Research Article

Effects of debonding a conventional & customized lingual appliance on enamel structure- An invitro study

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ABSTRACT

Introduction: To evaluate the surface changes on enamel structure after debonding of customized and conventional lingual brackets bonded using restorative dual cure bonding material and a chemically cured bonding material with and without sandblasting.

Materials and Method: The sample consisted of 40 premolar teeth extracted for the purpose of orthodontic treatment. Enamel surface changes, prior to bonding, were studied using a stereomicroscope (Olympus SZX7) and an optical microscope. 20 extracted premolars were arranged in 2 arch forms with 5 teeth in each quadrant, after which impression of the arches with rubber base impression material was made. These impressions were then sent to the laboratory for the fabrication of a customized lingual appliance. The remaining 20 premolars were divided into 2 arches, each arch having 10 extracted premolars divided into 4 sets, 1st to test customized brackets bonded with chemical cure resin without sandblasting, 2nd to test customized brackets with dual cure resin without sandblasting, 3rd to test conventional brackets with chemical sure resin with and without sandblasting and 4th to test conventional brackets bonded with dual cure resin with and without sandblasting. The post debonding photographs were analyzed using a standardized grid and Surface Roughness Index.

Result: Thus, enamel defects are likely to be caused post debonding despite of using any combination. However, the surface roughness index has been shown to be highest post debonding in cases where customized brackets have been bonded using dual cure resin along with sandblasting.

Conclusion: While a clinician may opt for a material like Rely X U200 to bond lingual appliances in order to have a better clinical management of the appliance, but he would have to keep the possibility of irreversible damage to enamel post debonding.

KEYWORDS: Chemical Cure Resin; Dual Cure Resin; Lingual appliance; Lingual orthodontics; Sandblasting.

INTRODUCTION

Esthetics is one of the primary reasons for which patients opt for orthodontic treatment which has made lingual orthodontic technique an integral part of orthodontics from mid-to late 1970s. Lingual orthodontics has emerged as a front runner in providing aesthetic orthodontic treatment to both children and adults. However, its success is often challenged by an extremely variable lingual anatomy of teeth affecting its biomechanical and functional efficiency often leading to poor retention of the appliance. Moreover, the chair side effort required to repair or rebond an appliance is very cumbersome.[1]

The dilemma in adhesion of brackets in orthodontics is that it should be strong enough to prevent failure during

all treatment, but also low enough so that enamel damage would be none or minimal during bracket removal after treatment. Micro sandblasting has traditionally been an approach to increase the surface energy and hence increase the bond strength but is largely opposed in this world of advancement due to its crude form. [2]

Though the advent of customized lingual brackets has increased the bond strength but since the surface area of a customized lingual bracket is greater than a conventional bracket, the anticipated damage that could happen to the enamel during debonding of a lingual appliance also increases. Similarly, the routinely used light cure and chemical cure bonding material in orthodontics have a much less shear bond strength than the newer dual cure material (RelyX U200: 35MPa).[3]

The introduction of customized CAD CAM 3D lingual appliance provides a very large bonding base and when used in conjunction with restorative bonding material like Rely X U-200 provides an effective bond. The problem of damage to the enamel surface however remains unexpected.[4]

Thus, this study was done to see the effects of enamel surface preparation along with different bonding materials on the enamel surface consequent to debonding of two different types of lingual appliance.

MATERIALS AND METHOD

The study was conducted at the Department of Orthodontics. The sample consisted of 40 premolar teeth extracted for the purpose of orthodontic treatment. The selected teeth were intact and there was no evident enamel damage, fillings or carious lesions on the lingual surface. In order to prevent dehydration, the extracted teeth were stored in normal saline, at the temperature of 37°C.

Enamel surface changes, prior to bonding, were studied using a stereomicroscope (Olympus SZX7) and an optical microscope. A camera was placed on the stereomicroscope and connected to a computer and a frame grabber of the same manufacturer.

Each sample was examined at:

a) 50X magnification mode (stereo microscope).
b) 200X magnification mode (optical microscope).

After pre-examination of the enamel surface, 20 extracted premolars were arranged in 2 arch forms with 5 teeth in each quadrant, after which impression of the arches with rubber base impression material was made. These impressions were then sent to the laboratory for the fabrication of a customized lingual appliance. 20 remaining premolars were divided into 2 arches, each arch having 10 extracted premolars.

