Original Article

Effects of Color and Glitter on the Removable Space Maintainer

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Abstract

Introduction: It may be necessary to make some modifications to the removable space maintainers for the persuasion of children to use this device. However, modification of the polymethyl methacrylate (PMMA) may affect its mechanical properties as well. Therefore, the present study aimed to evaluate the effects of color and glitter on the flexural strength of PMMA. **Methods:** For the purposes of the study, 40 PMMA specimens (64 mm×10 mm×2.5 mm) were prepared and divided into 4 groups (n=10). For all groups, PMMA resin was mixed according to the instructions provided by the manufacturers. Group 1 was prepared with clear resin and served as the control group. Group 2 was prepared with clear resin and glitter. Group 3 was prepared as colored by adding color concentrate. Group 4 was colored similar to Group 3 and glitter was added as well. Finally, a three-point flexure test was used to measure the flexural strength of the specimens. The flexural strength was analyzed using the Kruskal–Wallis test. The Conover-Iman test of multiple comparisons was used to detect the differences among the groups. In all the tests, a P-value of 0.05 was considered statistically significant. **Results:** The PMMA with glitter showed statistically significant reduced flexural strength value, compared to clear PMMA. Moreover, the addition of color caused an insignificant increase in the flexural strength of PMMA. **Conclusion:** The addition of glitter to clear PMMA reduced the flexural strength of the material while other modifications did not significantly affect the flexural strength of the PMMA.

Keywords: Coloring, Flexural Strength, PMMA, Space Maintainer

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Introduction

Premature loss of teeth may occur as a result of certain problems, such as caries, abnormal resorption, systemic diseases, and trauma (1, 2). Early loss of the primitive tooth may lead to the migration of the existing teeth and loss of arc space (2-4). Loss of arc space can lead to impairment in permanent teeth configuration, such as crowing, supra-eruption, and impaction (5). In order to avoid these problems, a space maintainer is needed to keep sufficient space for the permanent teeth to erupt and maintain a well-aligned position (3, 6). The principal function of a space maintainer is the guidance of the eruption of the permanent teeth and avoidance of crowding or supra eruption (7). A space maintainer should maintain the mesiodistal space and easily fabricated and withstand functional forces (1). The usage of space maintainers may prevent a more complex orthodontic treatment in the future (6). There are two major types of space maintainers, namely fixed and removable space maintainer (RSM) (3, 6, 8). The most commonly used RSMs are simple acrylic and removable partial dentures. Removable partial dentures help mastication, improve esthetics, and prevent unwanted tongue habits (3). However, children in the primary dentition ages may have difficulties using and taking care of their removable maintainers. Since they may lose their devices, acrylic maintainers are prone to damage (3).

In order to promote the adaptation of young patients to their devices, there is an increasing demand for colored or decorated devices. To fulfill this demand, color pigments, glitter, or other decorations have been used widely in the dental market (4). However, a review of the related literature shows that studies on the effects of pigment or glitter addition to polymethyl methacrylate (PMMA) are very limited. PMMA has become the most common denture base material for decades, compared to other available materials. The reason for this interest in PMMA is its features, such as easy manipulation, satisfactory esthetics, and low price (9, 10). However, its mechanical properties impose limitations on the material (11, 12). Pediatric or orthodontic appliances are prone to crack or fracture due to occlusal force and fatigue caused by insertions and extractions (14). In the previous literature, researchers investigated the survival and success of both removable and fixed space maintainers (14-16). The common idea in these studies was that gender and age did not affect the survival of the space maintainers. Tulunoglu et al. (14) and Martu et al. (15) stated that deformation of retentive parts and fractures were the most common causes of space maintainers failure. Furthermore, Quedimat et al. (16) declared that more fractures were observed in removable partial dentures, followed by a lower lingual holding arch. Beldiman et al. (17) in their study compared the mechanical properties of different space maintainers and stated that removable space maintainers were weaker than the fixed ones. Despite the fact that patient education and close observation may prevent any probable complications, any chance to decrease the risk factors would be advantageous (2). The null hypothesis of the study was that adding color and glitter would not affect the flexural strength of the PMMA.

