Invisalign eighth-generation features for deep-bite correction and posterior arch expansion

Mazyar Moshiri, Neal D. Kravitz, Jonathan Nicozisis, and Shawn Miller

Introduction

*E*very few years Align Technology releases generational enhancements to improve the efficacy and efficiency of their Invisalign system. Each generation may influence the ClinCheck software, the aligner material, the optimized attachments, the tooth activations, or the order in which teeth move.[1] Oftentimes, multiple changes occur within each new generation, working in unison to provide better biomechanical control.

For example, orthodontists have traditionally struggled to correct deep-bites in non-growing patients with Invisalign.[2–7] The fifth-generation (G5) enhancements improved the predictability of deep-bite correction by introducing pressure areas on the lingual of the upper and lower anterior teeth, precision bite ramps on the lingual of the upper incisors, and beveled dome-shaped retention attachments on the premolars (Fig. 1).[2]

The purpose of this article is to review the newest eighth-generation (G8) enhancements, which aim to further improve the predictability of deep-bite correction and minimize unwanted crown tipping during posterior arch expansion. This article serves as a follow-up to "Mechanical considerations for deep-bite correction with aligners" by Kravitz et al.[2]

New improvements for deep-bite correction

Invisalign G8 features four improvements to aid the predictability of deep-bite correction. These include: (1) balanced anterior en-masse intrusion, (2) a new optimized attachment for the lower lateral incisor, (3) overcorrection of lower incisor intrusion and a flattened Curve of Spee, and (4) automatic placement of precision bite ramps for lower incisor intrusion.

When intruding anterior teeth en-masse, the intrusive force on an individual tooth could be impacted by the vertical position of the adjacent tooth. For example, a supra-erupted central incisor could affect the intrusive force on the adjacent central and lateral incisor. With Invisalign G8, en-masse intrusion is calibrated individually per tooth to provide optimal forces for teeth starting at different vertical positions.

Typically, teeth undergoing intrusion do not need attachments, but adjacent teeth do for vertical anchorage (prevention of aligner liftoff). The new G8 domed-shaped optimized attachment for the lower lateral incisor was designed for this reason (Fig. 2A and B). This feature is triggered by the software when the prescribed intrusion is greater than 1 mm for either the adjacent canine or central incisor.

In this situation, the authors prefer a more robust 4 mm horizontal beveled attachment (HBA) over the smaller optimized attachment. This modification is an update to the deep-bite protocol previously presented.[2] Therefore, to reverse a steep mandibular Curve of Spee, the authors now advocate G5/G7 attachments on the extruded first molars and premolars, and HBAs on the intruded canines and lateral incisors.

Invisalign G8 also helps to reverse a steep mandibular Curve of Spee by overcorrecting incisor intrusion on the initial setup. This additional activation is automatically determined by the software (Fig. 3A and B). Nonetheless, additional overcorrection by the orthodontist is likely still needed. This is particularly true of more challenging deep-bite cases with a flat mandibular plane or where space closure or IPR is occurring.

SUMMARY OF RECENT GENERATIONAL ENHANCEMENTS (G5-G8)

Generation	Enhancements
G5	Deep-bite correction, pressure areas on the lingual of the anterior teeth, precision bite ramps, beveled dome-shaped attachments on premolars for anchorage
G6	Premolar extraction solution-maximum and moderate anchorage
G7	Molar retention attachments to decrease posterior open-bites, molar rotation attachments
G8	Enhanced deep-bite correction, flattened Curve of Spee, posterior arch expansion solution with new posterior attachments, buccal root torque activations

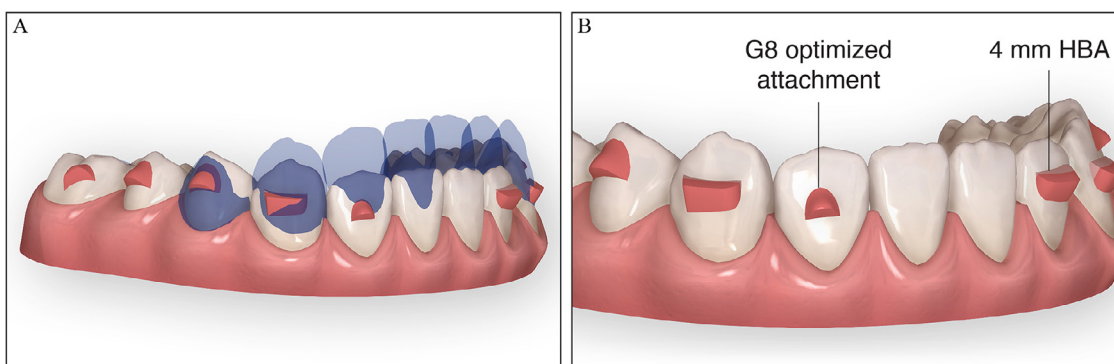**Fig. 1.** Summary of recent generational enhancements (G5-G8).

