RESEARCH

Effect of Office Bleaching Agents on the Shear Bond Strength of Metallic Brackets Bonded Using Self-Etching Primer System at Different Time Intervals – An In-Vitro Study

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Abstract

A common method of treating discoloured teeth is to bleach them using hydrogen peroxide. Many studies in the literature have concluded that bleaching reduces shear bond strength of composite resin significantly and thus, to achieve clinically adequate shear bond strength of composite for bonding brackets to bleached enamel, it is important to find out the various methods of reducing adverse effects of bleaching. It has been proposed by some authors that a delay in bonding effectively reverses the effects of bleaching on bond strength. OBJECTIVES- To test the null hypothesis that there is no statistical significance in (1) bond strength and (2) failure site location with bleached and unbleached enamel prepared with TransbondPlus Self-etching Primer between different time intervals. MATERIALS AND METHODS- Sixty freshly extracted human premolar teeth were randomly divided divided into three groups of 20 teeth each Bleaching treatment was performed at two different time intervals (bleaching immediately before bonding and bleaching 30 days before bonding). All brackets were bonded with a self-etching primer system. The shear bond strength of these brackets was measured and recorded in MPa. Adhesive remnant index (ARI) scores were determined after the brackets failed. RESULTS- The mean shear bond strength of Group A (control) is found to be 20.4315 MPa (SD± 6.81041) which was reduced to 11.1955 MPa (SD ± 4.58041) when bonding was done immediately after bleaching (group B). The shear bond strength increased to 14.9910 MPa (SD ± 4.74545) when enamel was 14.9910 MPa (SD ± 4.74545) when enamel was Group C) Pair wise comparison of shear bond strength between the three groups using Post hoc Tukey test showed that there is a very high statistically significant difference between shear bond strength of all three groups. CONCLUSION This study shows that bonding immediately after bleaching significantly reduces the shear bond strength , it can be reversed by a delay in the bonding by 30 days which shear bond strength , it can be reversed by a delay in the bonding by 30 days which improves the shear bond strength as reflected in the results of the study ,So it is advisable to delay the orthodontic bonding procedure by an interval of 30 days to improve survival rates and prevent frequent breakages of brackets due to bond failure.

KEYWORDS: Bleaching, Self etching Primer

Introduction

Charles Gordy once remarked "A smile is an inexpensive way to change your looks"!!! In the modern era, inexpensive may not be a very apt term. However, a radiant smile is nonetheless, the most beautiful ornament of human facial esthetics. The most common reason for seeking the services of the "smile specialist -the Orthodontist" is to improve the appearance of the teeth and face. Thus, esthetics has emerged as one of the prime goals of Orthodontics and Dentofacial Orthopaedics. Recent times have witnessed an unprecedented increase in awareness about facial esthetics within the general populace.

Likewise, dentistry has progressed by leaps and bounds in the last few decades owing to the rapid advances in technology and a surge in knowledge. At such a point in time, where dental interdisciplinary co-ordination is the order of the day, the field of Orthodontics can no longer be isolated from the increasing treatment possibilities supplied by other specialities. The recent popularity of tooth whitening or bleaching has had a significant impact on the practice of dentistry. Although bleaching of vital teeth has been known in dentistry since the 1800's[1], the use of peroxide based tooth whitening materials has increased substantially in the past few years. Various whitening systems are currently being used to bleach the teeth. Among the various whitening systems available, concentrated solutions of hydrogen peroxide are the most common agents.

Today, in-office or home bleaching has gained acceptance among dentists and patients as a simple, effective, and predictable method to whiten teeth. Patients approach the dentist for bleaching mainly because of aesthetic concerns and they often get inspired after bleaching for additional aesthetic dental procedures and orthodontic treatment. Thus, some patients who are interested in orthodontic treatment might have already had their teeth bleached or might be interested in bleaching. Also, increasing demands for adult orthodontics has resulted in patients who are not satisfied with merely well aligned teeth; but also want their teeth to be whiter.

