“COMPARISON OF MATERIAL PROPERTIES USED FOR INTERIM PROSTHESIS IN FIXED DENTAL PROSTHESIS”-AN INVITRO STUDY

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CONTENTS

INTRODUCTION

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The significance of the provisional (treatment) restoration among the procedures required for successful completion of a fixed partial denture is often overlooked. Perhaps the inaccurate assignment of the term “temporary” to the interim restoration has generated the misconception that, eventual placement of the permanent restoration will immediately and miraculously remedy the detrimental effects of a poorly conceived and fabricated transitional restoration. The treatment with provisional restorations is an integral part of restorative treatment procedures with fixed prosthetic restorations i.e. crowns and bridges.

Provisional has to fulfill important functions within the timeframe between preparation of a tooth and until fitting respectively luting of the final fixed metal or ceramic restoration. A well-made provisional fixed partial denture should provide a preview of the future prosthesis and enhance the health of the abutments and periodontium. The provisional restoration is often intended for diagnostic and therapeutic purposes, being a test structure where all the necessary functional, occlusal, and esthetic adjustments can be carried out to optimize incorporation of the definitive prosthesis. This is subsequently made on the basis of the information recorded from the provisional restoration, whose occlusal surface is made of resin and can be shaped and carved in accordance with the patient’s stomatognathic dynamics.

Several studies revealed that provisional’s with extended period in the oral cavity, which could be several months, is required to meet the above needs. Provisional restorations play an important role in restoring interim esthetics, provide pulpal protection by covering the prepared tooth structure, preserve occlusal and

arch relationships, prevent migration of abutments, allow evaluation of vertical dimension, aid in developing and also evaluating occlusal scheme, provide comfort, function and maintain periodontal health while, the final restoration is being made. They also help to gain patient's confidence and have favorable influence on the ultimate success of the final restoration.

A satisfactory temporary restoration can be made from auto polymerizing acrylic resin. However, the placement of unpolymerized acrylic resins on dentin and the gingivae may lead to thermal irritation from the exothermic polymerization reaction to the resin or chemical irritation from free or residual monomer. To combine reduced tissue toxicity and thermal irritation of the conventional resin systems with the ease of processing acrylic resins, new interim restorative materials that contains no methyl methacrylate has been introduced like

Visble light cure resin, bis-acrylic composite resins &visible and chemical cure (Dual cure) resins. The requirements for satisfactory provisional restorations differ only slightly from definitive crowns and fixed partial dentures (FPDs). Nevertheless, the fabrication time should be short and the time of use be limited from a few weeks to 6 months.

Research on temporary restorations is almost never performed in vivo. Controlled prospective clinical trials on temporary crowns and FPDs do not exist in the dental literature. Provisional fixed partial dentures (FPDs) are an important part of many prosthodontic treatment procedures. These provisional fixed prostheses must fulfill biologic, mechanical, and esthetic requirements to be considered successful. Resistance to functional loads and removal forces are "mechanical factors" that must be considered when, choosing a provisional restorative material for clinical use. Consideration of all these factors and requirements are important

because provisional resin restorations may be worn over a long period to assess the results of periodontal and endodontic therapies, and also during the restorative phase of implant restorative and reconstructive procedures.

Investigators have studied factors that contribute to the mechanical requirements of provisional restorative materials. For instance, mechanical properties of provisional resins have been assessed, and in these in -vitro studies, valuable information has been presented regarding the strength of various materials. Because provisional restorative materials are subjected to masticatory forces, an understanding of the mechanical properties of these materials is important in determining whether, the restoration will be able to survive repeated functional forces.

AIMS & OBJECTIVES

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The objectives of this study were

To find out the Flexural strength, compressive strength,microhardness,colour stability and polymerization shrinkage of three provisional materials namely,

1.**REVOTEC LC**

2.PROTEMP 4

3.**TEMSPAN**

This study was done with following aims and objectives..