Set 1: Teeth were numbered 1 to 10 from right side and arch was divided into two halves:

A) Teeth 1 to 5
B) Teeth 6 to 10

Customized lingual brackets were bonded to the teeth with the help of Orthodontic chemically cure bonding material after micro sandblasting on teeth 1 to 5 and whereas teeth 6 to 10 were bonded to the teeth with the help of Orthodontic chemically cure bonding material without micro sandblasting

Set 2: Teeth were numbered A to J from right side and arch was divided into two halves:

A) Teeth A to E
B) Teeth F to J

Customized lingual brackets were bonded to the teeth with the help of Restorative dual cure bonding material after micro sandblasting on teeth A to E and whereas teeth F to J were bonded to the teeth with the help of Restorative dual cure bonding material without micro sandblasting.

Set 3: Teeth were numbered 11 to 20 from right side and arch was divided into two halves:

A) Teeth 11 to 15
B) Teeth 16 to 20

Conventional lingual brackets were bonded to the teeth with the help of Orthodontic chemically cure bonding material after micro sandblasting on teeth 11 to 15 and whereas teeth 16 to 20 were be bonded to the teeth with the help of Orthodontic chemically cure bonding material without microsandblasting.

Set 4: Teeth were numbered A to J from right side and arch was divided into two halves:

A) Teeth K to O
B) Teeth P to T

Conventional lingual brackets were bonded to the teeth with the help of Restorative dual cure bonding material after micro sandblasting on teeth K to O and whereas teeth P to T were bonded to the teeth with the help of Restorative dual cure bonding material without micro sandblasting.

Brackets were debonded in a standardized manner using a bracket debonding plier. The lingual surface was studied

for surface defects post debonding under microscope.
The photographs (50X magnification) were analysed using a standardized grid and defects were quantified into 5 types:

1. Diffuse Opacities
2. Demarcated Opacities
3. Enamel Fissures
4. Enamel Cracks
5. Enamel surface roughness

The photographs (200X magnification) were analyzed by evaluating the appearance of the enamel surface (assessment of smoothness), using Surface Roughness Index (SRI), proposed by Howell & Weeks in 19905 as described below:

0 – Ideal Enamel Surface with no scratches or damage.
1 – Acceptable enamel smoothness with sporadic scratches.
2 – Fine, relatively shallow scratches over much of the enamel.
3 – Rough surface, deep scratches over the whole of the enamel surface.
4 – Very uneven surface, with very deep scratches over the whole of the surface.

RESULT

The results are outlined under three groups
GROUP I: Effect of sandblasting on enamel surfaces post debonding
The models involved, surfaces bonded with an orthodontic chemically cure bonding material and a restorative dual cure bonding material, using both customized and conventional lingual brackets.
Sandblasting is thus associated with increase in Enamel defects post debonding with demarcated opacities being the most prevalent one except when chemical cure resin is used with conventional brackets wherein Enamel is the most prevalent defect. (Figure 1-4).

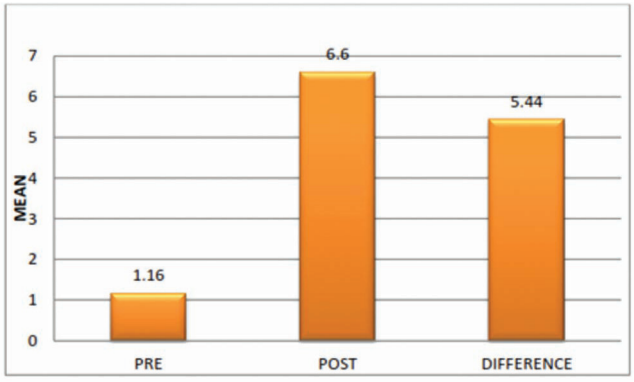

Figure 1: Enamel defects shown by Customized Lingual Appliance Bonded with Restorative Dual Cure Bonding Material with Sandblasting