Little is known about the biological and physical effects of bleaching agents, especially their effect on the dental restorative materials and on the shear bond strength of orthodontic adhesives bonded to human tooth enamel .There is conflicting evidence regarding the effect of bleaching on the shear bond strength of orthodontic bonding adhesives. Previous studies have shown changes in the enamel structure and composition when exposed to 30-35% hydrogen peroxide for in-office vital bleaching[2,3]. Some authors identified a substantial reduction in the bond strengths to enamel shortly after exposure to concentrated aqueous solutions of hydrogen peroxide[4,5] whereas others have found no significant difference in the bond strength between the bleached and the unbleached groups

In routine orthodontic practice, it is essential to obtain a reliable adhesive bond between an orthodontic attachment and tooth enamel .The continuing research & developments in dental material science have led to the improvement in adhesive bonding formulations, resulting in current availability of a wide range of products, including the single-step etch/primer solutions.

The Self etching primer systems have been recently introduced as an alternative to traditional acid etch methods; they are easy to use, manipulate and have decreasedthe chair side time by 65% ,and so have become increasingly popular for orthodontic use . It consists of an etchant & primer dispersed in a single unit. The acid component of the system demineralizes the enamel surface & the etched enamel gets simultaneously primed. Hence, the etching & priming are merged as a single step leading to fewer stages in bonding procedure, saving of time and smaller extent of enamel decalcification.

Several methods have been proposed to avoid clinical problems related to compromised bond strength after bleaching such as removal of superficial layer ofenamel[6], pretreatment of bleached enamel with alcohol and use of adhesives containing organic solvents7. Most common recommendation is to delay any bonding procedures after bleaching because the reduction of composite resin bond strength to freshly bleached enamel has shown to be transient. But recommended post bleaching period for bonding procedures in different studies varies between 24 hours to 4 weeks. Hence it seems necessary to investigate the effect of the office bleaching agent on the shear bond strength of metallic brackets bonded using self etching primer systems at different time intervals and also to identify the best time interval after bleaching to start orthodontic treatment. Thus, this study was conducted to evaluate the effects of office bleaching agent on the shear bond strength of metallic brackets bonded with self etching primer and orthodontic composite at two different time intervals.

AIMS AND OBJECTIVES

To determine the shear bond strength of metallic brackets bonded using self etching primer system, immediately after teeth have been bleached with 35% hydrogen peroxide solution.(Office bleach).

To determine the shear bond strength of metallic brackets bonded using self etching primer system, 30 days after teeth have been bleached with 35 % hydrogen peroxide solution (Office bleach).

To determine the shear bond strength of metallic brackets bonded using self etching primer system on unbleached teeth.

To determine whether there is a statistical difference in bond failure site locations with bleached and unbleached enamel, prepared with self etching primers between different time intervals.

To determine whether there is any statistical difference in shear bond strengths of metallic brackets with bleached and unbleached enamel prepared with self etching primers between different time intervals.

METHODOLOGY

This study was conducted on sixty samples. These were

divided into three groups oftwenty samples in each group.
The teeth were cleaned and stored in distilled water until used. Distilled water was changed twice weekly to prevent bacterial contamination. The teeth were used for the study within 6 months of extraction. The roots of each tooth were grooved inthe apical third with a diamond bur and then mounted in self curing acrylic till the cementoenamel junction with the long axis vertical. After the acrylic set, the buccal surface of each tooth was cleaned with fluoride free pumice slurry, then washed in distilled water and dried in compressed air. The teeth were then divided into 3 equal groups randomly with 20 teeth in each group.

Group A (Control):
The buccal surface of each tooth was polished with fluoride free pumice slurry, rinsed and dried. Teeth were etched and primed by using self-etching primer that is Transbond Plus (3M Unitek),which contains both the acid and the primer and it is applied on the enamel surface of teeth, according to the manufacturer's instructions. For activation, the 2 components are squeezed together, and the resulting mix is applied directly on the tooth surface. It contains a black (largest) reservoir, squeezed into white (middle) reservoir and then into purple (smallest) reservoir of the blister package ,using controlled pressure it was applied to the surface of each tooth by rubbing for 3 seconds. If any of the teeth did not appear glossy, more primer was applied to the teeth for another 3 seconds, followed by another burst of air. Transbond XT adhesive was applied on the bracket base and then, bracket was positioned lightly on the buccal surface of the tooth.
The bracket was adjusted to the final position and pressed firmly into place. Before curing, the excess resin material is removed with a sharp scaler without disturbing the bracket position; the adhesive was light cured for 10 seconds on each side of the bracket,a total of 40 seconds, following manufacturer's instructions.