- To evaluate the flexural strength values of three different provisional composite restorative materials.
- To evaluate the compressive strength of three different provisional composite restorative materials .
- To evaluate the color stability of three different provisional composite restorative materials at different immersion periods in a standardized coffee solution.
- To evaluate the change in micro hardness of three different provisional composite restorative materials at different immersion periods
- To evaluate the polymerization shrinkage of three different provisional composite restorative materials at different time intervals.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

David R Fredrick[27] (1975) , discussed the rationale and requirements of the provisional restoration in fixed prosthetic dentistry. The importance of this phase of restorative dentistry and a survey of techniques for making interim restorations were gleaned from a review of the literature. A method for the fabrication of a provisional fixed partial denture using an acrylic resin block is described. The technique provides a means of fabricating the interim restoration without the use of diagnostic casts and laboratory processing casts.

M.D. Gross[40] (1977) carried on colorimetric measurements on four composite resins before and after controlled immersion treatments. Solutions used for immersion were distilled water as a control, solution of distilled water and tea, and solution of distilled water and coffee. Specimens were immersed in three separate solutions at 55°C for 12 days. Of all the materials coffee produced greater color changes than the other two solutions.

Cathy Ameye[17] (1981) studied the possible color and marginal differences between the clinical behavior of restorative resins. Two conventional and three micro-filled resins were inserted in the patient and evaluated after 6 month, one and a half years. The loss of color stability and marginal adaptation were directly proportional to the clinical age, micro-filled resins were found to be more color stable.

Janet G. Bauer[47] (1983), Evaluated surface roughness, porosity, and striation formatios in composite restorations. The study concluded that the composite resin instrument moistened with alcohol gave the poorest surface finish. The best surface finish was obtained with the compound index with mylar and

Raformer techniques.The remaining techniques gave intermediate surface finishes. The compound index with affixed sheath material technique produced the poorest of these surfaces.The finish produced by the compound index with affixed sheath material, the composite resin instrument, and the composite resin instrument moistened with alcohol may be undesirable.

Yukimasa Hachiya[100] (1984) studied the influence of various polising systems on color stability of composite resins. Two different composite resins were evaluated for this study.After polymerization, finishing and polishing were performed at 15 minutes and 48 hours. Finishing was done with jet finishing carbide burs, carborundum points no 20 and white point. The polishing agents were silicon points brown and silicon point blue in an electrical engine. Silicon cup blue produced least susceptible discoloration, when compared to other systems.

Anthony G.Gegauff and Pryor HG[9] (1987) the purpose of this study was to evaluate the fracture-resistance of six provisional restoration materials polymerized at atmospheric pressure and in a pressure pot. It was found that the fracture resistance of the epimine and two PMMA > composite > PR'MA resins. Pressure curing, although reduced the internal porosity, did not significantly increase the fracture toughness of the six resins.

Antony H.L. Tjan[10] (1987) The purpose of this study was to compare quantitatively the marginal adaptation of temporary crowns made from recently introduced Bis-GMA composite with those made from epimine plastic, ethyl-methacrylate and vinylethylmethacrylate. Protemp,Trim and provisional materials produced temporary crowns of comparable accuracy. Crowns made from Scutan material had open margins.

Catherine J. Binkley[18] (1987) This article describes a method of making reinforced heat-processed acrylic resin provisional restorations. A base framework is waxed, cast and opaqued. The framework is incorporated in the body resin during processing and incisal resin is added to improve esthetics.

Khan Z, R. Razavi[55] (1988), This study compared the mechanical properties and surface characteristics of the Triad VLC fixed partial denture material with those of a conventional methyl methacrylate fixed partial denture material. Triad VLC material was found to have similar mechanical properties but wear and abrasion resistance superior to an acrylic resin temporary crown and fixed partial denture material.

