

## The Microetching Effect on the Shear Bond Strength of Orthodontic Metal Brackets.

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### الخلاصة

**أهداف البحث:** تهدف الدراسة المخبرية الى تقييم ومقارنة القوة القاصة للحاصرات التقويمية الجديدة مع الحاصرات التقويمية الجديدة بعد معاملتها باستخدام microetcher و الحاصرات التقويمية بعد فشل التلاصق مع السن و تنظيفها باستخدام microetcher عندما تلتصق إلى أسنان عذراء و أسنان ملصوقة سابقا". وعند لصق أسنان ملصوقة سابقا" بعد إزالة بقايا اللاصق القديم كيف ستكون القوة القاصة للحاصرات التقويمية مقارنة بالأسنان العذراء. **المواد وطرق العمل:** ثلاثون سن ضاحك بشري نسبوا و قسموا عشوائيا إلى ثلاث مجموعات من 10 أسنان. مجموعة V1 (أسنان عذراء تلتصق بحاصرات تقويمية جديدة)، مجموعة V2 (أسنان عذراء ملصوقة بحاصرات تقويمية جديدة بعد معاملتها باستخدام microetcher)، و مجموعة ال V3 (أسنان عذراء ملصوقة بحاصرات تقويمية مستخدمة بعد تنظيفها بواسطة microetcher). جميع المجموعات تم اختيارها لقياس مقدار القوة القاصة للحاصرات التقويمية. بعد ذلك يتم تنظيف الأسنان من بقايا المادة اللاصقة و تقسم الأسنان عشوائيا مرة ثانية إلى ثلاث مجاميع من أسنان. مجموعة P1 (أسنان ملصوقة مسبقا يعاد لصقها بحاصرات تقويمية جديدة)، مجموعة P2 (أسنان ملصوقة مسبقا يعاد لصقها باستخدام حاصرات تقويمية جديدة بعد معاملتها باستخدام microetcher)، و مجموعة P3 (أسنان ملصوقة مسبقا يعاد لصقها باستخدام حاصرات تقويمية مستخدمة مسبقا بعد تنظيفها باستخدام microetcher) و مرة ثانية جميع المجاميع يتم اختبارها لقياس القوة القاصة. **النتائج:** أظهرت النتائج انه لا توجد فروق ذات دلالة إحصائية بين المجموعات لأسنان العذراء و الأسنان المستخدمة سابقا عند تنظيف الأسنان الملصوقة مسبقا من المادة اللاصقة القديمة كما هو موضح في هذه الدراسة فضلا عن مجاميع الأسنان الملصوقة مسبقا أظهرت قيمة أقل من الأسنان العذراء. مجاميع الحاصرات التقويمية الجديدة بعد معاملتها باستخدام ال microetcher و الحاصرات التقويمية المستخدمة بعد تنظيفها باستخدام ال microetcher أظهرت قيمة أعلى بكثير مقارنة مع مجموعات الحاصرات التقويمية الجديدة، في حين لم تكن هناك فروق ذات دلالة إحصائية بين مجاميع الحاصرات التقويمية الجديدة بعد معاملتها باستخدام ال microetcher و مجاميع الحاصرات التقويمية المستخدمة بعد تنظيفها باستخدام ال microetcher مع قيمة أكبر لمجموعات التقويمية جديد بعد معاملتها باستخدام ال microetcher. **الاستنتاج:** أظهرت النتائج ان الحاصرات التقويمية بعد إعادة تدويرها باستخدام جزيئات أكسيد الألمنيوم (50-ميكرومتر) كانت طريقة فعالة جدا للحاصرات التقويمية بعد الفشل العرضي لعملية اللصق و الأسنان الملصوقة مسبقا كانت القوة القاصة مماثلة للأسنان العذراء (ملصوقة جديدة) عند إزالة بقايا اللاصق القديم

