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## **Evaluation of clear aligners attachment success rate with different composite types**

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**Abstract**--This study aimed to evaluate the survival rate of clear aligner attachment using different composite types. Twelve patients ranging from 15 to 25 years old participated in this research. Patients who met the inclusion criteria were randomly assigned to one of two

groups: packable composite, which contained packable composite attachments, or flowable composite, which included flowable composite attachments. There was no statistical difference in attachment failures between the two groups for all cases ( $\chi^2 = 3.003$ ,  $P = 0.083$ ) and individual cases. However, failures occurred in 75% of the FC group vs. 55.6% for the PC group (categorical data were compared using the Chi-Square or Fisher's exact test). According to the findings of this research, the composite type, whether packable or flowable, did not affect attachment failure.

**Keywords**---evaluation, aligners attachment, composite types.

## Introduction

Orthodontics is both an art and a science. The need for beauty and balance is art while the science of orthodontics is the understanding of the biological basis of tooth movement and the functioning of the orthodontic appliance. Mathematics, computer science, material, and biomechanics lie at the heart of optimal appliance design [1]. To meet the aesthetic desire for an alternative to traditional braces, researchers have created a variety of choices, including ceramic or composite braces, lingual orthodontics, and transparent aligners [2]. The movement of teeth using aligners was founded in 1926 by Remensnyder. Kesling popularized this method in 1945 and described it as the tooth positioning appliance. Later, Sheridan invented the Essix tooth moving system. With the Essix aligners, mild to moderate crowding can be solved [3]. Align Technology was founded in 1997, being the first company to use the former aligner techniques and combine them with CAD/CAM technology. Advances and innovations in this technology have further improved and enhanced different aligned systems using different software [3].

Removable thermoplastic orthodontic appliances are a recent method, and there are still many questions to be answered. These aligners put much pressure on the teeth because of their thickness and mechanical properties, especially stiffness, influenced by orthodontic force [4-7]. The orthodontic pressures generated depend on the activation level, material, and thickness of these items [8]. Variations in the degree of mobility are possible thanks to several types of removable thermoplastic equipment. With the Clear Smile system, teeth can be moved up to 0.5 mm farther in each aligner than with Invisalign (up to 1 degree of incisor torque per 0.25 mm of translation) [8-10]. Composite resin attachments are prone to wear, fracture, and separation owing to occlusion, the need to chew food, and the removal and insertion of aligners. Studies [11-14], have examined the risks of bracket bonding failure in standard orthodontic treatment, but very few have examined attachment damage during clear aligner therapy. All these factors have increased the likelihood of bracket bonding failure, including the kind of bonding material used, tooth type, arch, and bracket type. Attachment harm may be a factor in some of these risks [15-17]. This study sought to assess the success rate of Clear aligner attachment utilizing various composite kinds.

## Material and Methods

This research included 12 patients from 15 to 25 years old recruited from the outpatient orthodontic clinic at the Faculty of Dental Medicine, Al-Azhar University, Assiut branch. The patients presented to the orthodontic clinic were evaluated for eligibility using the following inclusion criteria.

### Inclusion criteria

- Patients aged 15 to 25 (mean = 19 years).
- Single or double arch treatment
- Non-extraction therapy.
- The patients should have complete dentition from the first molar to the first molar.
- Maintaining proper dental hygiene.
- A healthy periodontium.
- Anterior irregularity index higher than 5
- The use of intermaxillary or extraoral equipment, such as elastics, lip bumpers, or maxillary expansion appliances, is not intended for therapeutic intervention.