Group B (Bleached group):
The buccal surface of each tooth was polished with fluoride free pumice slurry, rinsed and dried. 35% hydrogen peroxide bleaching agent was mixed according to manufacturer's recommendations and applied with a brush onto the tooth surface in a layer of approximately 1mm in thickness ensuring no enamel was visible. The initial colour of the mix was red , it was then exposed to a LED curing light for 30 seconds and the bleaching agent was kept in place for 15 minutes , until the colour of the bleaching agent turned from red to green , before it was washed away. Brackets were then immediately bonded as in the control group.

Group C (Bonding 30 days after bleaching):
Teeth in this group were treated the same as in Group B except that after bleaching and before bonding, there was a time interval of 30 days. They were stored in distilled water and the water was changed daily. After 30 days brackets were bonded as in the control group.

Debonding:
After bonding, all the teeth were stored in distilled water for 24 hours. After 24 hours, each specimen was loaded into the universal testing machine (Lloyd, LR 50K,FIE,INDIA) at Composite Technology Park, Bangalore. Testing was done with the bracket base parallel to the direction of the shear force. The upper member of the machine was fitted with a chisel shaped blade which was positioned in the occlusogingival direction and to make contact with the bonded specimen. Bond strength was determined in the shear mode at a cross head speed of 1mm/min until debonding occurred. The values of failure loads (Newton) were recorded and converted into megapascals (MPa) by dividing the failure load (N) by the surface area of the bracket base (9.806mm2).
Bond strength (MPa) =Failure Load (N)/Surface area of bonding surface

Adhesive Remnant Index (ARI)
After bond failure of the brackets the surfaces of the teeth were examined to assess the Adhesive Remnant Index (ARI) which describes the amount of the adhesive left on thesurface of the tooth.

The ARI scores were noted using the following criteria The ARI scale has a range of 5 to1

5 = no composite remained on the enamel surface
4 = less than 10% of composite remained on the tooth surface
3 = more than 10% but less than 90% of the composite remained on the tooth surface
2 = more than 90% of the composite remained
1 = all of the composite, with an impression of the bracket base remained on the tooth surface.

Statistical analysis:
Descriptive statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean +_ SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5 % level of significance.

Analysis of variance (ANOVA) has been used to find the significance of study parameters between three or more groups of patients and Post-hoc test has been used to find significance difference in pairwise. Kruskal Wallis test has been used to find the significance of ARI score between groups , Mann Whiteny U test has been used to find the significance by pairwise for ARI score. One – minus of survival plot is calculated to find the median bondstrength in three groups .

Statistical software: The Statistical software namely SAS 9.0, SPSS 15.0, Stata 8.0,MedCalc 9.0.1 and Systat 11.0 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables, etc.

Bleaching Agent- 35% hydrogen peroxide (Whiteness FGM)

Transbond Plus Self etching Primer

Loading of the sample for shear bond strength

Universal Testing Machine (LLYOD LR50K)

Table 1 : Pair wise comparison of bond strength of bond strength between the three groups

Pair wise comparison by Tukey test		
Group A vs Group B	Group A vs Group C	Group B vs Group C
<0.001**	0.007**	0.081+

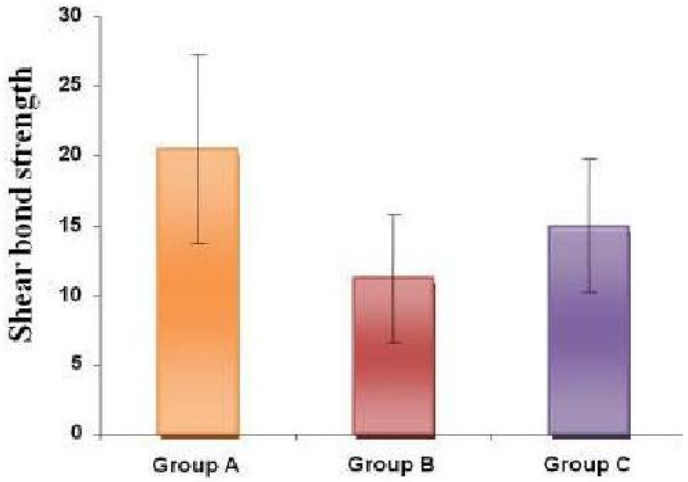

Figure 1: Comparision of shear bond strength (MPa) between the three groups

Group tested	n	Mean	Std. Deviation	Minimum	Maximum	Std. Error
A	20	20.4315	6.81041	8.71	29.06	1.5228
B	20	11.1955	4.58041	3.60	20.65	1.0242
C	20	14.9910	4.74545	7.34	25.03	1.0611
Total	60	15.5393	6.59969	3.60	29.06	.85202

