignment in the aesthetic zone. Detailed mechanics of attachments and tooth movement design reviewed for extrusion without the use of auxiliaries and extraction site space closure. One year retention follow-up included.

Background Information:

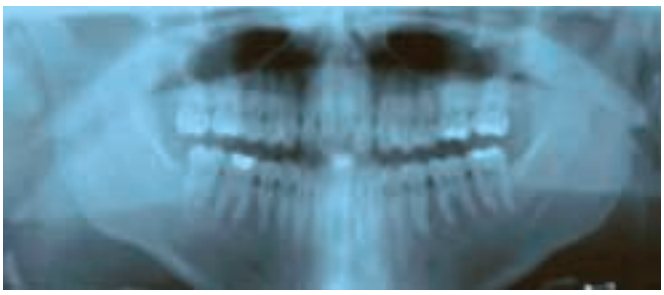
19-year-old college student
Dental and skeletal Class 3 with an anterior crossbite
Moderate U/L crowding
Uneven gingival margins upper anterior
Periodontal tissues are WNL
Third molars not present
No TMD signs or symptoms reported
Soft tissue profile: pronounced lower lip compared to upper

Treatment Options:

1) Extract a lower incisor
2) Extract a lower incisor with further IPR to retract lower anterior for positive OB/OJ
3) Extract upper 5s lower 4s without Sx
4) Extract upper 5s lower 4s with Sx
5) Heavy IPR lower 6-6

Treatment Plan Concerns and Considerations:

1) Ability to correct anterior crossbite and establishing a functioning occlusion
2) Evening out gingival margins for better aesthetics (extrusion required)
3) The usual issues with surgery



4) Closing extraction spaces
5) Would TADs make a difference in this case?
6) Would retracting the lower anterior perforate the cortical plate of bone?
7) Improving soft tissue profile
8) Retention

Actual Treatment Plan:

Lower incisor extraction and 3.5mm of IPR in the lower arch to obtain proper OB/OJ due to anterior crossbite and Class 3 occlusion using the Invisalign appliance system.

A Brief Review of Principles Used for Extrusion:

1) Visible space between teeth during alignment so there is no interproximal binding. Why not turn every crowded case into a minor spacing case via tooth movement, not IPR (just like we do with fixed appliances, open coil springs, NiTi wires, etc.)? For extrusive movements, this is more than just setting, "collision tolerance" to zero; this is creating 0.2mm or more of space interproximally so there is no binding of the teeth during the extrusion.

2) Because aligners are not proficient at "pulling" teeth in extrusive movements, design movements to have equal amounts of extrusion for each increment of retraction.

Why? This way you get two vectors of force on the tooth simultaneously – one extruding while the other is retracting. The net effect is a pushing force rather than a pulling force. How do I ask for this in my special instructions? In algebra where y=mx+b, and m=slope or rise over run on an X/Y axis, I design my movement to mimic M (slope) equal to 1/1.

It is ideal to ask for all of the extrusion to be completed prior to complete space closure. This will ensure that there are no collisions when performing the movement and the last bit of movement is tightening contacts with a virtual powerchain. Thus, the amount of interproximal spacing that needs to be created is really a function of the amount of extrusion that is necessary. So in review, for extrusion cases – design ClinCheck to have a net pushing effect rather than attempting a pure pulling action with space created interproximally with tooth movement.

3) Attachment design: design your attachments to maximize the attachment/aligner interface or surface area in relation to the vectors of force acting on the tooth. One should also design the attachment in relation to the natural anatomy of the crown in the incisal/occlusal third, which tends to taper and be inclined lingually. The goal is to create a contrasting angle to the natural anatomy in the incisal third so that the surface area of the aligner-attachment interface is maximized in relation to the applied vector of force.

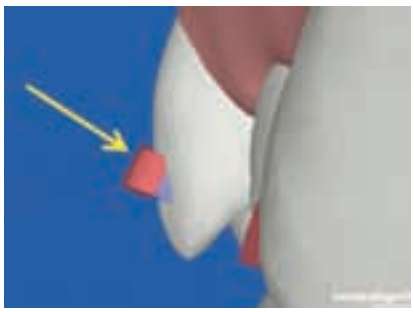
Accordingly, I design my attachment to be a "beveled" attachment thicker at the incisal margin, tapering toward the gingival margin. (Note: this is now the default configuration; this case is from 2006.)