### ABSTRACT

**Aims:** To evaluate and to compare the shear bond strength of new brackets, new microetched brackets and debond microetcher clean brackets when bond to virgin and previously bond teeth. **Materials and methods:** Thirty human premolars were randomly assigned into three groups, 10 teeth for each. Group V1 (virgin teeth bonded by new brackets), group V2 (virgin teeth bonded by new microetched brackets), and group V3 (virgin teeth bonded by debonded micretched cleaned brackets). All groups tested for shear bond strength. After that all teeth cleaned from composite and randomly assigned again into three groups, 10 teeth for each group. Group P1 (previously bonded teeth rebonded by new brackets), group P2 (previously bonded teeth rebonded by new microetched brackets), and group P3 (previously bonded teeth rebonded by debonded microetched clean brackets) and again all groups tested for shear bond strength. **Results:** There are no significant differences between virgin teeth groups and previously bonded teeth when clean previously bonded teeth from old adhesive as described in this study however the previously bonded teeth groups showed the lower mean value than virgin teeth. New microetched and debonded micretched brackets groups showed significantly higher value in comparing with new bracket groups while there were no significant differences between new micretched and debonded micretched groups with greater mean value for new micretched groups. **Conclusion:** Bracket recycled by microetching using 50- $\mu$ m aluminum oxide particle was appears to be very effective method for bracket accidental debonded and Previously bonded teeth had shear bond strengths comparable to virgin teeth(new bonded) when adhesive remnant removed by . **Keyword:** Microetch, shear bonding strength, orthodontic brackets.

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## INTRODUCTION

The unplanned debonding of brackets is a common occurrence among orthodontic patients. Various factors can contribute to the likelihood of a bond failure, including operator technique, patient behavior, variation in the enamel surface, and bracket properties. <sup>(1)</sup> Clinicians are concerned about how to best deal with the unintentionally debonded tooth. <sup>(2)</sup>

Shear bond strength of new and recycled brackets has been a subject of great interest in orthodontic research. A number of studies have been conducted concerning the etching of metal by microetching, the conclusions were that microetched metal was associated with increased bond strength when bonded to enamel with composite resin adhesive. <sup>(2)</sup> Improper orthodontic bracket position or bonding failure may necessitate the bracket removal and rebonding to establish a correct bracket position during the treatment to take full advantages of arch wire slot values and sliding mechanics. <sup>(3)</sup> The recycling process basically consists in removing bonding agent remnant from the bracket base, thus allowing the bracket to be reused without causing damage to the retention mesh and preserving its retentive characteristics. <sup>(4)</sup>

Aluminum oxide is the most commonly used industrial abrasive, and is classified by the U.S. Government as a "nuisance dust" rather than a "toxic dust". <sup>(5)</sup> This technique uses a high-speed stream of aluminum oxide particles propelled by compressed air to remove unfavorable oxides and contaminants and increase the surface area by increasing the surface roughness. <sup>(6)</sup> This process increases the area of composite bonding, which is essentially mechanical due to the micro-asperity of the bracket mesh. <sup>(7)</sup> It also has been used to improve the bond strength of new brackets and bands and to remove the remaining adhesive parts from the base of the accidentally debonded brackets in orthodontics. <sup>(7)</sup>

The results of studies reported in the literature in which shear bond strength (SBS) values are compared before and after sandblasting are equivocal. Some investigators have reported that rebond SBS values were higher after sandblasting, but others reported no significant differences.

Other investigators have concluded that sandblasting had no consistent effect. <sup>(8)</sup>

## MATERIALS AND METHODS

This study used 30 freshly extracted human teeth that had been extracted for orthodontic reasons. The criteria of tooth selection included the intact buccal enamel, not subjected to any pretreatment chemical agent (e.g., hydrogen peroxide), no cracks caused by the presence of the extraction forceps, and no caries. <sup>(9)</sup> The extracted teeth were washed free of adherent blood products and clean from the remnants of tissue by using distilled water and fine brush. The teeth were stored continuously in 70% ethyl alcohol. <sup>(10)</sup>

All teeth were mounted according to Germec et al, <sup>(11)</sup> Glass slide is painted with separating medium (Vaseline) around the stick wax where the tooth is fixed. The plastic ring of 2.5 cm in length and 1.5 cm in diameter is positioned around the fixed tooth in such a way that the crown portion of the tooth is protruded, then the powder and liquid of cold-cure acrylic are mixed and poured around the tooth to the level of the cement-enamel junction. The teeth were embedded in acrylic blocks leaving only the crown exposed.

After the completion of the polymerization of acrylic resin the mounted teeth were stored in distilled water at room temperature to prevent dehydration.

