

Attachments and Aligners. Part 1



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Attachments and Aligners

- Optimized force vectors
 - Bonding procedure
 - Ceramic adhesion
 - Lingual attachments
 - Predictability
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Attachments and aligners

Although there are a few articles published on treatments performed without attachments, based on plastic divots¹ and other auxiliaries, the use of attachments remains crucial to achieve good results, since they create new force vectors in between plastic and teeth, to achieve desired outcome by allowing the aligner to push these.

Understanding these mechanics is important, as well as the limitations and possibilities they offer in every plane of space, as long as they are carefully bonded and their presence in mouth is checked on every appointment.

That said, it is important to highlight the fact that their presence in digital treatment plans do not validate complex root movements and in cases in which staging is not appropriate, will not have expected effects², so their efficacy is associated to many other factors apart from their presence, geometry...

Also, it is important to understand that, since their effect is related to patient compliance (as with any other removable Orthodontic appliance), clinical expression of movements associated to their presence on the digital treatment plan might not be fully expressed.

For this reason, in some cases it might be reasonable to maintain attachments from one treatment plan to another, as long as there is not an specific need for any concrete movement, since they might increase retention and help designing simple movements with their interaction with plastic, avoiding constant etching and debonding, which, in the long term, might have undesired effects on teeth enamel³.

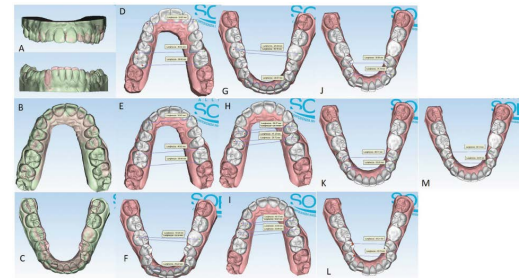


Fig 1. Treatment performed without attachments, just divots built into the aligner

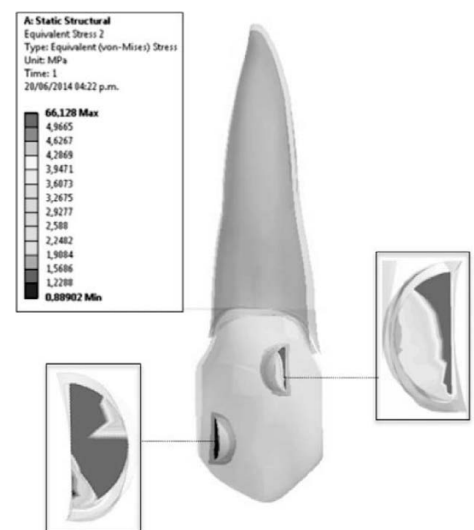


Fig 2. Equivalent stress patterns produced by aligner on active surfaces of attachments... which might not be fully expressed clinically⁴

- 1 Putrino A, Abed MR, Lilli C. Clear aligners with differentiated thickness and without attachments - A case report. *J Clin Exp Dent.* 2022 Jun 1;14(6):e514-e519. doi: 10.4317/jced.59618. PMID: 35765362; PMCID: PMC9233912.
- 2 Nucera R, Dolci C, Bellocchio AM, Costa S, Barbera S, Rustico L, Farronato M, Miliati A, Portelli M. Effects of Composite Attachments on Orthodontic Clear Aligners Therapy: A Systematic Review. *Materials (Basel).* 2022 Jan 11;15(2):533. doi: 10.3390/ma15020533. PMID: 35057250; PMCID: PMC8778413.
- 3 Eliades T, Papageorgiou SN, Ireland AJ. The use of attachments in aligner treatment: Analyzing the "innovation" of expanding the use of acid etching-mediated bonding of composites to enamel and its consequences. *Am J Orthod Dentofacial Orthop.* 2020 Aug;158(2):166-174. doi: 10.1016/j.ajodo.2020.04.008. Epub 2020 Jul 2. PMID: 32624347.
- 4 Gomez JP, Peña FM, Martínez V, Giraldo DC, Cardona CI. Initial force systems during bodily tooth movement with plastic aligners and composite attachments: A three-dimensional finite element analysis. *Angle Orthod.* 2015 May;85(3):454-60. doi: 10.2319/050714-330.1. Epub 2014 Sep 2. PMID: 25181252; PMCID: PMC8612436.

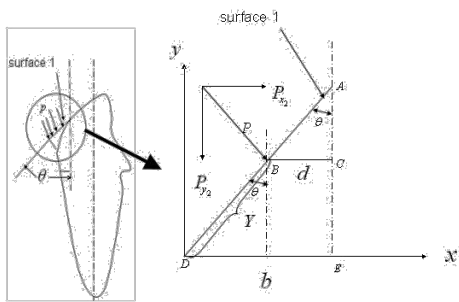


Fig 3. Attachment design results in complex force vectors⁵

Optimized force vectors

Independently from any commercial considerations, it is important to highlight the fact that force vectors are created around attachments, being therefore important to base movements on these, which should be customized for every tooth.

For this reason, attachment design cannot be simplified to 3-4 shapes and sizes, specially in a digital environment in which artificial intelligence and big data can offer us extraordinary help on treatment planning, as does Align Technology with the use of optimized attachments and other SmartForces: even if result is not 100% predictable, it makes sense to think this is the way to go in the future.

Bonding procedure

Adhesive dentistry has developed so many innovations during the last century, many of which can be applied in today's modern aligner Orthodontics, creating a full range of possibilities around these attachments.