Fig. 2. A and B. A. Invisalign G8 optimized support attachment for the lower right lateral incisor. B. Note the 4 mm HBA on the lower left lateral incisor. This attachment is preferred by the authors for their deep-bite correction protocol.
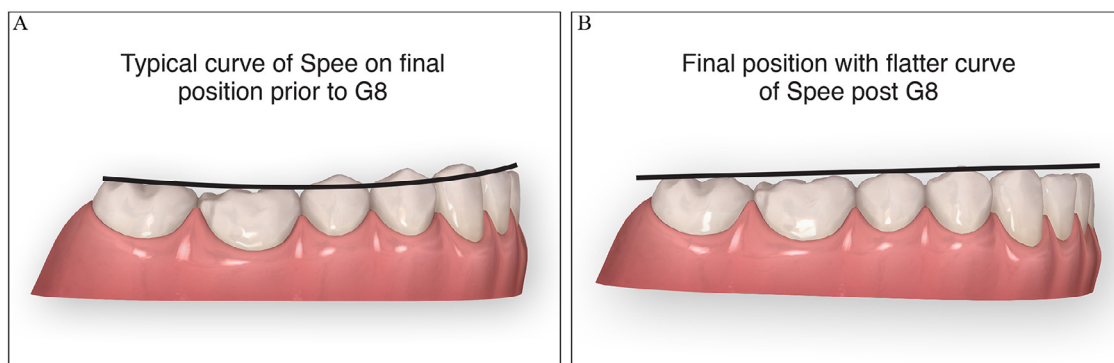

Fig. 3. A and B. A. Typical curve of Spee on the final position prior to G8. B. Final position with a flatter curve of Spee post G8.

To activate these intrusion features, a threshold of at least 0.5 mm of anterior intrusion must be prescribed in the ClinCheck treatment plan. It is worth noting that the same threshold was required by Invisalign G5 to activate the placement of pressure areas on the anterior teeth. However, these features will not be triggered by the software during closure of premolar

> **Bite Ramps** (Aligner protrusions on the lingual of the upper incisors)
>
> ⦿ Automatically place precision bite ramps whenever lower incisor intrusion is more than 1.5 mm
> ○ Place Bite Ramps on lingual of these upper teeth
>   ○ Incisors
>   Note: Placement of Bite Ramps will take the place of the upper anterior intrusion features
>   (Pressure Areas) if applicable.
>   ■ Central incisors
>   ■ Lateral incisors
>   ○ Canines
> ○ None
> Note: In some cases, bite ramps placement may not be possible due to excessive overjet.

Fig. 4. Select the first option for automatic placement of bite ramps on the upper incisors when the lower incisor intrusion is greater than 1.5 mm. Select the second option to specify bite ramp placement on the centrals, laterals, or canines.

extraction spaces, although it would be advisable to add them to prevent deepening of the Curve of Spee.

In addition, Invisalign G8 has updated the ClinCheck questionnaire to allow for automatic placement of precision bite ramps on the upper incisors in deep-bite cases. Internal data from Align Technology has shown that the use of bite ramps improves lower incisor intrusion by up to 30%. Although this feature can be pre-selected in ClinCheck, it is only triggered if the prescribed lower incisor intrusion is greater than 1.5 mm (Fig. 4).

New improvements for posterior arch expansion

Invisalign G8 also features four improvements to aid the predictability of posterior arch expansion. These include: (1) balanced posterior expansion forces, (2) automatic placement of buccal root torque, (3) optimized support attachments on the premolars and first molars, and (4) prioritization of expansion on the tooth activation hierarchy.

Like intruding anterior teeth en-masse, posterior arch expansion requires movement of multiple teeth simultaneously, and the force of expansion on an individual tooth could be impacted by the position of the adjacent tooth. With Invisalign G8, posterior arch expansion is calibrated individually per tooth to provide sufficient and optimal forces for teeth with different expansion amounts.

Traditionally, uncontrolled posterior arch expansion with Invisalign produces unwanted tipping of the premolar and molar crowns.[8,9] This results in extrusion of the palatal cusps and the development of a posterior open-bite. To minimize crown tipping during dental expansion, Invisalign G8 will automatically apply buccal root torque to the premolars and first molars.

This tooth activation works synergistically with the new G8 optimized expansion support attachments for the premolars and first molars. These horizontal dome-shaped attachments are a modification of the G5 attachments. One notable difference, however, is that the G8 attachment comes with a rotational version (Fig. 5A and B). In other words, it does not need to be manually adjusted in ClinCheck Pro for premolars or first molars that require both expansion and rotation.

