

Effect of Immersion Time in Artificial Saliva on Flexural Strength of Provisional Crown and Bridge Materials: Light zPolymerization versus Autopolymerization System

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ABSTRACT

Objective: The aim of this study was to investigate the effect of immersion time in artificial saliva on the flexural strength of provisional crown and bridge (p-c&b) materials. **Materials and Methods:** Two types of p-c&b materials were used in this study: Light polymerized p-c&b material (Revotek LC) and autopolymerized p-c&b material (PerfectTemp II). A total of 100 specimens were fabricated and measured according to ISO 4049/2000. A stainless steel mould was used to prepare 2mm x 2mm x 25mm bar shaped specimens. All materials were dispensed and manipulated according to the manufacturers' instructions. The specimens were divided into 5 groups (n=10). Each specimen of the first group was measured immediately after preparation. The second, third, fourth and fifth groups were immersed in artificial saliva at 37°C in an incubator for 1 hour, 1 day, 7 days, 14 days, respectively. Flexural strength was tested by Universal Mechanical Testing Machine Shimadzu in a 3-point bending test. The Repeated ANOVA and Post-Hoc Bonferroni test were used to compare the continuous variables between the groups. **Results:** The results showed flexural strength of Revotek LC were higher than PerfectTemp II at first and second group. However, flexural strength of PerfectTemp II was higher than Revotek LC at third, fourth and fifth group. The highest flexural strength of Revotek LC was achieved in 1 hour immersion, whereas PerfectTemp II achieved the highest value in 7 days. **Conclusion:** Flexural strength of p-c&b materials were influenced by immersion time in artificial saliva and the type of p-c&b materials.

Key words : Flexural strength, provisional crown and bridge materials, immersion time in artificial saliva.

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INTRODUCTION

Fabrication of provisional crown and bridge (p-c&b) restorations is an important step to achieve successful definitive crown and bridge restorations. They are used in the interim between tooth preparation and fitting a definitive crown and bridge restorations.¹⁻⁴ Though p-c&b restorations are used in a limited period of time (1-2 weeks up to several months) they should provide enough strength, retention and esthetic for the prepared teeth prior inserting the original crown and bridge.^{1,2}

The flexural strength of p-c&b materials or known as transverse strength is the ability of a material to withstand flexural forces before breaking. It is obtained when ultimate flexibility of a material is achieved before its proportional limit. Flexural forces are crucial and its results are generated in clinical situation as compressive, tensile and shear forces during mastication.^{3,5}

The p-c&b materials available for fabricating provisional crowns and bridges are divided into two main groups: Methacrylate resins and Composite resin-based materials.⁴ The methacrylate resins commonly used are polymethyl methacrylate (PMMA) and polyethyl methacrylate (PEMA).³ PMMA has a high wear resistance; easy to add to; has good strength and esthetic. However, they have disadvantages when they are used in direct technique such as polymerization shrinkage; polymerization exotherm that can damage

pulp; and residual monomer that may cause allergy and gingival damage. PEMA is less exothermic than PMMA and usually used for indirect technique. However, its strength, wear resistance, esthetic and color stability are not as good as PMMA.^{3,6}

The other materials for fabricating p-c&b restorations are composite resin-based materials. The setting reactions of composite resin-based materials available are autopolymerization and dual polymerization systems.^{1,2} The autopolymerized composite resin material uses bis-acryl resin, a hydrophobic material that is similar to bis-GMA, whereas dual polymerized resin material uses urethane dimethacrylate (UDMA) resin.⁴ Recent developments in the p-c&b material was Revotek LC contains UDMA resins and is supplied in a putty stick form. Its advantages claimed by the manufacturer GC America are without MMA content, exothermic heat, odor and irritation; unlimited working time; superior handling, easy to place, contour, sculpt or shape and reduced polymerization shrinkage (0,388%).⁶

It was reported that flexural strength of Revotek LC was greater than flexural strength of bis-acryl in 30 minutes after setting. However, the water sorption of bis-acryl was lower than Revotek LC.⁷ Many studies showed that immersion in water or artificial saliva could decrease the flexural strength of p-c&b materials.¹⁻³ It can be assumed that saliva can also degrade and p-c&b materials can stay in the mouth after fabrication up to 1-2 weeks.