To ensure that all patients met the inclusion criteria, they were divided into two groups: those who received attachments made of packable composite and those who received them made of flowable composite. The split-mouth design was used in this study, with attachments in one quadrant of each patient made of packable composite and attachments in the other quadrant made of flowable composite. All patients in both groups received a rubber base impression (heavy and light) to ensure that all of the smallest details were recorded. All teeth were cleaned for 30 seconds with water and then dried with an oil-free air syringe before being placed in the mouth. A 37 percent orthophosphoric acid gel (Total Etch, Ivoclar, Vivadent, Schaan, Liechtenstein) was used to etch the enamel for 30 seconds before being washed with water and air-dried. The Ivoclar, Vivadent, Te-Econom Bond universal dental glue (Ivoclar, Schaan, Liechtenstein) was applied with a small brush and oil-free compressed air. To begin, a skilled assistant prepared the template by cleaning it, using oil-free compressed air to dry it, and then injecting the FC (Flowable, Light-curing, Microhybrid, Restorative Composite, Ivoclar, Schaan, Liechtenstein) or the PC (Conventional light-curing resin-based dental restorative material, Ivoclar, Schaan, Liechtenstein) into it. A LED lamp (HL-LED2 CURING LIGHT, ZONERAY, CHINA) was used to light cure the template for 20 seconds per the attachment, and then the flash was withdrawn. Each patient received their aligners and instructions on how and when to wear them after the attachment was done.

### Data Collection

Following the initial placement of the appliances, attachments were examined when the patients returned for their routine visits every 2 weeks<sup>8</sup>. A datasheet was used for each patient to document the date of attachment damage and the teeth impacted. Damage was determined by the presence or absence of residual

composite with an irregularly formed connection. For six months, all patients were observed at their routine orthodontic appointments.

### Statistical Analysis

IBM-SPSS 26.0 software was used to enter and evaluate the data. Absolute frequency (N) and percentages were used to express the qualitative data (percent). Quantitative data (age) was put through the Shapiro-Wilk test to see if it was normally distributed ( $p > 0.050$ ). The boxplots examined were scrutinized to determine whether there were any notable outliers (extreme values). We computed the quantitative mean and standard deviation (age) (normally distributed). Categorical data were compared using the Chi-Square or Fisher's exact test. The technique of point biserial correlation was employed to investigate the connection between a binary variable (sex) and a quantitative variable (number of attachment failures). To determine if there was a connection between age and the frequency of attachment failures, Spearman's correlation test was used. If any of the tests conducted had a p-value less than 0.050, the results were considered statistically significant. When required, graphic representations of the results were produced. This study included 12 participants (6 male and 6 female cases). Their mean, standard deviation age was  $19 \pm 3.4$  years, ranging from 15 to 24 years (Figure 1).

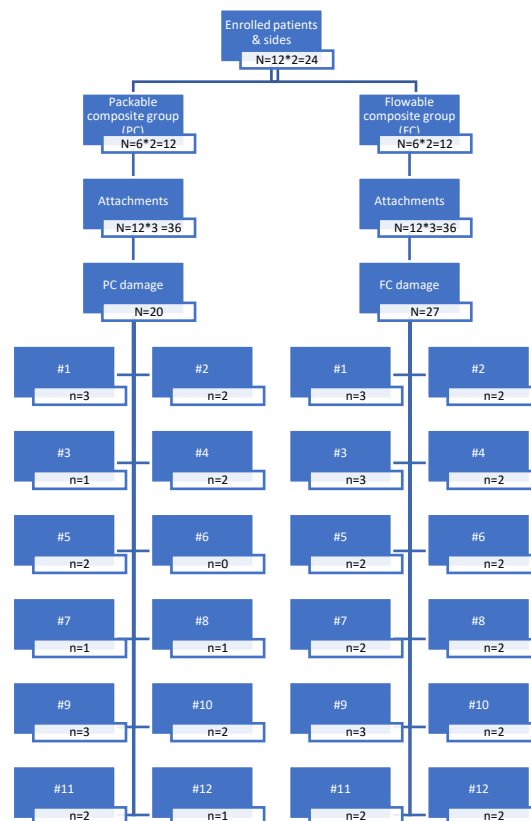


Figure 1. Sample grouping

Table 1  
Correlation between age (years) and sex with attachment failure

Character	Attachment failure					
	Fc			PC		Total
	Coefficient	P value		Coefficient	P value	
Sex	0.192	0.549	-0.392	0.207	-0.224	0.484
Age (years)	-0.600	0.039	-0.514	0.087	-.590	0.044