*Virgin (new bonded teeth) groups:*

The teeth randomly assigned to 3 groups, each group of 10 teeth, all the teeth used in this study were bonded with stainless steel lower premolar brackets (MIM Technology Lancer Co. Roth, Type made in USA) with the use of composite resin made specifically for orthodontic (One Step Orthodontic Adhesive Bonding System Prime-dent made in USA) as follows:

Group V1: virgin teeth were bonded by new brackets.

Group V2: virgin teeth were bonded by new microetched brackets (sandblasting) for 4 seconds at 3 mm from bracket base before bonding.

Group V3: virgin teeth were bonded by 10 brackets debonded from group V used after debonding, the brackets were cleaned of resin with a microetcher as described later, and

then rebonded to the teeth.

Before bonding of brackets all micro-etched brackets were examined under x 13 magnification to assess any damage done or any adhesive remain in the bracket base.<sup>(2)</sup>

Procedures of bonding were as follows and according to manufacturer instruction. Polishing of the buccal surface of each tooth is carried out using a non-fluoridated pumice and water slurry in a rubber cup attached to a low speed handpiece for 30 seconds, following which, the teeth were washed with the water spray for 30 seconds, and dried for 30 seconds.

The buccal enamel surface was treated for 90 seconds using 37% phosphoric acid solution with one disposable brush for each tooth. Final rinsing was undertaken using a copious amount of water for 30 seconds and then the teeth are dried with an oil free stream of air for 20 seconds.<sup>(12)</sup> The buccal enamel surface of the etched tooth appears chalky white in colour, then the bracket (lower first premolar bracket Roth type) was bonded to the tooth according to the manufacture instructions by apply a thin coat of primer to each etched, dry tooth on the surface to which the bracket is to be bonded and to the underside of each bracket base. Then a small amount of paste was added to the bracket base. The bracket was positioned in the middle third of the buccal surface and parallel to the long axis using a clamping tweezer. Light press was applied on the bracket against the tooth so that any excess resin squeeze out from the edges and carefully removed with dental probe without distributing the seat bracket, so that not overlap the base. The adhesive was allowed to set for 10 minutes before the teeth were stored in distal water at room temperature.

Each sample will test for shear bond strength after 24 hour as described later.

*Previously Bonded Teeth:*

To simulate the enamel surface of teeth that have accidental lost a bracket during orthodontic treatment, all the teeth used in the virgin groups will use in the previously bonded teeth groups.

The 30 debonded teeth from virgin group washed with tap water and the residual composite resin on all the teeth care-

fully remove from enamel surface with hand scalers one and 12 fluted finishing bur (S.S. white bure, Inc., Franklin park, III, FG-557) in a high-speed dental hand-piece under dry condition. Removal of resin considered complete when no resin apparent on visual inspection.<sup>(2)</sup> The determination of complete resin removal was judged at the time of re-etching for placement of the brackets. If any part of the surface was not a frosty white, the removal procedure once again performed.<sup>(13)</sup>

Each tooth was again stored in distal water at room temperature. Before bonding the brackets, all 30 teeth etched on the labial surface for 90 seconds with 37% phosphoric acid, rinsed and dried as described in virgin groups.

Group P1: previously bonded teeth by new brackets.

Group P2: previously bonded teeth by new brackets microetched for 4 seconds at 3 mm from bracket base before bonded to the teeth.

Group P3: previously bonded teeth by 10 brackets randomly select from brackets debonded on virgin groups, the brackets cleaned from resin with a microetcher, and then rebonded to the teeth

All microetched brackets before bonded were examined under x13 magnification to assess any damage done or any adhesive remain in bracket base.<sup>(2)</sup>

All brackets were bonded to the teeth as described in virgin groups with the same composite resin. Then shear bond strength tested after 24 hour for all sample.

*Recycling of the debonded brackets (Microetching Model II):*

The microetcher model II (Danville Engineering Co., USA) consists of a micro-hand piece air line, an autoclaveble nozzle and aluminum oxide container; it is designed to be held like a pencil allowing the thumb to activate the finger button control.