There was lack of information on flexural strength of light polymerized p-c&b materials with immersion time in artificial saliva. Hence, the aim of this study was to investigate the effect of immersion time in artificial saliva on the flexural strength of light polymerized compared to autopolymerized p-c&b resin composite.

MATERIALS AND METHODS

The p-c&b materials used in this study are listed in Table 1. A total of hundred specimens were fabricated according to ISO 4049/2000.⁸ A stainless steel mould was used to prepare 2mm x 2mm x 25 mm bar shaped specimens. The materials were dispensed and manipulated according to the manufacturers' instructions.

Table 1. Compositions of Provisional Crown and Bridge Materials

Material	Composition	Material type (delivery form)	Manufacturer
Revotek LC	45-55% UDMA 15-20% Silica powder <0,1% Camphorquinone	Light polymerizing	GC America
PerfecTemp II	32% Bis-GMA, ethoxyl 44% Barium glass 3% Silica 9% Polyester 1% Catalyst, stabilizer, pigments	Autopolymerizing (paste/paste)	Discus Dental USA

For PerfecTemp II, the mixing tip was fixed in position and a small amount of material was dispensed onto a mixing pad. Subsequently, the material was injected to the mould covered with a transparent polyethylene strip and a glass plate was attached tightly to the stainless steel mould using a clamp. The interval time between

mixing and dispensing into the mould was 60 seconds with setting time of 6 minutes. After dispensing into the mould, Revotek LC was polymerized with Light Curing Unit Hilux LEDMAX 500, Benlioglu Dental. The top and bottom surfaces were irradiated for 15 seconds in the Fast cure mode, with the light tip positioned directly onto the transparent polyethylene strip. After setting, the specimens were removed from the mould and any flash carefully removed by gently abrading with 320 grit abrasive paper. These specimens were then divided into 5 groups of 10 samples each. In group I, each specimen was measured immediately after preparation.⁹ Group II, III, IV and V were immersed in artificial saliva at 37°C for 1 hour, 1 day, 7 days and 14 days, respectively.

A three point bending test was used to evaluate the flexural strength using a universal mechanical testing machine with 250 kgf load cell (support bar distance 20 mm; radius of the support 1 mm) at crosshead speed of 1 mm/min to record the ultimate force at the point of fracture. The flexural strength was calculated using Equation:

$$FS = 3Fl / 2bh^2$$

where F = Ultimate force (kgf); b = width (mm); h = height (mm); l = distance between support bars (mm).

Repeated ANOVA and Post-Hoc Bonferroni test were used to compare the continuous variables result datas between the groups.

RESULTS

The mean flexural strength of the p-c&b restorative materials are shown in Table 2 and Figure 1. The effect of immersion time and the type of provisional materials on the flexural strength were statistically significant ($p < 0,05$). In Group I (without immersion) and Group II (1 hour immersion), the flexural strength of Revotek LC were significantly higher than PerfectTemp II. The flexural strength of PerfectTemp II was significantly higher than Revotek LC in Group III, IV and V.

Table 2. Mean Flexural Strength with Standard Deviations

Flexural Strength (MPa)	Time of immersion				
	0	1 hour	1 day	7 days	14 days
Revotek LC	43,02 (5,16)	51,93 (4,64)*	47,74 (3,69)	44,26 (2,98)*	42,61 (2,41)*
PerfectTemp II	22,95 (8,04)	45,14 (9,04)*	65,73 (12,34)*	85,19 (8,34)*	81,99 (7,49)

*) Significance with $p < 0,005$



Fig. 1. Mean Flexural Strength of Provisional Crown and Bridge Materials

As observed in Group II (1 hour) Revotek LC had the highest flexural strength after one hour of immersion. Its flexural strength decreased but not significantly different. Highest flexural strength of PerfectTemp II was noted in Group IV (7 days immersion).