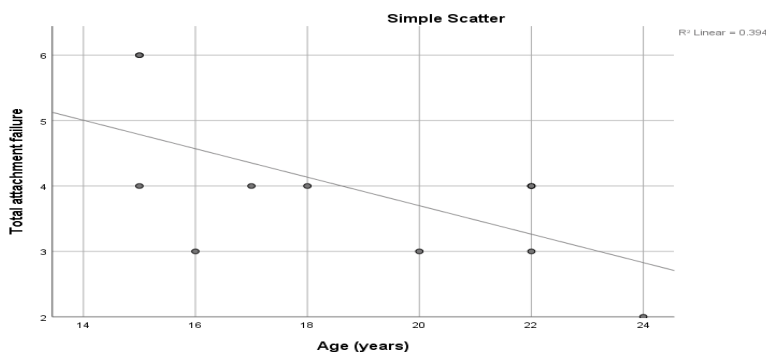


Figure 2. Correlation between age and total attachment failure

According to table 1, there is no statistically significant connection between sex and attachment failure. However, there is a statistically significant strong negative relationship between age with FC and full failure. Figure 2 shows the negative correlation between age and total attachment failure. As age goes up, the number of attachment failures goes down, with the change in age being responsible for 39.4% of the change in total attachment failure number (coefficient of determination  $[R^2] = 0.394$ ). Table 2 shows no statistically significant difference in attachment failures between the two groups for all cases ( $\chi^2 = 3.003$ ,  $P = 0.083$ ) and individual cases. However, failures occur in 75% of the FC group vs. 55.6% for the PC group.

Table 2  
Comparisons of attachment failures between the two groups

Cases	PC	FC	P value
Case # 1	3 (100%)	3 (100%)	-
Case # 2	2 (66.7%)	2 (66.7%)	1.000
Case # 3	1 (33.3%)	3 (100%)	0.400
Case # 4	2 (66.7%)	2 (66.7%)	1.000
Case # 5	2 (66.7%)	2 (66.7%)	1.000
Case # 6	0 (0%)	2 (66.7%)	0.400
Case # 7	1 (33.3%)	2 (66.7%)	1.000
Case # 8	1 (33.3%)	2 (66.7%)	1.000
Case # 9	3 (100%)	3 (100%)	-
Case # 10	2 (66.7%)	2 (66.7%)	1.000
Case # 11	2 (66.7%)	2 (66.7%)	1.000

Case # 12	1 (33.3%)	2 (66.7%)	1.000
All cases	20 (55.6%)	27 (75%)	0.083

Notes: PC=Packable composite group. FC= Flowable composite group. The test of significance is the Chi-Square test for all cases and Fisher's exact test for individual cases.