Using 50-µm aluminum oxide abrasive powder at 3mm from bracket base,<sup>(8)</sup> The tip of the nozzle moves in a mesiodistal direction sweep technique by using a holder designed to make the nozzle move for 6 mm mesiodistal direction; and base of each debond bracket was etched under 65 PSI pressure with aluminum oxide 50-µm particle.<sup>(14)</sup> Microetching was stopped when the metal base appeared roughened

and no resin remnants were apparent on visual inspection. After microetching the bracket base was cleaned free of abrasive grit with a 2 seconds blast of pressurized air. (2)

**Bond Strength Test:**

Shear strength measurement were done with a universal testing machine with cross head speed of 0.5 mm/minute. (15)

Mounting apparatus with hole and chisel end rod have been specially made for this study. The specimen is fitted inside the hole of the mounting apparatus and the chisel end rod is fitted inside the upper arm of the testing machine to provide a force in an occluso-gingival direction.

The point at which the bracket breaks off from the tooth was recorded in kilograms and the stress in mega Pascal (Map) was calculated by converting the bond

force into Newton, and then dividing this by the bracket base bonding area in square meters. (16)

**RESULTS**

The descriptive analysis (minimum, maximum, mean value, and SD) for both virgin teeth groups and previously bonded teeth groups, are given in Table (1). It can be noticed, in the virgin groups that the mean shear bond strength of the new brackets microetched group (V2) is the highest (12.76), while the new bracket group (V1) is the lowest (9.76), also in the previously bonded teeth can notice that the mean shear bond strength of the new brackets microetched group (P2) is the highest (12.34), while the new bracket group (P1) the lowest (9.76).

Table (1): Descriptive Statistics Demonstrating the Effect of Groups on Shear Bond Strength of Brackets.

Groups	No.	Minimum	Maximum	mean*	SD	Std. Error of mean
V1	10	9.10	11.80	10.50	0.874	0.276
V2	10	11.40	14.50	12.76	1.133	0.358
V3	10	10.80	13.90	12.40	1.226	0.378
P1	10	8.50	11.00	9.76	0.974	0.308
P2	10	10.40	13.90	12.34	1.138	0.360
P3	10	9.80	13.40	11.78	1.387	0.438

Sd: Standard deviation

The t-test (Table 2) has been used to compare between virgin groups and previously bonded groups, the results were obtained and showed that there are no statistical significant differences between virgin groups and previously bonded

groups, if other factors had been constant at  $P \leq 0.05$ , although there are no significant differences, the virgin groups showing higher mean value for all groups when compared with comparable previously bonded teeth.

Table (2): Comparison of Shear Bond Strength (Mpa) Between Groups Bonded to Virgin Teeth with Groups Bonded to Previously Bonded Teeth By t-test, when type of brackets was constant.

	Groups	Mean* ± SD	T – Value	P – Value	
V1 vs P1	V1	10.50± 0.87	1.649	0.134	NS
	P1	9.760± 0.97			
V2 vs P2	V2	12.76± 1.13	1.367	0.205	NS
	P2	12.34±1.13			
V3 vs P3	V3	12.40±1.22	1.840	0.099	NS
	P3	11.78±1.38			

\* Mean Measurement in MPa; NS: Non significant

The analysis of variance (ANOVA) for virgin groups bonded teeth showed significant differences ( $P < 0.001$ ) among them as illustrated in Tables (3), also the analysis of variance (ANOVA) for previously bonded teeth showed significant differences ( $p < 0.001$ ) among them as illustrated in Table (4). The result of Duncan Multiple Analysis Range Test for virgin groups (Table 3) showed that the new bracket (V1) group had the significant decrease of shear bond strength mean in comparison

with (V2,V3) groups at ( $P \leq 0.05$ ), while the remain groups (V2, V3) showed no significant differences. Also the result of Duncan Multiple Analysis Range Test for previously bonded groups (Table 4) showed that the new bracket (P1) group had the significant decrease of shear bond strength mean in comparison with (P2,P3) groups at ( $P \leq 0.05$ ), while the remain groups (P2,P3) showed no significant differences.

Table (3): ANOVA and Duncan's Among Virgin Teeth Groups for Determining the Effects of Microetching in the Shear Bond Strength of Brackets.