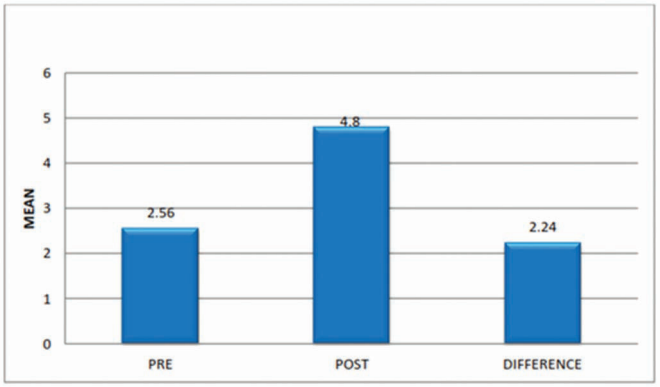

Figure 2: Enamel defects shown by Customized Lingual Appliance Bonded with an Orthodontic Chemically Cure Bonding Material with Sandblasting

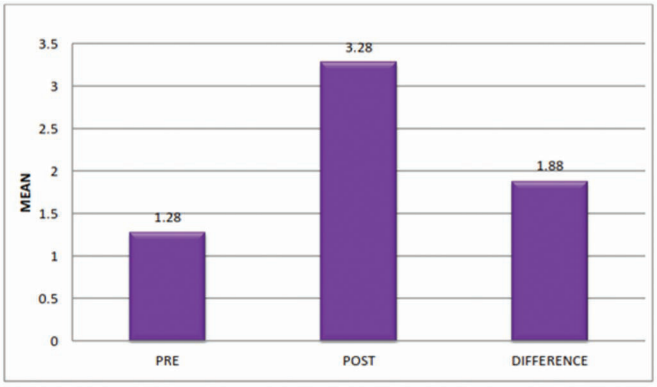

Figure 3: Enamel defects shown by Conventional Lingual Appliance Bonded with an Orthodontic Chemically Cure Bonding Material with Sandblasting

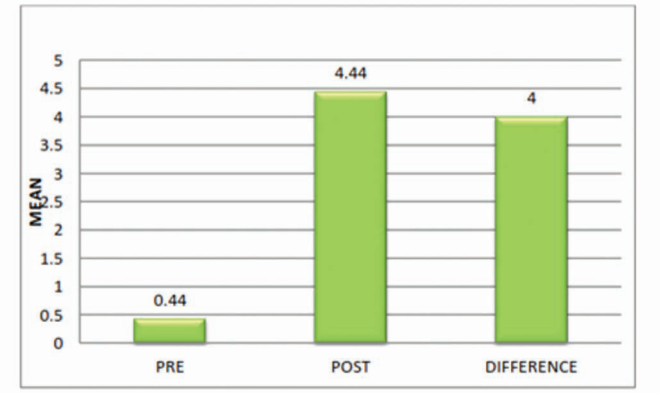

Figure 4: Enamel defects shown by Conventional Lingual Appliance Bonded with Restorative Dual Cure Bonding Material with Sandblasting

GROUP II: Effect of an orthodontic chemically cure bonding material on post debonded enamel surfaces

GROUP III: Effect of a dual cure restorative bonding material on post debonded enamel surfaces

Both chemical (Figure 5,6) and dual cure resin (Figure 7,8) is associated with increase in enamel defects post debonding with enamel surface roughness being the most prevalent one.

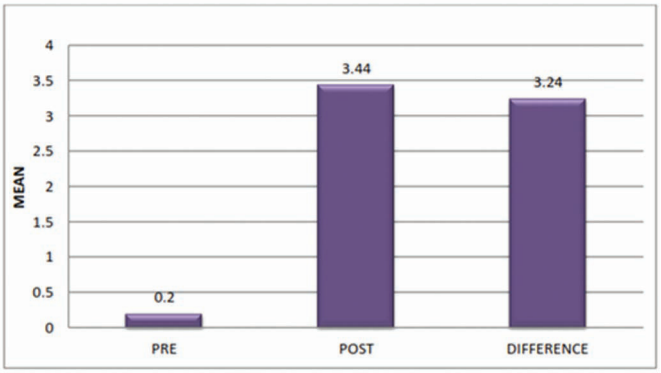

Figure 5: Enamel defects shown by Customized Lingual Appliance Bonded with an Orthodontic Chemically Cure Bonding Material without Sandblasting