Table 2: Comparison of Shear bond strength (MPa) between the three groups

Table 3 : Comparison of Adhesive Remanent Index scores between the groups

ARI	Group A	Group B	Group C
Score 1	5(20.0%)	1(4.0%)	0
Score 2	8(32.0%)	4(16.0%)	0
Score 3	6(24.0%)	6(24.0%)	4(16.0%)
Score 4	1(4.0%)	6(24.0%)	8(32.0%)
Score 5	0	3(12.0%)	8(32.0%)
Total	20(100.0%)	20(100.0%)	20(100.0%)
Mean ± SD	2.15±0.88	3. 3 0± 1.13	4.20±0.77

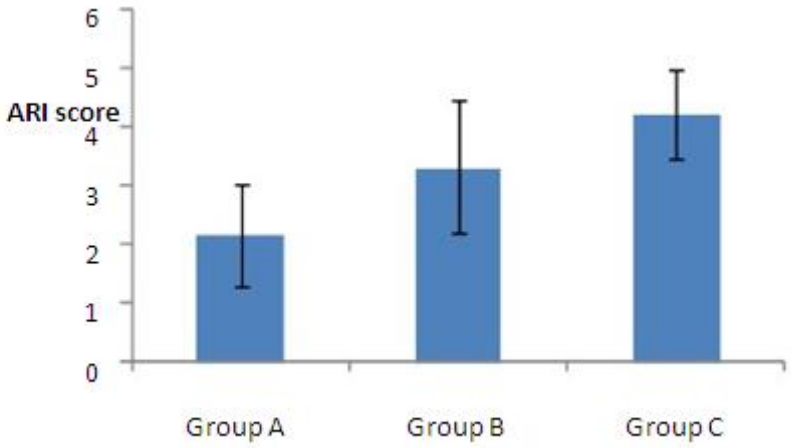

Figure2 - Comparison of Adhesive Remnant index scores for each group

Pairwise comparison	P value
Group A- Group B	0.033*
Group A-Group C	<0.001**
Group B-Group C	0.080+

Pair wise comparison	P value
Group A- Group B	0.002**
Group A-Group C	<0.001**
Group B-Group C	0.012*

Table 4a and 4b- Pair wise comparison of ARI scores between the three groups

Significant figures: *+ Suggestive significance (P value: 0.05<P<0.10), * Moderately significant (P value: 0.01<P ≤ ・0.05), ** Strongly significant (P value: P≤0.01*

Pair wise comparision of bond strength between the three groups are given in Table 1 Pair wise comparison of shear bond strength between the three groups using Post hoc Tukey test show that there is a very high statistically significant difference between shear bond strengths of Group A &B and Group A &C (P value : P≤0.01**) and shear bond strength between Group B & C is suggestive of statistical significance (P value:0.05<P<0.10)

After the study was done the following results were obtained. Mean bond strengths are given in Table 2 Group A (control) group showed highest bond strength of 20.4315 +/-6.81041 and least bond strength was found with Group B (bonding immediately after bleaching) 11.1955 +/- 4.58041 . Figure 1 shows the graphical representation of the shear bond strengths of all the three groups .

Adhesive remnant index was scored for each group .The distribution of the scores ranging from 1-5 for each group in shown in Table 3. Group A &B show scores ranging from 1-4 , whereas Group C shows scores range of 3-5. Group A &B , indicated cohesive failures within the resin. In GroupC, the failures showed adhesive(resin/enamel interface) and cohesive characteristics. . Comparison of Adhesive remnant index score for each group shown in Figure 2.