		Sum of square	df	Mean square	F- Value	P
<b>ANOVA</b>	Between groups	29.491	2	14.745		
	Within groups	31.984	27	1.185	12.448	$P < 0.001$
	Total	61.475	29			
<b>Duncan</b>	Groups	Mean* $\pm$ SE			Duncan Groups**	
	V1	10.50 $\pm$ 0.276			A	
	V2	12.76 $\pm$ 0.358			B	
	V3	12.40 $\pm$ 0.387			B	

\* Measurement in MPa; \*\* Different Litters Mean significant difference ( $P \leq 0.05$ )

Table (4): ANOVA and Duncan's Among previously Bonded teeth Groups for Determining the Effects of Microetching in Shear Bond Strength of Brackets.

		Sum of square	df	Mean square	F- Value	P
<b>ANOVA</b>	Between Groups	36.835	2	18.417		
	Within Groups	37.524	27	1.390	13.255	$P < 0.001$
	Total	74.359	29			
<b>Duncan</b>	Groups	Mean* $\pm$ SE			Duncan Groups**	
	P1	9.760 $\pm$ 0.308			A	
	P2	12.340 $\pm$ 0.360			B	
	P3	11.780 $\pm$ 0.438			B	

\* Measurement in Mpa; \*\* Different Litters Mean significant difference ( $P \leq 0.05$ )

Figure (1) clearly revealed the mean shear bond strength of virgin groups and previously bonded groups.

Microscopic view under 13x of magnification for brackets retentive base showed that the new bracket groups clear, well demarcated and luster as in Figure (2,A), new microetched brackets groups appeared clear, the mesh well demarcated, loss of luster and no damage as in Figure (2,B); Debonded microetched bracket appeared clear, the mesh well demarcated,

loss of luster and there is no damage or adhesive remnant as showed in Figure (2.C); Debonded bracket before micreched appeared completely covered with composite as in Figure (2,D).

## DISCUSSION

The use of 50- $\mu$ m aluminum oxide particle stream has been recommended for bracket recycling to increase retention by creating a roughened surface. <sup>(17)</sup> Aluminum oxide air-abrasion has been proved a

good option for bracket recycling by offering a slim, easy-of-handle technique. Sandblasting can be performed in the dental office, which reduces the costs and working time.<sup>(4)</sup> In spite of its increasingly widespread use for recycling purposes,

aluminum-oxide blasting technique was originally intended to enhance the mechanical retention of new brackets and improve bracket bonding to restored teeth as well as to prepare the enamel surface.<sup>(7)</sup>

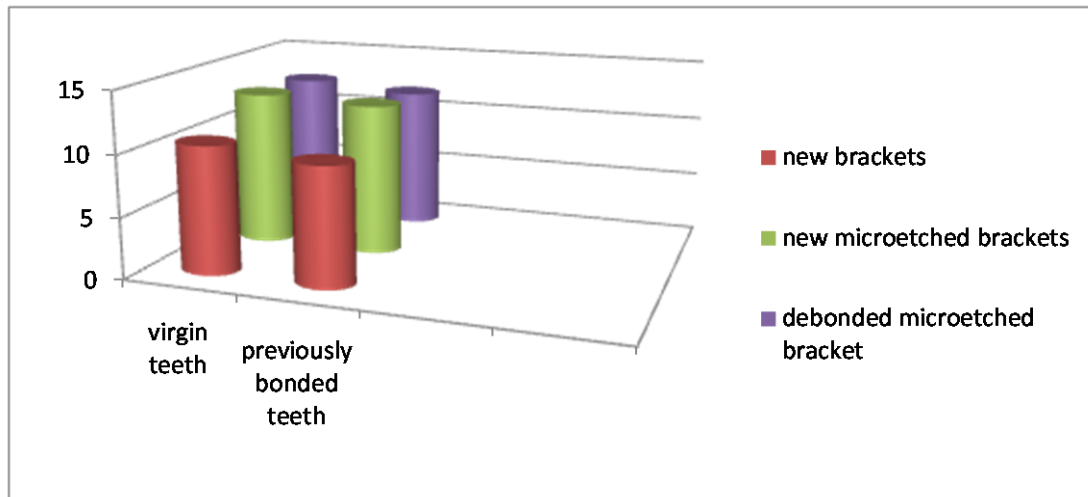


Figure (1): A Histogram showing mean shear bond strength in Mpa for virgin groups and previously bonded teeth groups.

