

A Comparative Evaluation of Flexural Strength and Hardness of Different Provisional Fixed Restorative Resins With Varied Setting Reactions – An In Vitro Study

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Abstracts: Aim: The aim of this research work was to compare and evaluate the hardness and flexural strength of three different commercially available fixed provisional restorative resins. Objective: The objectives of this research work are, to assess whether setting mechanism of fixed provisional restorative resins has an effect on the physical and mechanical properties and to compare and contrast the flexural strength and hardness of three different fixed provisional restorative resins viz: a) Revotek LC(visible light cure resin – GC Corporation,Tokyo,Japan), 2) Tempspan (Dual cure resin – Pentron / wallingford, CT U.S.A), and c) Integrity (Self cure resin - Dentsply Caulk, Milford, DE,U.S.A). Methods: Commercially available composite resin Revotek LC(GC India), Tempspan(Pentron), Integrity (Dentsply). Brass mould was fabricated according to ANSI standardization, and specimen size was 25x2x2 mm. Sample size was 75 (25 for each). Specimens was fabricated according to manufacture instruction. After the fabrication of specimens, was stored in artificial saliva, and then hardness & flexural strength was measured. The mean flexural strength and hardness of three materials was compared using ANOVA test and pair-Wise comparison was done using Tukey's honesty significant (HSD) test. Results: There was statistically significant difrence found between all three provisional restorative materials for Hardness and Flexural strength. Conclusion: The highest average Hardness (Shore D) value was observed in Tempspan and lowest observed in Revotek LC and for flexural strength highest average value observed in Integrity and lowest observed in Revotek LC. [Bhargav N NJIRM 2017; 8(2):72-77]

Key Words: Flexural strength, Hardness, Provisional restoration

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Introduction: Fixed Prosthodontic treatment involves the replacement and restoration of teeth by artificial substitutes that are not readily removable from the mouth. Its focus is to restore functions, esthetics and comfort. It can transform an unhealthy, unattractive dentition with poor function into a comfortable, healthy occlusion capable of years of further service and greatly enhanced esthetics. Treatment can range from the fairly straightforward restoration of a single tooth or replacement of one or more missing teeth with a fixed dental prosthesis.

In spite of treatment modalities like replacement of teeth with dental implants, fixed partial denture remains an important aspect of fixed prosthodontic treatment. They are easy to fabricate, durable, esthetic and an economical choice of treatment. Hence fixed partial dentures are still a popular mode of treatment and, for most patients, the treatment of choice especially in our subcontinent.

The success of fixed prosthodontic treatment relies on a vast array of factors wherein provisional restorations play a very significant role. For any fixed prosthodontic treatment an interim restoration is an indispensable component of treatment procedure, and a necessity.

Historically this necessity for provisional treatment has been primarily from the mythological process of fabrication of the fixed prostheses. The importance of interim treatment, however, is more far reaching than is portrayed by this procedural necessity and the requirements for satisfactory provisional restorations differ only slightly from the definitive treatment they precede.¹ Provisional restorations are a critical component of fixed prosthodontic treatment, biologically and biomechanically.²

Provisional restorations are used during the interval between tooth reduction and the placement of the definitive restoration and there are many characteristics essential to ensure that the provisional restorations have a positive influence on the definitive restoration. The rationale for provisional treatment mainly includes the protection of pulpal tissues and maintenance of periodontal integrity. Provisional restoration serve to protect the teeth from dental caries, provide comfort and function, and work towards maintaining esthetics and can also provide anchorage for orthodontic brackets during tooth movement.³

The term provisional, interim or transitional have been routinely used interchangeably in the literature. The use of the term temporary, however, is controversial and is considered inappropriate by some prosthodontist because provisional restorations serve many functions, and “temporary” treatment may be interpreted as one of lesser importance or value.⁴ Provisional restoration should be akin to a definitive restoration in all aspects, except for the material from which they are fabricated.⁵ There is a vast array of materials available in the market to fabricate fixed provisional restorations. Clinicians should select a product based on factors that include ease of manipulation, cost effectiveness, esthetics, strength, and marginal accuracy.