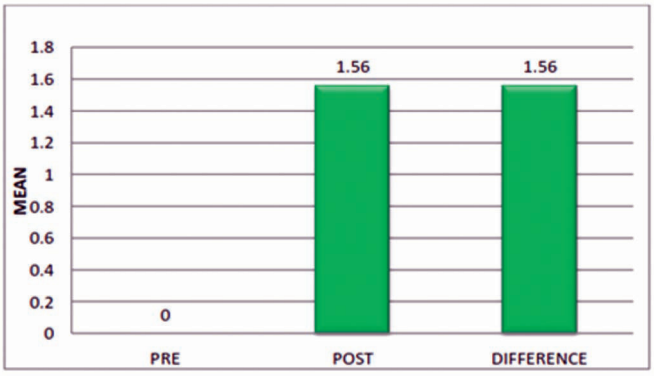

Figure 6: Enamel defects shown by Conventional Lingual Appliance Bonded with an Orthodontic Chemically Cure Bonding Material without Sandblasting

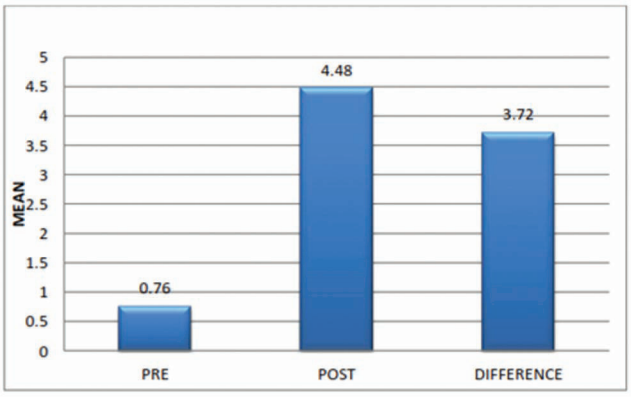

Figure 7: Enamel defects shown by Customized Lingual Appliance Bonded with Restorative Dual Cure Bonding Material without Sandblasting

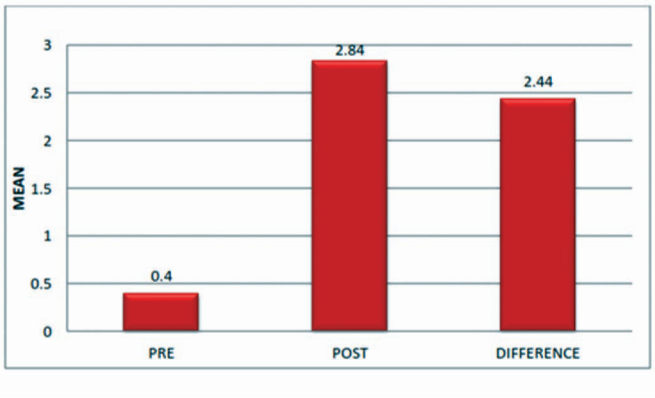

Figure 8: Enamel defects shown by Conventional Lingual Appliance Bonded with Restorative Dual Cure Bonding Material without Sandblasting

Surface Roughness Index

The surface roughness index has been shown to be highest post debonding in cases where customized brackets have been bonded using dual cure resin along with sandblasting. (Figure 9-14).

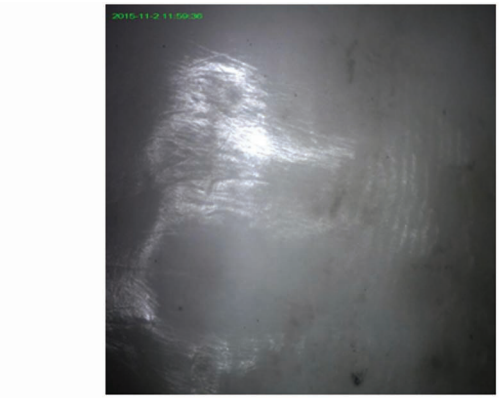

Figure 9: Tooth No.: F (Pre: 50 X MAGNIFICATION) Customized Lingual Appliance Bonded with Restorative Dual Cure Bonding Material with Sandblasting