Stephen F. Rosenstiel[89] (1988) In this study, the effects of various cementing agents on the hardness of commercially available provisional resins were measured.ZOE had a statistically significant softening effect. Softening effect was more pronounced on Snap and Trim which are Poly R methacrylate resins. It was less so on alike and Jet (PMMA) and on Protemp(Bis GMA).

Wang RL[96] (1989) the purpose of this study was to compare four acrylic resins and two composite resins for fabricating provisional fixed restorations. The comparative tests performed were: temperature change, surface hardness, transverse repair strength, surface roughness and polishability, Color stability and stain resistance. In comparing various provisional fixed restoration materials, no one material was superior to the others although some had advantageous properties in one or more of the tests.

Rees J.H, P.H. Jacobsen[74] (1989), The purpose of this study was to adapt the Dilatometer method for external-energy-cured composites for determining volumetric polymerization shrinkage. Six materials were investigated: Aurafill, Silar, Concise, Heliomolar, P-30, and Occlusin. Measurements were taken over one hour, and results ranged from 0.9 to.24 volume percent.The method not only avoids the use of mercury, but also requires no expensive electronic monitoring equipment. The method was found to be simple and accurate, and was concluded to be ideally suited to measure polymerization shrinkage of externally activated materials.

Jack H. Koumjian, Arthur Nimmo[43] (1990) Conducted a study to evaluate the transverse strengths of provisional resins under varied conditions. Uniform samples were made from seven resins and tested immediately after the set of the material, after 7 days of dry storage, and after 7 days of wet storage. The fractured samples from the 7-day wet storage group were repaired with the same provisional material and the sample was made from and fractured again to determine transverse strength for repaired samples. Five of the resins tested demonstrated statistically similar strength in the 7-day wet group. Two were found to be significantly weaker. Absorption of water resulted in a slight, but insignificant decrease in strength. Transverse strengths varied widely in the repaired group, and all materials showed a statistically significant reduction compared with the 7-day wet storage group.

Koumjian HJ, Firtell ND et all,[45] (1991) studies the color stability of seven provisional materials in vivo. Patients selected for the study were totally edentulous and complete denture wearers. The sample disks were prepared and one of each material was placed in the facial flange of each side of maxillary denture and lingual flange of mandibular denture. The observation of the color change was made at 1, 5 and 9 weeks. No change was detected at the first two evaluations. At the 9 week

evaluation, four materials showed significantly less staining than did the other three resins tested. It was also concluded that all materials showed some degree of stain at the 9 week evaluation.

Jerald Blum, Saul Weiner[48] (1991) Studies of intracoronal resinous restorations have demonstrated marginal changes resulting from thermal gradients, but extracoronal provisional crowns differ in design and use. This study examined the effects of thermo cycling on the margins of poly methyl methacrylate resin crowns.Cold thermocycling resulted in only limited deterioration, but the changes after hot thermocycling was more pronounced. Tooth preparation designs did not influence the effect of thermocycling.

Donna L. Dixon, Karl G. Ekstrand, Larry C. Breeding[32] (1992) ten specimens each of (1) Lucitone 199, short-and long-cured, (2) Accelar 20, and (3) Traid materials were broken using a 3-point load on an Instron Universal testing machine after processing and air drying. Five specimens of each resin also were broken after storage in deionized distilled water at 37° C for 30, 60 and 90 days. Triad material demonstrated the lowest transverse strengths of all three materials overall. However, Triad material was unaffected by water storage. The other resins all showed decreased strengths with water storage.

Douglass B.Roberts[34] (1992) This article describes a procedure for making indirect interim restorations from a cast and dies made of PVS impression marerial. The use of these flexible casts and dies facilitates the removal of the polymerized resin from the cast and the rapid set of the polyvinyl materials reduce the time involved in making the indirect interim restorations.

Timothy M.Campbell[93] (1992) A die made from vinyl polysiloxane is a great aid for making interim restorations and for establishing correct gingival contours for finer restorations. This article describes the rationale and procedures for such a procedure.