Procedure is dependent on materials used: self-etching adhesives, self-bonding composites... for this, respecting manufacturers' instructions is crucial to maximize adhesion and avoid attachments loss during treatment evolution because of a lack of adhesion.

In regards to attachments template, some manufacturers have created softer templates that are easier to use, not offering better attachment shape which is mostly dependent on technique and composite used on its constructions

Other companies have developed windows laser cuts on the attachment areas in these templates to ensure etching is not extended more than needed and in the area mentioned side effects related to repeated demineralization for attachment bonding



Fig 4. Tests on soft and hard templates show similar results for final attachment characteristics

- 5 Cai Y, He B, Yang X, Yao J. Optimization of configuration of attachment in tooth translation with transparent tooth correction by appropriate moment-to-force ratios: Biomechanical analysis. *Biomed Mater Eng.* 2015;26 Suppl 1:S507-17. doi: 10.3233/BME-151340. PMID: 26406042.
- 6 Valeri C, Aloisio A, Mummolo S, Quinzi V. Performance of Rigid and Soft Transfer Templates Using Viscous and Fluid Resin-Based Composites in the Attachment Bonding Process of Clear Aligners. *Int J Dent.* 2022 Feb 12;2022:1637594. doi: 10.1155/2022/1637594. PMID: 35190741; PMCID: PMC8858075.



Ceramic adhesion

One of the advantages of aligners over braces is the fact that we can 'avoid' bonding attachments/brackets in ceramic structures, which are frequent in adult patients undergoing Orthodontic treatment, creating difficulties with fully fixed appliances treatments.

That said, even considering that attachments can be avoided in these sometimes (specially in dental implants, since they cannot be moved), in certain occasions, specially when we use these for anchorage, etching is mandatory, and since attachments occupy a small teeth area, drilling ceramic prior to fluorhidric acid etching and silanization is mandatory, together with a two step bonding system combined with its own composite⁷.

Lingual attachments

At the early beginning of this Century, lingual braces emerged thanks to CAD/CAM design, offering a new treatment option for patients all over the world. With the only advantage of offering a better aesthetic outcome, they had more complicated mechanics, due to reduced interbracket distance and difficult access to the lingual side of the teeth.

Same happens with lingual attachments and clear aligners: mechanics offer less chances of moving teeth, and it is only an Aesthetic advantage which they can offer. For this reason, they are not considered an option for any optimal result.

This should be communicated to patients to make them understand this reality, since many of them will compromise appliance esthetics during treatment if it resulted in a better outcome⁸.



Fig 5. Attachments have an impact on smile Aesthetics during treatment that cannot be substituted by the moment with the use of them on the lingual side of teeth

7 Alsaud BA, Hajjaj MS, Masoud AI, Abou Neel EA, Abuelenain DA, Linjawi AI. Bonding of Clear Aligner Composite Attachments to Ceramic Materials: An In Vitro Study. *Materials (Basel)*. 2022 Jun 10;15(12):4145. doi: 10.3390/ma15124145. PMID: 35744204; PMCID: PMC9229529.

8 Thai JK, Araujo E, McCray J, Schneider PP, Kim KB. Esthetic perception of clear aligner therapy attachments using eye-tracking technology. *Am J Orthod Dentofacial Orthop*. 2020 Sep;158(3):400-409. doi: 10.1016/j.ajodo.2019.09.014. Epub 2020 Jun 30. PMID: 32620476.



Predictability

As stated during this text, predictability of movements is dependant on so many factors apart from attachment selection and design, the reason why during the last decade published evidence has been controversial

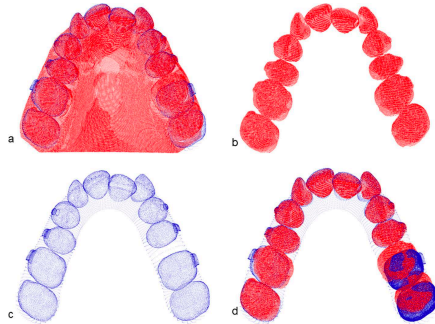


Fig 6. Crown movement” analysis for distalization with aligners

This is something that is also related with the “crown movement analysis”⁹ done in many articles, probably related to this view on treatment plans, which cannot be accepted as a proper measurement in Orthodontics, since it does not include roots, which are obviously meant to be taken into consideration.

On the next lecture we will cover in depth possibilities of movements in the three planes of space with the anchorage provided by attachments, being important to understand that even with these, in many cases the outcome in the screen has to be overengineered in order to obtain desired clinical results ¹⁰.

- 9 Simon M, Keilig L, Schwarze J, Jung BA, Bourauel C. Treatment outcome and efficacy of an aligner technique--regarding incisor torque, premolar derotation and molar distalization. *BMC Oral Health*. 2014 Jun 11;14:68. doi: 10.1186/1472-6831-14-68. PMID: 24923279; PMCID: PMC4068978.
- 10 Liu L, Song Q, Zhou J, Kuang Q, Yan X, Zhang X, Shan Y, Li X, Long H, Lai W. The effects of aligner overtreatment on torque control and intrusion of incisors for anterior retraction with clear aligners: A finite-element study. *Am J Orthod Dentofacial Orthop*. 2022 Jul;162(1):33-41. doi: 10.1016/j.ajodo.2021.02.020. Epub 2022 Feb 23. PMID: 35219555.



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