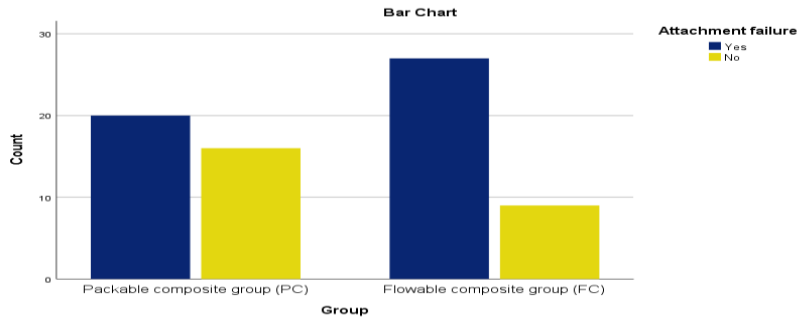


Figure 3. Comparison of attachment failure between the two groups

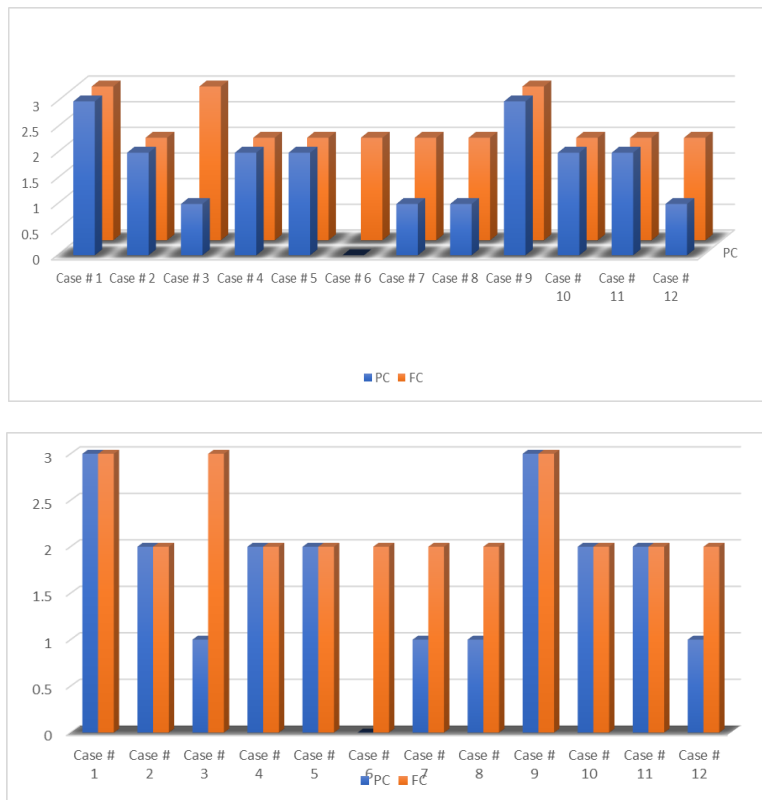


Figure 4. Comparison of attachment failure between both types of composite in each case

## Discussion

The split-mouth design was used in this study, with attachments in one quadrant of each patient made of packable composite and attachments in the other quadrant made of flowable composite. As a result, patients were used as controls in this study, which helped reduce bias and better control individual variations and their effect on the study's results. When compared to orthodontic brackets, this research discovered a significant incidence of attachment damage.<sup>13,14</sup> This may be explained by the patients' frequent use and removal of the clear aligner many times each day, which may impose extra stress on the composite attachments, especially after appliance removal. This study discovered no statistically significant difference between the two groups in terms of attachment failures across all patients ( $P = 0.083$ ) or individual occurrences. On the other hand, failures occur in 75% of the FC group compared to 55.6% of the PC group.

There was no obvious difference between the two composites despite the FC having a greater damage rate than the PC. An FC and PC utilized as occlusal restorative materials performed similarly in a clinical trial, despite the FC having a stronger in vitro link.<sup>16</sup> In addition, the bond destruction rate and lifespan were influenced by the bond's strength and the patients' behaviors and diets. These results show that both materials are equally effective; however, using the FC for attachments in CA treatment saves time. Other studies have shown that other possible risk variables, including the arch, tooth type, sex, attachment type, presence of overbite, and the occurrence of extraction, had no effect on attachment damage, and this study found no statistically significant link between the two. Previous research on bracket bonding failure indicated that the sex, arch, and tooth extraction status did not affect bracket failure. This study's results indicated a negative correlation between age and total attachment failure. With increasing age, the number of attachment failures reduces, with age accounting for 39.4% of the change in the total number of attachment failures (coefficient of determination  $[R^2] = 0.394$ ). This may be because older patients seem more aware of the restricted diet and appliance removal instructions.



Figure 5. Flowable composite attachment (to the left) and packable composite (to the right)

One limitation of the study was that it was performed in a single clinic by a single operator, so the results may not be widely applicable to other operators. Only the Ivoclar, Schaan, Liechtenstein Flowable Restorative and Ivoclar, Schaan, Liechtenstein Restorative composites were tested. The results cannot be generalized to all FCs and PCs.

## Conclusion

According to the findings of this research, the composite type, whether packable or flowable, did not affect attachment failure. The results of this study also suggested that the attachment can be fabricated from flowable composite with the benefits of ease of use and saving time.

## Conflicts of interest

The authors declare no conflict of interest.

## Ethics approval

The study was approved by the Ethical Committee for Animal Studies from xxxxxxxxxxxx).