Y.I. Osman, C.P. Owen[101] (1993) this study tested five auto polymerizing provisional resin materials under conditions that related the stresses acting on them to those acting on a fixed partial denture. The highest values for fracture resistance were displayed by Snap poly (ethyl methacrylate) material. However the fracture resistance of the other materials in decresing order was as follows: the poly (methyl methacrylate) materials, Caulk temporary bridge resin and G-C Unifast temporary resin; the composite material, Protemp; and the Epimine material, Scutan.

Chung-Ming Hung[20] (1993) This in vitro study suggested that significant changes occurred at the margins of acrylic resin provisional crowns after thermocycling and occlusal loading. These alterations included widening of the marginal gap with a loss of cementation at the crown-die interface and modifications in axial dimension. However, this experimental model possesses certain limitations in regard to simulation of the oral environment. Thermocycling and occlusal loading of provisional acrylic resin crowns in an artificial oral environment resulted in significantly enlarged marginal gaps and changes in axial contour.

Abdul-Haq Suliman[1] (1994) Polymerizntion shrinkage of two posterior composite resin restorative materials was measured by dilatometry. The results were compared with a decrease in cavity width of MOD preparations in extracted premolar restored with the composite resins. A highly filled hybrid composite exhibited greater free shrinkage cuspal deformation than a hybrid composite with a lower filler content. Hydrated teeth exhibited less deformation than dehydrated teeth

because of polymerization shrinkage. Greater cuspal deformations were measured with the technique than with interferometry because of differences in experimental design.

Didier Dietschi , Gaetano Campanile et all,[31] (1994)

They evaluated the color stability of 10 brands of modern light-cured composites including hybrids, microfine hybrids and microfilled when subjected, to various physiochemical and staining conditions such as thermo cycling, post curing, polishing or immersion in saline, prior to staining with E110 food dye, vinegar and erythrosine. According to CIE L*a*b* system calorimetric evaluation was performed after one and three weeks. Among the colorants, erythrosine caused the maximum discolouration, polishing caused less discoloration, signifying the resistance of modern composites to discoloration because of improved structure and manipulation.

Doray GP, Wang X, Powers MJ, Burgess O.J.[33] (1997)

The color stability of two shades each of five acrylic resin and seven resin composite provisional restorative materials was evaluated by reflection spectrophotometry following in vitro accelerated aging.Aging was done in an artificial aging chamber with exposure to a total ultraviolet irradiation of 60 kJ/m2. Color was measured by CIE L*a*b* on a reflection spectrophotometer before and after aging. Color change was calculated and analyzed statistically.It was concluded from the measurements that four out of five types of acrylic resin materials and five out of seven resin composite provisional materials changed color significantly and perceptibly when exposed to invitro accelerated aging conditions.

Robinson GF, Haywood BV, Myers M[76] (1997), They evaluated five commercially available provisional restoration materials and polycarbonate crowns in vitro by placing them in five different bleaching agents that contained 10 percent Carbamide peroxide. Specimens were analysed after 14 consecutive days of simulated NGVB(night guard vital bleaching) treatment and made the following conclusions, that all bleaching solution that contained 10% carbamide peroxide discolored all methacrylate provisional restoration materials, regardless of the base material of the bleaching agent. The bisacryl composite resin and the Polycarbonate crown were not discolored by any of the bleaching agent used.

Anthony H. L. Tjan,[8] (1997) This in vitro study compared vertical discrepancies of margins for complete crowns made with six provisional materials (Provipont, Protemp Garant, Unifast LC, Triad VLC, Splintline, and ~et). A direct technique was used to fabricate 60 provisional complete crowns on prepared molars. A measuring microscope was used to measure vertical marginal discrepancies at ×100. This study indicated that provisional crowns fabricated with Splintline and Protemp Garant interim restorative materials recorded the least marginal discrepancies.