Attachment design in this configuration:

a) maximizes attachments/aligner interface in relation to the pushing force vectors acting on it
b) creates a contrasting angle to that of the clinical crown which has a natural tendency to taper lingually

It is my belief that if extrusion is attempted with the formally recommended attachment once the attachment slips contact with the aligner, it acts as a wedge and pushes the tooth out of the aligner in the opposite direction of the desired movement. I believe it is a result of the attachment surface with the larger surface area being oriented in the same direction as the natural inclination of the clinical crown.

If an attachment slips out of aligner during extrusion using a beveled gingival attachment, its broader surface exposed to the vector of force will continue to push the tooth in the desired direction.



Two vectors of force are acting on the tooth (one retraction, the other extrusion) for a net effect of a pushing vector. The net pushing vector is against an attachment surface that is as perpendicular as possible to the vector to maximize the surface area.

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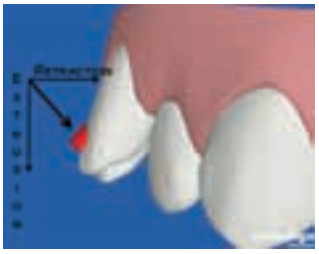
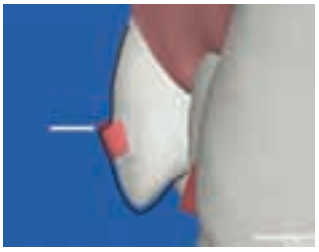
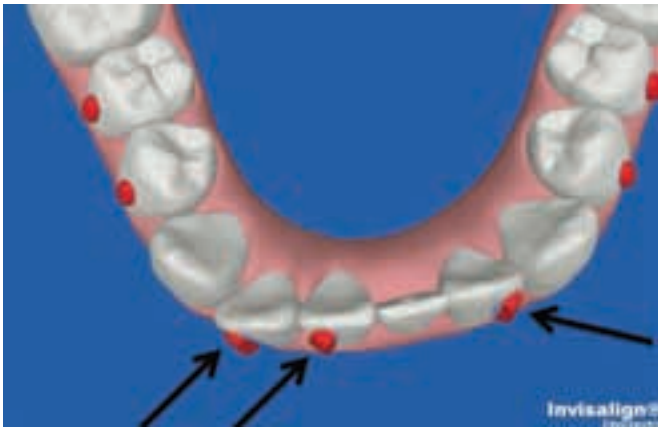


Former default configuration:



All these principles are applied for extruding #9 4mm in total.

Space closure of a single lower incisor:



Principles applied for attachment design and placement:

It is well accepted that aligners are more proficient at pushing teeth rather than pulling them into position.

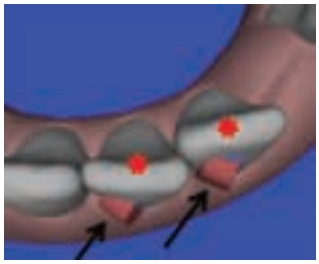
1) When pushing an object, simple logic would have you maximize the surface area that you are pushing against to distribute the force over that area and to increase the interface of the object and force vector. Imagine pushing an object with the palm of your hand (broader surface of a beveled attachment) as opposed to your fingertip (ellipsoid).

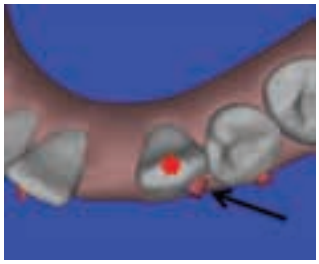
2) Furthermore, a vector of force is most efficient when it is directed perpendicular to the surface rather than at an angle.

3) Finally, it is best to push an object from behind its center of resistance rather than next to it or in front of it.

In this fashion, the vector of force passes through the center of resistance for better control of the object's directional movement. The result is that the force vector hits the attachment first as far behind the center of resistance as possible for better directional tooth control. As an example, imagine pushing a car in neutral from behind the trunk versus next to it by the window versus next to the front bumper. Thus design your attachment and place them on the clinical crowns taking these three things into consideration.

More specifically in extraction cases, place a vertical rectangular beveled attachment on the side of the crown away from the extraction space as you are moving the teeth toward the space to close it. Thus you can start pushing from behind the center of resistance for better directional control of movement. Bevel the attachments so the broader surface is as perpendicular as possible to force vector pushing on it. As a result you will maximize the attachment/aligner surface area interface.