Materials and Methods

A total of 40 PMMA specimens (64 mm×10 mm×2.5 mm) simulating a retainer were prepared and divided into 4 groups (n=10). For all groups, PMMA resin (Orthocryl, Dentaurum, Germany) was mixed at room temperature (22℃) according to the instructions provided by the manufacturers. Group 1 was prepared with clear resin and served as the control group. Group 2 was prepared with clear resin and glitter (Orthocryl® Disco Glitter, Dentaurum, Germany) with a ratio of 0.5:100 (glitter/powder). Group 3 was prepared as colored (red) by adding color concentrate (Orthocryl® Color Concentrate, Dentaurum, Germany) with a ratio of 1:30 (coloring concentrate/liquid). Group 4 was colored similar to Group 3 and glitter was added as well. The specimens were packed into stone molds and brass flasks. Prior to packing, the molds were immersed in warm water for 15 min, until no more air bubbles emerged from the plaster. The resins were polymerized at 46℃ for 25 min in a pressure chamber (Polimer 180, Zhermack SpA – Badia Polesine, Italy) under 32 psi pressure.

After the polymerization of resins, the excess material was removed with a tungsten carbide bur (Euro Carbide Bur; Dedeco, NY, USA) at 15.000 revolutions per min, and the surfaces were finished with 200 and 600 grid sandpapers. The specimens were thermocycled at 5℃ and 55℃ for 1000 times (Esetron, Mechatronics, Ankara, Turkey). The cycle periods were 15 sec for hot and cold water and 30 sec of dwell time.

A three-point flexure test (ISO 1567) was performed to measure the flexural strength of the specimens. The specimens were placed in a test machine (Esetron Mecathronics, Ankara, Turkey) on a test rig with cylindrical supports which were 3.2 mm in diameter and 50 mm apart. The load was applied to the specimens at a crosshead speed of 5 mm/min. The fracture force was recorded in Newton (N) and flexural strength (Fs) was calculated with the formula of ”$Fs = 3PL/2\ bd^2$” where P was the maximum load, L was span length, b was specimen width, and d was specimen thickness.

Statistical analysis was conducted in SPSS software (version 19). The flexural strength was analyzed using the Kruskal–Wallis test. The Conover-Iman test of multiple comparisons was performed to detect the differences among the groups. In all the tests, a P-value of 0.05 was considered statistically significant.