Pair wise comparison of Adhesive remnant index scores between the three groups was done using 2 X 5 Fischer Exact test and Mann Whitney U test . Table 4a shows statistically significant differences of ARI scores between Group A&B, Group A&C. Table 4b shows statistically significant differences between all three groups.

DISCUSSION

Vital bleaching with various whitening agents has gained worldwide acceptance among clinicians and patients for whitening teeth. Many bleaching products and techniques are now available to the clinician and over the counter for use by consumers without a dental professional's supervision. Some of these users might be scheduled for orthodontic or restorative treatment shortly after bleaching. Alterations in the bond strength might be significant with regard to clinical procedures that involve composite resin bonding ,such as bonding orthodontic brackets ,porcelain veneers or composite restorations. It is still controversial that whether these bleaching agents induce changes in surface topography of enamel and thus adversely influence the bond strengths of composite bonding adhesives bonded to the enamel.

Several authors have reported a significant decrease in the bond strength of composite resin to bleached enamel when compared to unbleached enamel. [10,2,] On the other hand, some authors found no significant difference in the bond strength between bleached and unbleached groups.[12,14]

Compared with phosphoric acid, Transbond Plus Self Etching Primer produced a uniform and more conservative etch pattern, with regular adhesive penetration and a less aggressive enamel demineralization.[17] However, a review of the literature indicated that no researchers have investigated the effect of bleaching treatment on the bond strength of metallic brackets bonded with orthodontic composites to enamel that have been prepared with Transbond plus Self Etching Primer.

In the present study, Group B (bonding with Transbond plus SEP immediately after bleaching) showed the least mean shear bond strength among all the groups. The mean shear bond strength of group B is 11.195MPa (SD ±4.58041) which is much less than group A (control) which has mean shear bond strength of 20.4315MPa(SD ±6.81041). Thus, the result of this study demonstrated that the reduction in shear bond strength of composite resin to enamel immediately after bleaching with 35% hydrogen peroxide was significant when compared with the control group. This is in accordance with a number of studies[10,4,5,] that showed significant reduction in shear bond strength, whereasother studies[13,14,] did not show any significant reduction in shear bond strength of composite resin to enamel immediately after bleaching with 35% hydrogen peroxide .

This reduction in the bond strength of composite resins after bleaching has been attributed to various reasons like increased porosity of enamel, loss of Calcium, decrease in microhardness and alteration in the organic substance.[8]

Based on the scanning electron microscopic examination which shows bubbled appearance and voids at the interface between resin and bleached enamel, it has been proposed by many authors that residual oxygen from the bleaching agents inhibits resin polymerization of composite resins due to which the bond strength is reduced, it also suggested that hydrogen peroxide and oxygen which are soluble in water can readily reach the dentinal fluid through enamel and bereleased later by diffusion.[4,11,]

In the present study, Group C (bonding with Transbond Plus SEP 30 days after bleaching) showed mean shear bond strength of 14.9910MPa (SD±4.74545) which is more than group B -mean shear bond strength 11.195 MPa (SD ±4.58041) and less than group A (control) showing a mean shear bond strength of 20.4315 MPa (SD ±6.81041).

This is in accordance with some studies that show a delay of at least 2 weeks is needed after bleaching for the tooth structure to regain its prebleaching adhesive properties.[18,19] However, other studies did not observe a significant difference in bond strength between bleached and unbleached teeth.[15]

When Transbond Plus Self Etching Primer was used for the enamel surface preparation, the result of the present study is in agreement with those findings assuming that the immersion process is removing the residual oxygen from the bleaching material and that the tooth structure regains its prebleaching adhesive properties.

A study suggested that a minimum bond strength of 6 to 8 MPa is adequate for most clinical orthodontic routine clinical use[5]. All bond strength values of composites used in this study were greater than this minimum requirement and fell within clinically acceptable ranges. However, clinical conditions may significantly differ from an in vitro setting. Moreover, heat and humidity conditions of the oral cavity are highly variable.

The results of the Adhesive Remnant Index score comparisons in the current study indicated that there were significant differences among the three groups tested. In groups A and B, there was a higher frequency of ARI scores of 1 to 4, indicating cohesive failures within the resin. In group C, the failures had shown adhesive (resin/enamel interface)and cohesive characteristics. In the literature, three similar investigations evaluated the ARI scores. Some authors [16] have shown a prevalence of cohesive characteristics.