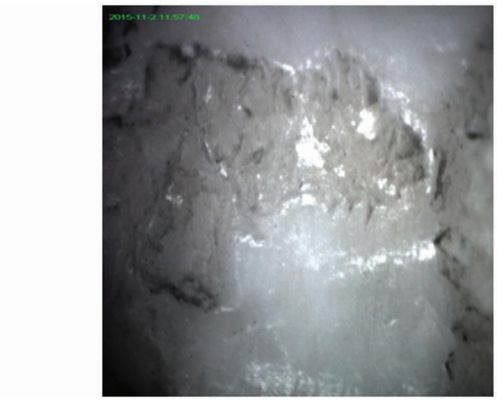

Figure 10: Tooth No.: F (Post Debonding: 50 X MAGNIFICATION: Demarcated Opacity) Customized Lingual Appliance Bonded with Restorative Dual Cure Bonding Material with Sandblasting

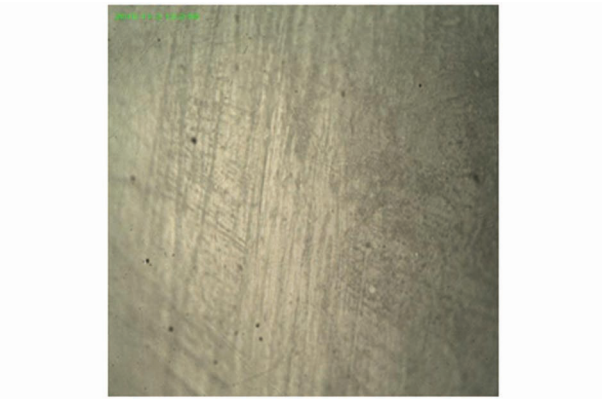

Figure 11: Tooth No.: 1 (Pre: 200 X MAGNIFICATION) Customized Lingual Appliance Bonded with an Orthodontic Chemically Cure Bonding Material without Sandblasting

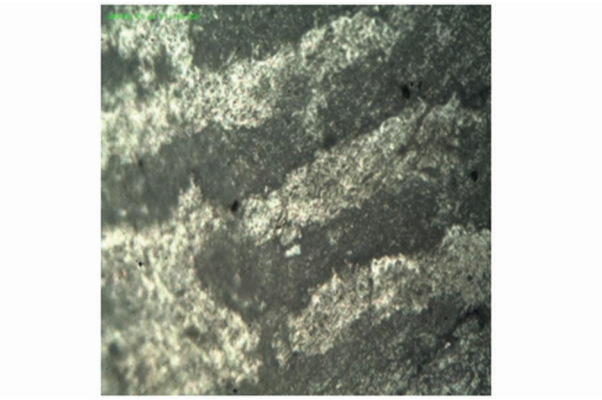

Figure 12: Tooth No.: 1 (Post Debonding: 200 X MAGNIFICATION: Enamel surface roughness) Customized Lingual Appliance Bonded with an Orthodontic Chemically Cure Bonding Material without Sandblasting

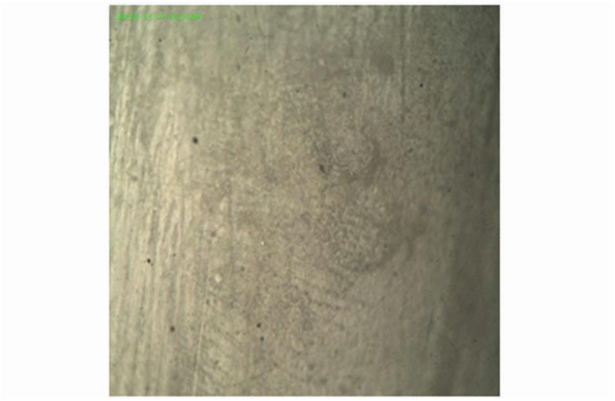

Figure 13: Tooth No.: F (Pre: 200 X MAGNIFICATION) Customized Lingual Appliance Bonded with Restorative Dual Cure Bonding Material with Sandblasting

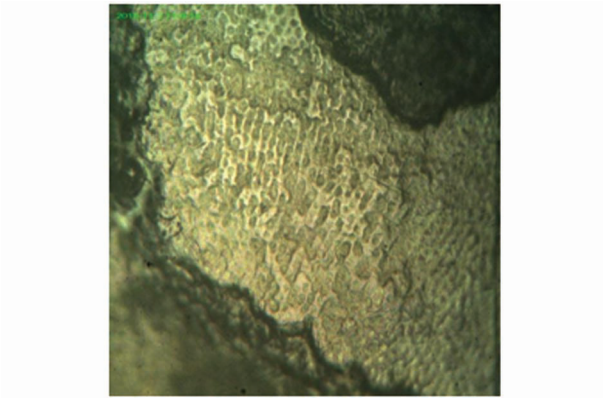

Figure 14: Tooth No.: F (Post Debonding: 200 X MAGNIFICATION: Deep scratches and uneven enamel surface) Customized Lingual Appliance Bonded with Restorative Dual Cure Bonding Material with Sandblasting