Robert Scotti, Mascellani CS, Forniti F.[75] (1997) did an in vitro study in order to know the color stability of acrylic resins for provisional restorations. Four types of acrylic resins having different composition i.e. Vinyl Ethyl Poly methyl methacrylate, Diacrylic, bisacryl methacrylate esters and Methyl Poly methyl methacrylate were chosen for the study. The staining solutions used were synthetic saliva, synthetic saliva and tea, synthetic saliva and coffee, synthetic saliva and 0.125 Chlorhexidine solution.. Following immersion in the staining solution color measurements were made at 20 days and 30 days. All specimens were analyzed

using a spectrophotometer. It was found that polymethyl methacrylates was color stable in all staining solutions, while the others showed color changes in different staining solutions. It was also noted that color instability was found to be less in artificial saliva and in combination of artificial saliva and tea than the other two solutions.

Kazumoto Hoshiai, Tanaka Y, Hiranuma K[53] (1998) compared a new auto curing temporary acrylic resin (Unifast II) with four temporary restorative materials in terms of color and dimensional accuracy. Five specimens measuring 50mm in diameter and 4mm thick were prepared for each material using a mold. Baseline color measurement was done for the specimens using a CIELAB uniform color scale. After this the specimens were preserved in three conditions i.e. 23ºC in air, 37ºC in water and 60ºC in air. After two weeks color measurement was done again. Five specimens of each material were fabricated for comparing the dimensional accuracy and transverse strength and modulus. For measuring dimensional accuracy a microscope was used and for measuring transverse strength and modulus. Instron Universal Testing Machine was used. It was found that Unifast II showed better color stability and dimensional stability and had no significant transverse strength difference from two of the other materials being compared and had no significant transverse modulus difference from three of the other materials being compared.

Hirobumi Uchida and Jayalaxmi[42] (1998) did a study to provide the insight into the quantitive color changes that take place during the overall discoloration for this study. 5 shades of composites were subjected to ultraviolet light exposure at 37ºC for 24 hours after initial storage. The lightness and chromaticity values of color were measured both before and after ultraviolet light

exposure with a Minolta Chromameter. The total color change as well as changes in the lightness and chromacity values were measured in the CIE L*a*b* scale and analyzed to monitor color degradation. It was concluded that lighter shades of composition were likely to be subjected to higher color degradation through environmental effects of ultraviolet light exposure.

Michele F, Ireland[61] (1998) this study recorded and compared the flexural elastic moduli and moduli of rupture of four materials used to make provisional restorations. Samples underwent a standard 3 point bend test on an Instron universal testing machine at a crosshead speed of 0.5cm / minute. Stress strain curves were generated, and the values for flexural elastic moduli and moduli of rupture were calculated. Provipoint DC resin exhibited the significantly highest elastic **modulus** and modulus of rupture values at the 24 hour test time. The Provipoint DC resin exhibited the greatest decrease in flexural elastic modulus and modulus of rupture values over time. Triad demonstrated the highest modulus of rupture, except for the modulus of rupture demonstrated by the Provipoint resin at 24 hours. Triad also exhibited no difference in modulus of rupture among three test times.

Scott R Okubo[82] (1998) this study was evaluated to compare the ability of a new computerized colorimeter and a simple visual test to match ceramic shade guide teeth. Observers with normal color vision were allowed unlimited time to match one set of vita lumin shade guide teeth to the corresponding shade guide teeth of a second vita lumin shade guide. The same test was administered to 14 of the observers several months later to determine subject variability. Computerized colorimeter equipped with a positioning guide was used to measure the middle third of each shade guide tooth. Colotron II instrument correctly matched 8 of the 16 tabs (50% correct) where as visual matching by examiners averaged 7.7 of 16 correct

matches (48% correct) the authors concluded that shade determination by visual means was inconsistent. Accuracy of a new colorimeter in matching porcelain shade guide teeth was only slightly better.