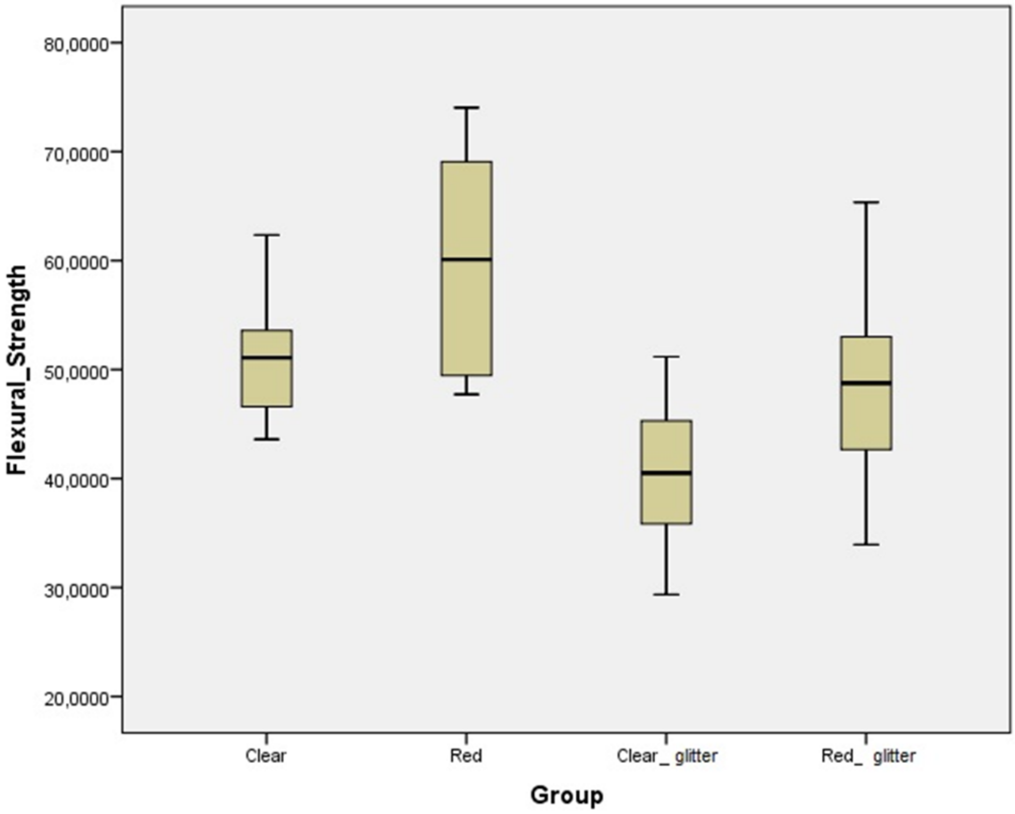
Results

The mean flexural strength values of tested resin groups are displayed in Figure 1. The Kruskal–Wallis test showed that there were significant differences among the groups regarding flexural strength (P=0.001). Iman Conover pairwise comparison test showed that the clear-glitter group (40,76±6,5447130 MPa) was significantly different from the clear group (50,67±5,50 MPa) (P=0.001). Besides, other groups (red color 59,40±10,07 MPa and red-glitter 47,96±9,047 MPa), did not have significant differences with each other (P>0.05). (Table I)

Table I. Mean, standard deviation, flexural strength, and minimum and maximum values of the samples

Group	N	Mean	Std. Deviation	Minimum	Maximum	Median
Clear	10	50,679600	5,5011782	43,6080	62,3400	51,093000
Red	10	59,401200	10,0759253	47,7180	74,0400	60,096000
Clear-glitter	10	40,763400	6,5447130	29,3580	51,1740	40,506000
Red-glitter	10	47,968200	9,0477105	33,9300	65,3460	48,762000
Total	40	49,703100	10,2377909	29,3580	74,0400	48,882000

Figure 1. Boxplot graphic of the studied polymethyl methacrylate



Discussion

The null hypothesis was declined since the coloring of the PMMA increased the flexural strength of PMMA while glitter reduced it. It is a common thought that “the best space maintainer is a well maintained primary tooth” (3). However, in the case of early primary tooth loss, it is important to maintain the space for the emerging permanent tooth. The previous studies focused on space maintainers indications, contraindications, success, and failures. According to our knowledge, there is no study about the flexural strength of PMMA used for RSM.

As mentioned before there are different space maintainers for different indications. In the current study, the focus was on RSM and PMMA that was used to manufacture the device. RSMs can be manufactured by either heat-cured or self-curing PMMA. However, self-curing PMMA has lower flexural strength and modulus than heat-cured PMMA (18). Low flexural strength is one of the main drawbacks of PMMA (19). If the patient is a child or an adolescent, the risk of fracture may increase. Based on the results of a previous study, nearly one third (31%) of the RSMs were broken during the maintenance period (16). According to the review of the related literature, many studies have been conducted on the improvement of the mechanical properties of PMMA, such as fiber reinforcement, metal reinforcement, and chemical modification of the PMMA, as well as the usage of micro or nanofillers (18-20). Fiber reinforcement of the PMMA should be made with pre-treated fibers that would create better adhesion between the fibers and the resin. Untreated fibers would act as inclusion bodies which would weaken the resin instead of strengthening it (20). In the current study, the lowest fractural strength of the PMMA was observed in the clear resin with glitters embedded in it. This could be due to the fact that glitter acts as an inclusion body and weaken the resin.

The size of the fillers may change the mechanical properties of the resin. In addition, micro or nanofillers can infiltrate into the PMMA matrix and behave like integrated structure and, thereby strengthen the resin. In the current study, the colored PMMA samples showed the highest flexural strength values. No chemical investigations were made in this study, however, the authors estimate that this result could be due to the color pigments that diffused into the resin matrix and strengthened it. More studies can be conducted in order to verify this hypothesis. Similar to the outcome of the present study, Telles et al.(4) observed an increased flexural strength in two pigments used to color the clear PMMA.

However, the current study is an in vitro investigation and in vivo conditions would differ. Besides, there are many different brands commercially available and, different particle sizes, various PMMA compositions might effect the flexural strength of the resin.

Conclusion

Different coloring agents and glitters are commercially available in the dental market. According to the results of this study, the addition of color to the resin did not have a significant effect on the flexural strength of the PMMA, while the addition of glitter reduced the flexural strength of the PMMA which was acceptable.

Conflict of Interest

The authors claim that there was no conflict of interest in this study.

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