DISCUSSION

Findings of group I indicates that sandblasting affects the enamel surface in all the cases. Sandblasting of enamel surface prior to bonding results in higher bond strength, as discussed by various authors.[6,7] Effects were more pronounced when customized lingual brackets, which have a greater bonding base as compared to conventional lingual brackets, were used. Also, the restorative dual cure bonding material has higher shear bond strength than the Orthodontic chemically cured bonding material. Hence, when the customized lingual brackets were bonded with a restorative dual cure bonding material, on sandblasted enamel, a greater number of enamel defects were found post debonding.

Numerous studies had been conducted on the effect of sandblasting on shear bond strength as well as on the enamel surface. Julio P. Cal –Neto and co-workers found that there was a significant increase in bond strength with sand blasting.[6] Julissa Janet Robles-Ruiz and co-workers concluded in their study that lingual enamel conditioning with aluminium oxide sandblasting results in greater roughness.[7]

These findings are in accordance to our findings of group I samples in which it is clearly evident that sandblasting of enamel surface results in better strength and hence a higher number of defects were calculated.

In group II of our study in which the effects of a chemically cured orthodontic bonding material, after debonding of both conventional as well as customized

lingual brackets was studied, it was observed that there were a greater number of enamel defects in samples pertaining to the customized sample as compared to the conventional samples. This could be attributed to the greater bracket base surface area of customized lingual brackets in comparison to the conventional brackets.

The above-mentioned findings are in accordance to a study conducted by G.A McColl and co-workers in 1998 on the relationship between bond strength and orthodontic bracket base surface area.[8] They concluded that a significant reduction in bond strength was observed with a reduction in bracket base surface area. Also, the general pattern of enamel defects observed were such that after debonding of a conventional appliance, a greater amount of surface roughness was observed which in turn is a reversible type of defect. On the other hand, in case of customized appliances, the defects ranged from enamel fissure to enamel cracks, which are irreversible.[9]

For Group III our results revealed that orthodontic bonding done with a dual cure restorative bonding material provides good bond strength clinically but it results in more damage to enamel surface compared to the bonding done with an Orthodontic chemically cured bonding material. The above-mentioned findings are in accordance to the study conducted by Ascension Vicente and co-workers in which they found that Rely X has higher bond strength and results in less adhesive remaining on enamel surface post bonding.[10]

The samples analyzed at 200X magnification, also supported the finding of results obtained at 50X magnification. According to the SRI index given by Howell & Weeks in 1990, the structure of enamel prior to bonding, ranged from normal to acceptable, or small amount of shallow scratches on some.[5] Post debonding in samples where a restorative bonding material is used to bond a larger based customized lingual bracket, the enamel surface shows incidence of uneven & deep scratches over the entire enamel surface. Comparatively better enamel surface was observed in samples pertaining to the use of conventional brackets bonded using orthodontic bonding material.

CONCLUSION

The salient results of the study prove that sandblasting of enamel surface prior to bonding increases the bond strength of brackets and hence results in an increase number of enamel defects post debonding. When sandblasting is coupled with greater bracket base surface area of a customized lingual bracket,it results in greater damage to enamel as compared with the conventional lingual brackets. Increase shear bond strength of a dual cure restorative bonding material, as compared to a chemically cured orthodontic bonding material, results in greater number of enamel defects post debonding, especially when the restorative bonding material in coupled with larger bracket base of a customized bracket with sandblasting done prior to bonding. The samples in which an orthodontic bonding material was used to bond a conventional lingual bracket, without sandblasting of tooth surface, showed the best results. The only significant enamel defect found in this sample was enamel surface roughness, which is completely reversible. Irreversible enamel defects like fissures, cracks and demarcated opacities were found in other samples in which sandblasting was coupled with a customized lingual bracket and a high strength restorative bonding material.

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