Yannikakis AS, Zissis JA, Polyzois LG[99] (1998) studied the color stability of provisional resin restorative materials. The materials used were a heat cured polymethyl methacrylate material, two dual cured (chemically-light) composite based resins, chemically cured, a bisacryl composite based resins, and two chemically cured polymethyl methacrylate resin. Two staining solutions in the form of tea and coffee were used in the study. Heat cured polymethyl methacrylate and chemically cured polymethyl methacrylate displayed the best color stability over the 3 immersion periods and among both the solutions. Bisacryl composite resins resulted in intermediate staining. It was also found that coffee solution exhibited more staining capacity that the tea solutions.

Paolo Baldissara[66] (1998) This in vitro study evaluated the marginal microleakage of 4 provisional cements, a cavity base compound and a zinc-phosphate luting cement in provisional acrylic resin crowns fixed on extracted human teeth. A high dye penetration in the tooth/cement interface was present in all 4 provisional cements. Microleakage existed in specimens where zinc-phosphate and cavity base compounds were used; however, it was lower than the other materials. A significant difference ($P<.05$) was found between zinc-phosphate and one eugenol-free cement and between cavity base and the same eugenol-free cement. All materials tested demonstrated different degrees of microleakage. Zinc-phosphate and cavity base compound cements had the best sealing properties. This latter, even if conceived as a cavity base, may be considered a good provisional cement as far as microleakage is concerned.

Kawara. M, O. Komiyama, S. Kimoto[52] (1998) There have been many reports on fatal distortion of heat-activated acrylic denture-base resin which is still widelyused in the field of removable prosthodontics. However, these reports have failed to report quantitatively on polymerization and thermal shrinkage factors. In the present study, attempts were made to verify that the shrinkage of heat activated acrylic denture-base resin was caused mainly by thermal contraction after processing.

Daniel Galindo[26] (1998) Extensive prosthodontic treatment often requires fabrication of long term provisional restorations. Numerous materials and techniques have been described for prolonged insertion of interim restorations. This article describes a procedure for fabrication of long term reinforced heat processed provisional restorations based on a diagnostic wax up.

P.K. Vallittu[69] (1998) studied the load required to fracture a three-unit provisional fixed partial denture restoration, which had been reinforced with an experimental glass fiber reinforcement. Provisional fixed partial dentures were fabricated from a resin of poly ethyl methacrylate powder and n-butyl methacrylate liquid. The fixed partial dentures in the control group were unreinforced. In the other groups, the fixed partial dentures were reinforced either with one, two, or three unidirectional glass fiber reinforcements and one glass fiber weave reinforcement. The load was applied to the fixed partial dentures by a steel ball placed in the cavity in the middle fossa of the pontic tooth. It was found that the unidirectional reinforcements were positioned on the side of the occlusal surface of the fixed partial denture, namely, the side of compression during loading. The results suggest that, even though the glass fiber reinforcements were positioned on the least favorable side of the fixed partial.

Shahram Emtiaz, Dennis P. Tarnow[86] (1998) This article describes a modification of the design of a cast metal reinforced acrylic resin provisional restoration for extensive, long term reconstruction with implants, because some of the treatments rendered to patients require temporization for upto 2 years.

Kenneth G. Boberick[54] (1999) Efficient fabrication of a clinically acceptable provisional restoration for a fixed partial denture is an important part of treatment success. Fabrication of provisional restorations that uses the indirect technique produces accurate fitting provisional restorations without the chemical and thermal irritation associated with direct fabrication. With a typodont model, an indirect method is presented that uses an elastic cast for fabrication of multiple unit provisional restorations for fixed partial dentures. The cast is available within 6 minutes of impression making, can be trimmed with a sharp scalpel, and provides flexibility that allows easy separation of the acrylic provisional from the cast. The cast can also be used to evaluate the clinical acceptability of the preparations before impression making. This method has also been successfully used for the fabrication of acrylic provisional restorations for onlay preparations.