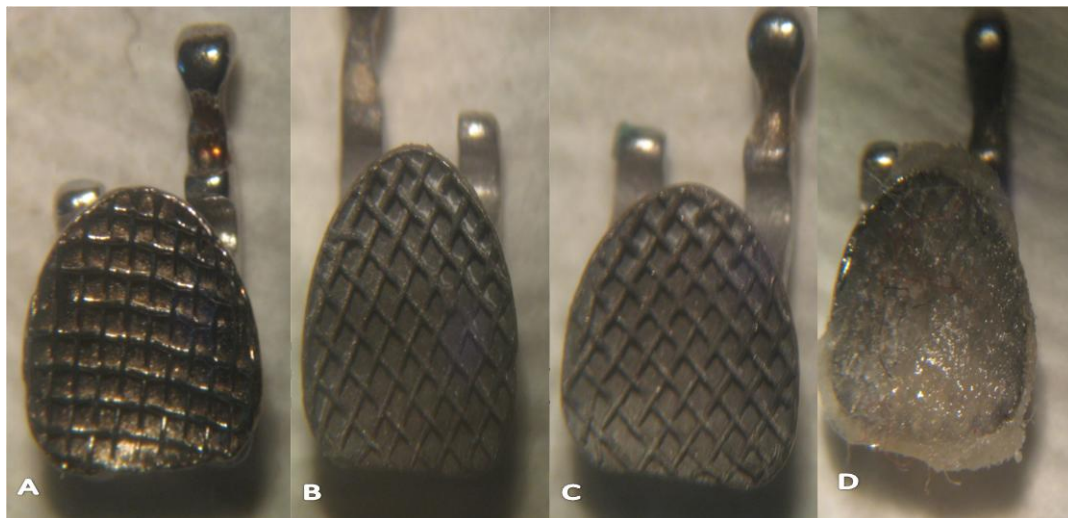


Figure (2). Microscopic examination of brackets base (A) new bracket (B) new micro-etched bracket (C) debonded microetched bracket (D) debonded bracket.

In this study, only 1 type of cement was used to ensure that the any significant variations in shear bond strength were clearly attributable to variation in bracket base or variation on enamel surfaces<sup>(8)</sup>. The results of this study showed no statistically significant difference between virgin bonded teeth and previously bonded teeth when compared Groups V1 with P1,

V2 with P2 and V3 with P3 and this results supports the use of hand scalers one with 12 fluted carbide finishing bur to Remove resin remnant from enamel surface after failure of the bonding this finding agree with James et al<sup>(2)</sup> and Stenyo, et al.<sup>(4)</sup> However, the results showed that the mean value of virgin groups was higher than the mean value of previously bonded

groups. This finding clearly due to old adhesive remnant in the enamel surface but it is very small that have no significant effect.

The result of this study showed no statistically difference between the new microetched brackets and debonded microetched brackets, this result is in agreement with (James *et al*<sup>(2)</sup>; Mete and Selim<sup>(6)</sup>). Also this study founded that shear bond strengths of new microetched brackets and debonded microetched rebounded brackets were significantly greater than new brackets. This finding is clearly due to the fact that aluminum oxide sandblasting of brackets base creates an effective micro-roughened surface on the bracket base, which increase the area available for composite bonding in comparison to the new brackets.<sup>(18)</sup> This result is in agreement with Demas *et al*.<sup>(19)</sup> The finding also differ from those of James *et al*; Mete and Selim; Stenyo *et al*,<sup>(2,6,4)</sup> who found that there is no statistically significant differences in mean bond strength between the new brackets and debonded etched rebounded brackets.

Results showed that microetching new brackets is an effective means of enhancing bond strengths for new brackets because new brackets groups had significantly decrease shear bond strength mean in compared with new microetched groups in both virgin and previously bonded groups, in spite of that this study do not suggest microetching new brackets because the bond strengths of the new brackets appear quite adequate for clinical service and pass the acceptable shear bond strength (6-8 Mpa), so any enhancement of the resin-bracket interface bond strength above the new brackets strengths could lead to increased damage of the enamel surface at debonding

### CONCLUSION

1. This study supports the used of microetching by aluminum oxide 50- $\mu$ m as a viable procedure when rebonding accidental failure bracket.
2. This study showed that previously bonded teeth had shear bond strength less but comparable with virgin teeth when removed the old adhesive remnant complete-

ly.

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