Stage 9:

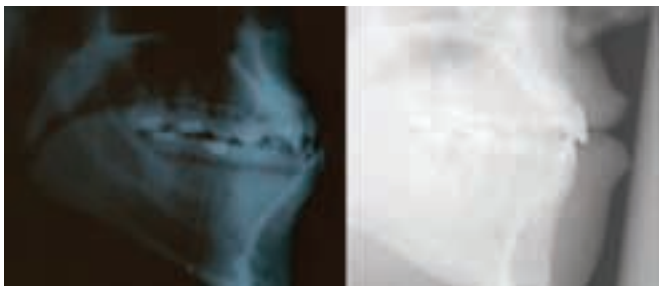
Stage 15:

Stage 22:

Stage 26:

Final after 34 Stages and 17 months of treatment (no refinement):

Before and after comparisons:



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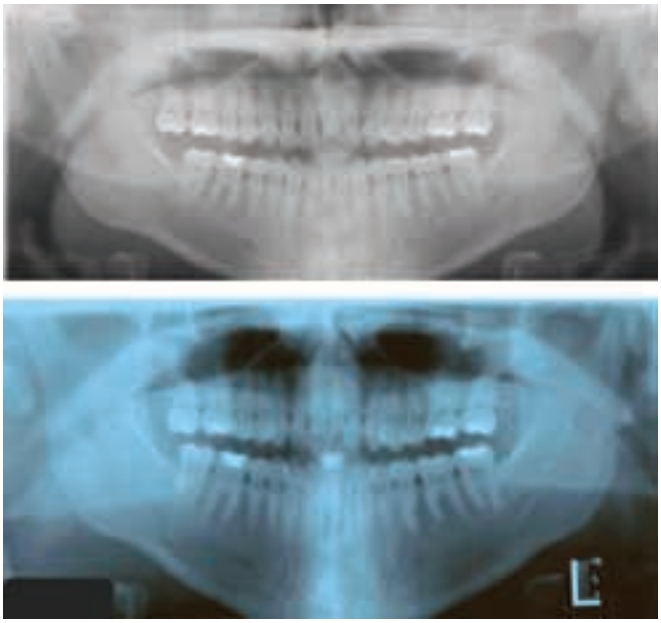

One year post retention:

In Review:

1) Anterior crossbite corrected, upper cuspid guidance on lower first bicuspids
2) Gingival margins are even for improved aesthetics via extrusion protocol and gingival beveled attachment design
3) Surgery avoided
4) Extraction space closed with parallel roots using vertical beveled attachments
   - placed behind center of resistance for better directional control
   - angled to be as perpendicular as possible to the vector of force
   - angled to maximize surface area of attachment/aligner interface
5) Would TADs or elastics have made a difference or changed the treatment plan?
6) Cortical plate of bone not perforated
7) Soft tissue profile improved

These attachment designs and mechanics employed are very consistent with Align Technology's New Improvements released in the Fall of 2009 as related to extrusion movements. This case was treatment planned in 2006 prior to benchtop engineering. I am very pleased that recent benchtop testing has optimized such attachment design related to an individual tooth's center of resistance. I would like to caution, however, extrusion is not simply an attachment, but an attachment and properly designed tooth movement designed with the aforementioned principles. Any interproximal binding during extrusion will often cause teeth not to track well.

It is hopeful that further testing will validate clinical application and placement of vertical rectangular beveled attachments or some derivation of them.

This case is unique for all the detailed mechanics used in attachment design with the force vectors applied in mind. ■

Author's Bio

Dr. Jonathan Nicozisis has been in the specialty practice of orthodontics since 1999 in Princeton, New Jersey. He completed his dental education at the University of Pennsylvania before attending Temple University for his orthodontic residency where he received his specialty Certificate in Orthodontics and a Master's Degree in oral biology. He is a member of the Angle Society and Diplomate of the ABO. Dr. Nicozisis is on the Invisalign National Speaker's Bureau and is the founding orthodontist of BAS Medical (now Corthera). It was founded in 2003 to explore the use of Relaxin as a therapeutic adjunct in orthodontic therapy. An initial round of human clinical trials overseen by the FDA has been completed. In February 2010, Corthera was acquired by Novartis and is exploring the use of Relaxin in cardiac failure in the critical care setting. Dr. Nicozisis holds patents related to the Appliance removal tool available through Dentsply/Raintree Essix. His Aligner treatment planning lectures are available at www.clearseminars.com.