While selecting the materials certain requirement should be kept in mind. Some of the ideal requirements for provisional restoration material include good marginal adaptation, adequate retention and resistance to dislodgment during normal masticatory function. Provisional restorative materials should possess strength, durability, hardness, resilience, and they should not irritate the pulp. The material should be conducive to promote good soft tissue and hard tissue health.

Consistent with nearly all areas of dental management where material science plays such a significant role, there is presently no ideal provisional material suitable for all clinical condition, however, there are many materials that have been used successfully for this purpose.⁶

A provisional restoration is subjected to masticatory forces in an oral environment, hence understanding its mechanical properties is necessary to evaluate products that are available in the market. Among mechanical properties, the flexural strength, fracture toughness and hardness of the interim prosthesis are important, particularly in a long span provisional prosthesis with short pontic height and connectors and when the patient presents with parafunctional habits such as bruxism and/or clenching. The flexural strength is also important if the patient is expected to wear the restoration for a long period of time as is often a requisite for full mouth rehabilitation cases. Hardness is a measure of the wear resistance and long term integrity of prosthesis.

From a processing perspective, provisional restorations have been divided into the following categories based on how they are converted from a plastic to a solid mass. They are as follows,

- 1) Chemically activated acrylic resins
- 2) Heat activated acrylic resins
- 3) Light activated composite resins and
- 4) Dual (Light and Chemically)activated composite resins.

Methods: This research work undertaken to evaluate the hardness and flexural strength of three commercially available provisional restorative materials, and selected materials are listed in Table 1. A customized brass mould was fabricated according to ANSI (American national standards institute) /ADA (American Dental Association) specification no. 27 (25 mm length x 2 mm width x 2 mm height).

Table 1 - List Of Materials

No	Materials	Manufacture
1	Revotek LC (Light Cure)	GC corporation, Tokyo, Japan
2	Tempspan (Dual Cure)	Pentron /Wallingford CT U.S.A.
3	Integrity (Self Cure)	L.D Caulk. Dentsply Int, Milford, Del.

The dimensions of specimens were standardized by using a customized 4 piece brass mould. Four screws were attached at the corners of the mould which helped in assembling and stabilizing the brass mould. For the light cure and dual cure materials the plastic lid was placed on the specimens for light to pass through and enable curing of the material. To apply the pressure on mould, four clips were attached. The custom made brass mould was used to fabricate uniform specimens. Total sample size was 75, to be divided into 25 samples for each type of material.

For dual cure (Tempspan) polymerized provisional resin, the material was packed in the mould according to manufacturer’s instruction. For cartridge dispensed materials, a small amount was extruded and discarded before application of the material into the mould. The material was extruded from the mixing tip, taking care that the mixing tip was not lifted to avoid incorporation of voids, and after the mould was filled with resin, a well lubricated plastic lid was placed over it and was light cured for 20 seconds with LED curing light, 2 mm distance was maintained between

specimens and LED curing light with the help of customized assembly. The plastic lid was then removed and the sample was retrieved.

For visible light cure (Revotek LC) resin, material was dispensed into the mould with the help of scoop, according to manufacturer’s instruction and the mould was filled with resin, a well lubricated plastic lid was placed over it and was light cured for 10 seconds with LED curing light, similar to visible light cure specimens, 2 mm distance was maintained between specimens and LED curing light with the help of customized assembly. The wave length of this LED curing light was 420 to 480 nm. The plastic lid was then removed and sample was retrieved.

For self cure (Integrity) polymerized resin, the material was dispensed into the mould according to manufacturer’s instruction. As this material was cartridge-dispensed material, so, a small amount was extruded and discarded before application of the material into the mould. After which, the mould was filled with the resin, a well lubricated plastic lid was placed over it and after 3 minutes of polymerization reaction, the sample was retrieved from the mould. The formed specimens were stored in artificial saliva at 37° C in incubator for 10 days. Following the 10 day of storage, each type of specimens underwent, hardness and flexural strength tests respectively.