LIMITATIONS OF THE PRESENT STUDY:

The present study is an in-vitro study which cannot exactly simulate the in-vivoconditions where there are many variations in the oral environment with respect to presence of saliva, variations in the amount and direction of force, and variations in oral temperature. There is a wide disparity among the various in-vitro studies (types of teeth used, sample storage conditions before testing, cross head speed of testing machine). Therefore, an in vivo study should be carried out to confirm the results. Various studies have questioned the appropriateness of average stress as the measurement used in bond studies. Bond strength is calculated by dividing the maximum loading force by the surface area of the bracket base. Finite element method model calculations have shown that stresses at the bracket adhesive tooth interface are not uniform and they depend on the method of force application.

SCOPE FOR FURTHER RESEARCH:

A study can be undertaken to compare the effect of contact of antioxidant with the tooth for different timeframes on the composite bond strengthbonded to bleached enamel. Further studies can be done to find out the effects of various concentrations of antioxidants on the bond strength of composites.

CLINICAL IMPLICATIONS:

Adverse effects of bleaching on composite bond strength is transient and it is recommended to delay bonding to reverse the effects of bleaching. Therefore this study is in concurrencewith previously reported studies, as the results of this study show that a delay in the bonding procedure by a time interval of four weeks after bleaching with 35 % hydrogen peroxide greatly improve the shear bond strength as compared with bonding immediately after bleaching . Thus, it is recommended to delay bonding by a time interval of 30 days, after an office bleaching procedure with 35% hydrogen peroxide to improve the survival rates of metallic orthodontic brackets in the mouth .

CONCLUSION

There is a statistically significant difference in bond failure site location with bleached and unbleached enamel prepared with self etching primer between different time intervals, the Adhesive Remnant scores of Group B (immediately after bleaching) showed cohesive failures within the resin whereas the Group C (30 days after bleaching) showed that the failures are of both adhesive(resin /enamel interface) and cohesive in nature.
It can be concluded from the above results that bleaching with 35% hydrogen peroxide office bleaching agent significantly reduces the shear bond strength ,when bonding is carried out immediately after bleaching and this reduction in shear bond strength can be effectively reversed by a delay in the bonding procedure by 30 days after bleaching .Delay of 30 days after bleaching is recommended to prevent frequent breakages of brackets due to bond failure during active orthodontic treatment/enamel interface) and cohesive in nature.

The following conclusions can be drawn from the present study:

Group A - Enamel prepared with TransbondPlus Self Etching Primer has clinically acceptable shear bond strength in ideal bonding environment, it showed highest shear bond strength among all three groups. The mean shear bond strength of this group is 20.4315 MPa (SD ± 6.81041)

Group B showed significantly less shear bond strength when compared to unbleached group (group A) indicating that bleaching with 35% hydrogen peroxide reduces the shear bond strength significantly when bonded immediately after bleaching. The mean shear bond strength of this group is 11.1955 MPa (SD± 4.58041)

Group C showed improved shear bond strength of metallic brackets bonded using self etching primer system, 30 days after teeth have been bleached with 35

% hydrogen peroxide solution (Office bleach). The mean shear bond strength of this group is 14.9910 MPa (SD ± 4.74545)

There is a statistically significant difference in shear bond strength of metallic brackets with bleached and unbleached enamel prepared with self etching primer between different time intervals, as the results show that Group B (immediately after bleaching) has the least shear bond strength and Group C(30 days after bleaching) showed higher shear bond strength in comparison with Group B There is a statistically significant difference in bond failure site location with bleached and unbleached enamel prepared with self etching primer between different time intervals, the Adhesive Remnant scores of Group B (immediately after bleaching) showed cohesive failures within the resin whereas the Group C (30 days after bleaching) showed that the failures are of both adhesive(resin /enamel interface) and cohesive in nature .

It can be concluded from the above results that bleaching with 35% hydrogen peroxide office bleaching agent significantly reduces the shear bond strength ,when bonding is carried out immediately after bleaching and this reduction in shear bond strength can be effectively reversed by a delay in the bonding procedure by 30 days after bleaching . Delay of 30 days after bleaching is recommended to prevent frequent breakages ofbrackets due to bond failure during active orthodontic treatment .

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