The new attachment corresponds with the software's updated hierarchy for tooth activation. With Invisalign G8, expansion is now the second priority for the software; two levels above rotational correction (Fig. 6). Though the software makes an initial attempt to provide the best solution, it is then up to the orthodontist to evaluate the proposed force systems and to determine if they are appropriate and properly sequenced.

Like anterior intrusion, a threshold of at least 0.5 mm of buccal expansion must be prescribed in the ClinCheck treatment plan to activate the G8 expansion features.
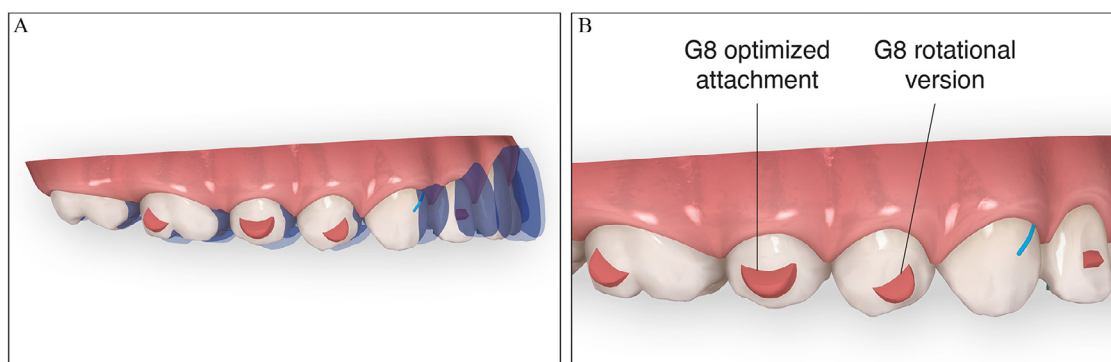
Fig. 5. A and B. A. Invisalign G8 optimized expansion support attachments for the premolars and first molars. B. If a tooth is rotated, a rotational version of the attachment is applied, which places its push surface perpendicular to the forces acting on the tooth.

OPTIMIZED SMARTFORCE DEFAULT PLACEMENT HIERARCHY

Priority	High Level Hierarchy
P1	Premolar extraction and multi-tooth extrusion movements
P2	Optimized expansion support
P3	Root movements (mesial-distal)
P4	Single tooth vertical and rotation
P5	Anchorage for intrusion
P6	Power Ridge feature for lingual root torque

Fig. 6. Updates in the default placement hierarchy following the release of G8.

Conclusion

Invisalign's newest G8 enhancements have two primary functions: to improve the predictability of lower incisor intrusion and to minimize crown tipping during posterior arch expansion. At least 0.5 mm of anterior intrusion or buccal expansion must be prescribed in ClinCheck to trigger these features. Despite the software's algorithms creating compensation mechanisms, additional overcorrection by the orthodontist is still occasionally needed.

References

1. Moshiri M. Product review and demonstration of the Invisalign clear aligner system. *Am J Orthod Dentofacial Orthop Clin Companion.* 2021;1:7–21.
2. Kravitz ND, Moshiri M, Nicozisis J, Miller S. Mechanical considerations for deep-bite correction with aligners. *Semin Orthod.* 2020;26:134–138.
3. Kravitz ND, Kusnoto B, BeGole E, Obrez A, Agran B. How well does Invisalign work? A prospective clinical study evaluating the efficacy of tooth movement with Invisalign. *Am J Orthod Dentofacial Orthop.* 2009;135:27–35.
4. Haouili N, Kravitz ND, Vaid NR, Ferguson DJ, Makki L. Has Invisalign improved? A prospective follow-up study on the efficacy of tooth movement with Invisalign. *Am J Orthod Dentofacial Orthop.* 2020;158:420–425.
5. Grünheid T, Loh C, Larson BE. How accurate is Invisalign in nonextraction cases? Are predicted tooth positions achieved? *Angle Orthod.* 2017;87:809–815.
6. Khosravi R, Cohanim B, Hujoel P, Daher S, Neal M, Liu W, Huang G. Management of overbite with the Invisalign appliance. *Am J Orthod Dentofacial Orthop.* 2017;151:691–699.
7. Charalampakis O, Iliadi A, Ueno H, Oliver DR, Kim KB. Accuracy of clear aligners: a retrospective study of patients who needed refinement. *Am J Orthod Dentofacial Orthop.* 2018;154:47–54.
8. Zhou N, Guo J. Efficiency of upper arch expansion with the Invisalign system. *Angle Orthod.* 2020;90:23–30.
9. Houle JP, Piedade L, Todescan R, Pinheiro FH. The predictability of transverse changes with Invisalign. *Angle Orthod.* 2017;87:19–24.