The hardness test (Shore D), was conducted at Central Institute of Plastics Engineering And Technology, Vatva, Ahmedabad , and later the flexural strength test was performed at the Faculty Of Mechanical Engineering, Charotar University Of Science and Technology, CHARUSAT Campus, Changa.

Hardness testing was done using Durometer hardness tester (Shore D) according to ASTM-D2240 (American Standards of Testing and Materials). Three measurements for indentation hardness were taken on each specimen and their average value was recorded.

To measure the flexural strength of specimens, they were taken under the three point bending test on the universal testing machine (Tinius Olsen L Series H50KL, England) with 0.75 mm/min crosshead speed. The load was applied to the center of the specimen. The loading begins at 0 N and was continued till fracture

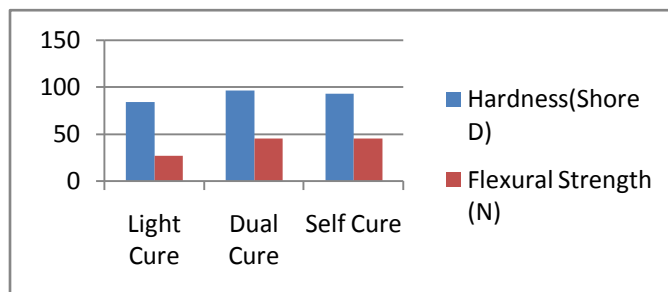
occurs. The load at which the fracture occurs was recorded in N and was termed as the “breaking load”. The statistical analysis was performed using the one – way analysis of variance (ANOVA) and Tukey’S HSD test for multiple comparisons between and within groups. For all statistical analyses, the significant level of @ 5% (0.05) was used. The equipments used in this study are listed in table (Table 2).

Table 2 - List Of Equipments

No	Materials
1	Brass Mould
2	Vernier Calliper
3	Artificial Saliva
4	LED Light
5	Universal Testing Machine (Tinius Olsen L Series)
6	Durometer Hardness Tester (Shore D)

Result: The Hardness and Flexural strength of specimens were evaluated after removing it from incubator after 10 days. Hardness testing was done using Durometer hardness tester (Shore D) according to ASTM-D2240 (American Standards of Testing and Materials). Three measurements for indentation hardness were done on each specimens and their average value was recorded.

The mean values with standard error of the Hardness (Shore D) of the materials ranged has been noted between 84.41 ± 0.23 (for light cure) to 96.29 ± 0.11 (for dual cure).The tables below showed one way analysis result and it has been found most significant difference in the hardness between three materials is 0.00 (P value)



After hardness test flexural strength was measured, each specimen was subjected to a 3- point bending test, using a universal testing apparatus (Tinius Olsen L Series H50KL,England). The load ware applied to the center of the specimen. The loading was begin at 0 N and was continued till fracture occurs. The load at

which fracture occurs was recorded in N and was termed the breaking. The mean values with standard error of the Flexural strength of the materials ranged has been noted between 27.47 ± 0.46 (for Light cure) to 45.66 ± 0.21 (for material Self cure). The tables below showed one way analysis result and it has been found most significant difference in the flexural strength between three materials is 0.00 (p value).

Discussion: Provisional restorations in fixed prosthodontic rehabilitation are important treatment procedures, particularly if the restorations are expected to function for extended period of time or when additional therapy is required before completion of the rehabilitation. These materials should not only satisfy the mechanical requirements such as strength and resistance to wear but also to meet the biologic and esthetic demands. Various materials are available for the fabrication of provisional restoration but till date none have proven to be the most accurate and stable. Every material has its own merits and demerits that could be attributable to numerous factors.