DISCUSSION

Higher flexural strength of p-c&b materials is very important in fixed prosthetic treatment. It is designed as a combination of tensile strength at the lower surface of the fixed prosthetics, compressive strength at the upper surface and shear strength in parallel direction to the load which are subjected as masticary forces to p-c&b. According to the ISO 4049/2000, the flexural strength of p-c&b materials should be 50 MPa at minimum.⁹ In this study, the flexural strength of Revotek LC material was in accordance with the minimum requirement of ISO's one hour immersion time, whereas PerfectTemp II met the ISO requirement after 24 hours or one day immersion.

It was noted that flexural strength of Revotek LC was higher than PerfectTemp II in Group I and II which were influenced by the type of polymerization. Light polymerization system using light curing unit could produce more heat than the auto polymerized system. The heat could accelerate the mobility of the polymer chain than auto polymerized materials. In this study, Revotek LC was polymerized using Light Emitting Diode (LED) that had the same absorbance wavelength as camphorquinone initiator (400-500 nm) which made the polymerization more effectively.¹⁰ Polymerization also could be influenced by the tip distance between the light source and specimen. The closer the light tip to the material, the higher the specimen would

absorb the light intensity.¹¹ With the light tip close to the specimen surface, Revotek LC polymerized optimally and increased its flexural strength. After dispensing into the mould, the initiator of PerfectTemp II changed into free radicals to initiate the polymerization. During polymerization, a high amount of stress was created inside the polymeric network, which made it susceptible to fracture. However, the flexural strength of both materials increased in one hour of immersion time as a result of the elevated temperature (37°C) that increased the polymer chains mobility.^{1,2}

After immersion in artificial saliva for an hour, flexural strength of Revotek LC decreased, whereas PerfectTemp II significantly increased until day 7th. This phenomenon might be explained by the increasing water uptake into the polymer networks.¹² The sorption in polymer networks was mainly dependent on the hydrophilicity of the polymer matrices.¹³ The amount of the hydrophilic groups in the UDMA backbones (i.e., >CO=, -O-, -NH-) was higher than the hydrophilic groups in the backbone of Bis-GMA (i.e., >CO=, OH). Therefore, Revotek LC which contains UDMA would absorb more water than PerfectTemp II that contains Bis-GMA. The diffusion of water caused the polymer networks to swell which was associated with a reduction of the intermolecular forces between the polymer chains.¹⁴ This explained the decrease of flexural strength of Revotek LC which was faster than PerfectTemp II as the

water sorption of Revotek LC was higher than PerfectTemp II.

The filler content could also be an important factor in evaluating mechanical properties.¹⁶ If a mechanical load or force were exerted on the composites, the force would be absorbed by the resin matrix passed through a coupling agent to the stiffer and stronger inorganic filler particles.⁹ With more filler particles, the more force was absorbed by the filler and the composites would take a longer time to fracture than the composites that content less filler particles.¹⁶ Revotek LC had 15- 20% filler, whereas PerfectTemp II had more filler content, 47 % (44% Barium glass dan 3% Silica). Therefore, the flexural strength of PerfectTemp II was higher than the flexural strength of Revotek LC after one day of immersion.

CONCLUSION

It can be concluded that the flexural strength of light polymerized p-c&b material decreased after one hour immersion in artificial saliva whereas autopolymerized p-c&b material decreased after 7 days of immersion. In addition, the type, chemical structure; composition, and filler amount of p-c&b materials can affect its flexural strength..

Dentist should be aware of the fact that the autopolymerized p-c&b restoration has lower flexural strength in one hour immersion than the light polymerized p-c&b restoration.

If a high mechanical strength is indispensable, a light polymerized p-c&b material can be recommended. On the other hand, if we need longer usage period of p-c&b restoration in the mouth, autopolymerized p-c&b material can be used as an alternative.

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