## Data availability

Data analyzed in this article is available from the first author

## References

1. Barbagallo LJ, ShenG, JonesAS, Swain MV, Petocz P, Darendeliler MA. A novel pressure film approach for determining the force imparted by clear removable thermoplastic appliances. *Ann Biomed Eng.* 2008; 36:335-41.
2. Barbosa IV, Ladewig VM, Almeida-Pedrin RR, Cardoso MA, Santiago Junior JF, Conti A. The association between patient's compliance and age with the bonding failure of orthodontic brackets: a cross-sectional study. *Prog Orthod.*2018; 19(1):11.
3. Boyd RL. Predictability of successful orthodontic treatment using Invisalign. The Greater Philadelphia Society of Orthodontists page. [[http://www.gpsoc.org/events/2003\\_outline.pdf](http://www.gpsoc.org/events/2003_outline.pdf)].
4. Bradley TG, Teske L, Eliades G, Zinelis S, Eliades T. Do the mechanical and chemical properties of Invisalign appliances change after use? A retrieval analysis. *Eur J Orthod.* 2015.
5. Cal-Neto JP, Quintao CA, Almeida MA, Miguel JA. Bond failure rates with a self-etching primer: a randomized controlled trial. *Am J Orthod Dentofacial Orthop.* 2009; 135: 782–6.
6. Hahn W, Dathe H, Fialka-Fricke J, Fricke-Zec S, Zapf A, Kubein-Meesenburg D, et al. Influence of thermoplastic appliance thickness on the magnitude of force delivered to a maxillary central incisor during tipping. *Am J Orthod Dentofac Orthop.* 2009; 136:12-17.
7. Hahn W, Engelke B, Jung K, Dathe H, Fialka-Fricke J, Kubein-Meesenburg D, et al. Initial forces and moments delivered by removable thermoplastic appliances during rotation of an upper central incisor. *Angle Orthod.* 2010; 80:239-46.
8. Hammad SM, El Banna MS, Elsaka SE. The twelve-month bracket failure rate with amorphous calcium phosphate bonding system. *Eur J Orthod.* 2013; 35:622–627.



9. Mohammed RE, Abass S, Abubakr NH, Mohammed ZM. Comparing orthodontic bond failures of light-cured composite resin with chemical-cured composite resin: a 12-month clinical trial. *Am J Orthod Dentofacial Orthop.* 2016; 150:290–294.
10. Roelofs T, Merkens N, Roelofs J, Bronkhorst E, Breuning H. A retrospective survey of the causes of bracket- and tubebonding failures. *Angle Orthod.* 2017; 87:111–117.
11. Rossini G, Parrini S, Castroflorio T, Deregibus A, Debernadi CL. Efficacy of Clear-aligners in Controlling Orthodontic Tooth Movement - A Systematic Review, *Angle Orthod.* 2014, Nov 20.
12. Serin BA, Yazicioglu I, Devenci C, Dogan MC. Clinical evaluation of a self-adhering flowable composite as an occlusal restorative material in primary molars: one-year results. *Eur Oral Res.* 2019; 53:119–124.
13. Simon M, Keilig L, Schwarze J, Jung BA, Bourauel C. Forces and moments generated by removable thermoplastic aligners: incisor torque, premolar derotation, and molar distalization. *Am J Orthod Dentofac Orthop.* 2014; 145:728-36.
14. Steiner R, Edelhoff D, Stawarczyk B, Dumfahrt H, Lente I. Effect of dentin bonding agents, various resin composites and curing modes on bond strength to human dentin. 2019; 12:3395.
15. Vardimon AD, Robbins D, Brosh T. In-vivo von Mises strains during Invisalign treatment. *Am J Orthod Dentofac Orthop.* 2010; 138:399-409.
16. Werner S, Julia H. *Aligner Orthodontics*, Quintessence Publishing Co. Ltd, London, UK. 2016; 2: 28.
17. Ziuchkovski JP, Fields HW, Johnston WM, Lindsey DT. Assessment of perceived orthodontic appliance attractiveness. *Am J Orthod Dentofac Orthop.* 2008; 133:68-78.