This study is taken up with the aim of evaluating and compare the Hardness and Flexural strength of commercially available composite (Bis-Acryl) resin provisional restorative materials. Both the properties are important for the long term temporization in Prosthodontics hence both the properties is studied in this research.²⁸

Autopolymerizing polymethyl methacrylate first appeared around 1940 and remains the most frequently used material for fabrication of interim restorations. These have the advantages of good wear resistance, good colour stability, high polish ability, and good esthetics. Although this material meet most of the requirement and is popular even today, its use is on decline because of their disadvantages and development of new and improved materials. The disadvantage of PMMA have been identified as high level of monomer release, exothermic reaction and polymerization shrinkage.²⁸

The visible Light polymerized (VLC) material was first introduced in the 1980s and contained urethane dimethacrylate, a resin whose polymerization is catalyzed by visible light and camphoroquinone as initiator. UDMA usually incorporate filler such as microfine silica to improve physical properties like reduced polymerization shrinkage. Unlike

methacrylate resins they do not produce residual free monomer after polymerization, which explain why they exhibit decreased tissue toxicity. Haddix JE indicated that VLC materials could produce provisional restorations with a similar quality but with less time and expense.²⁸

Nejatidanesh F et al. evaluated the flexural strength of 7 interim materials, and they found that bis-acryl provisional restorative materials exhibited higher flexural strength than the methacrylate resins.²⁶

Dymus ZY et al. evaluated the flexural strength of provisional crown and fixed partial denture both with and without reinforced fiber, and suggested that the use of fibers is an effective method of increasing flexural strength of provisional restoration resin.²⁴

Poonacha et al. compared the flexural strength and elastic modulus of three provisional materials. They concluded that the flexural strength of methacrylate resin reduced significantly; while bis-acrylic composite resins showed a significant increase in its flexural strength after being stored in artificial saliva for 24 hours.²⁹

Ireland & Dixon tested the modulus of rupture (flexural strength) of four provisional material and found Bis-acryl to have the higher flexural strength. Osman et al. showed that methyl methacrylate provisional materials had higher flexural strength than a composite material. Wang et al stated that no significant differences were found between methyl methacrylate and composite provisional materials tested. From the previous studies, there was no proper conclusion that which material has higher flexural strength and hardness than other.⁷

Present study selected three commercially available Bis-acryl composite restorative materials, of three materials Revotek LC is visible-light cure composite provisional restorative material which consists of Urethane Dimethacrylate (UDMA), Tempspn is dual cure bis-acryl composite provisional restoration material which consists of Mixture of polyfunctional methacrylate resins and Urethane Dimethacrylate (UDMA), and Integrity is auto-polymerized bis-acryl composite resin which consist of Urethane Dimethacrylate (UDMA). All selected materials consist Urethane Dimethacrylate (UDMA) but only difference in their curing system.

In the present study hardness and flexural strength were tested. Based on this study the mean values of the Hardness (Shore D) of the materials ranged has been noted between 84.41 ± 0.23 (for Light cure) to 96.29 ± 0.11 (for Dual Cure) and for flexural strength mean value of the materials ranged between 27.47 ± 0.46 (for Light Cure) to 45.66 ± 0.21 (for Self Cure).

So, this study showed statistically most significant difference between three materials. In this Study Dual Cure showed highest Hardness (Shore D) value and Light Cure showed lowest Hardness (Shore D) value, and for flexural strength Self Cure showed highest value and Light Cure showed lowest value. Hence, Light Cure showed lowest value for Hardness (Shore D) and for Flexural strength too.

Differences in flexural strength and hardness of methacrylate base and bis-acry resins is due to different monomer compositions. Multifunctional monomers of bis-acry resins increase the strength of a resin as a result of cross-linking with other monomers. Additional inorganic fillers of these materials can also improve the strength and hardness.³⁴

Conclusion: Within the limitation of the present study, it can be concluded that bis-acryl interim materials present highest Hardness and flexural strength than methacrylate based resins. Therefore, application of bis-acryl in the patient with heavy occlusion can be considered. It seems that these provisional restoration might work in long-term use.

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