Ana M.Diaz-Arnold[7] (1999) evaluated the microhardness of 5 prosthodontic provisional materials. Cylindrical samples were wet sand dried through 600 grit abrasive and stored in artificial saliva for 37ºC for a total of 14 days. Baseline Knoop hardness (KHN) was measured 24 hours after specimen fabrication. 3 microhardness measurements were obtained from each specimen. Knoop hardness was again recorded after 14 days of storage. It was found that the hardness of most materials (Integrity, Protemp Garant and Jet) decreased over time. All of the Bis-acrylic composite materials exhibited superior microhardness over traditional methyl methacrylate (Jet, Temporary Bridge) resins.

Xavier Lepe[98] (1999) This study evaluated the retention of provisional restorations made with 2 materials and cemented with 4 temporary cements. material. Recently extracted molars were prepared with a flat occlusal surface, 4-mm axial length and 20-degree angle of convergence. Specimens were distributed into equivalent groups. Provisional crowns were constructed for each preparation with polymethyl methacrylate (Temporary Bridge Resin) or bis-acrylic composite (Protemp Garant) and later cemented with Temp-Bond, Temp-Bond NE, Temrex, and an experimental calcium hydroxide temporary cement. A second group with Temrex was evaluated using half the recommended liquid. A cementing force of 2.5 kg for 5 minutes was used. After initial bench set followed by 24 hours in room temperature water, the crowns were removed with an Instron mechanical testing machine at 0.5 mm/min.

A 2-factor ANOVA was used with a=.05 (n = 10). Mode of debonding was analyzed with a nonparametric chi-square test of association.To conclude the polymethyl methacrylate crowns were 19.3% more retentive than the composite crowns .There was nostatistically significant difference among the 4 temporary cements when the manufacturer's mixing instructions were followed (P=.186). However, the thicker consistency Temrex was more retentive than the recommended Temrex mix and Temp-Bond.

Naomi Tanoue[64] (1999) His study examined properties of a prosthetic veneering composite polymerized with 3 polymerizing systems to evaluate the effects of varying polymerization modes on hardness, solubility, and depth of cure. A composite material designed for a prosthetic veneer (Conquest Crown and Bridge) was polymerized using 3 methods: (1) exposure in the proprietary photopolymerizing unit with 2 halogen lamps (Cure-Lite Plus), followed by heating

in an oven (Conquest Automatic Curing Unit); (2) exposure in a photopolymerizing unit with a xenon stroboscopic light source (Dentacolor XS); and (3) exposure in a photopolymerizing unit with 2 metal halide lamps (Hyper LII). Knoop hardness, water solubility, and depth of cure were determined for groups of 5 specimens, according to standardized testing methods. Data were compared using analysis of variance and the Duncan new multiple range test.

Denture in terms of the physical properties of the materials, these reinforcements considerably increased the fracture resistance of the provisional fixed partial denture.

Pekka K. Vallittu[68] (1999) conducted a study to describe and test a novel system to use polymer-preimpregnated reinforcing fibres with commonly used multiphase acrylic resins. Continuous unidirectional and woven preimpregnated glass fibre reinforcements (stick and stick net) were used to reinforce heat curing denture base and auto polymerizing denture base polymers temporary fixed denture base polymer was also reinforced with stick reinforcement material. 5 test specimens were fabricated for unreinforced control groups and for stick and stick net reinforced groups. 3 point loading test was used to measure transverse strength and flexural modulus of the materials and ultimate strain at fracture was calculated. Cross sections of the specimens were examined with a SEM to evaluate degree of impregnation of fibres with polymer matrix. Stick net reinforcement increased the strain at fracture, where as stick reinforcement decreased the stain values. Novel glass fiber reinforcements may considerably enhance flexural properties of multiphase dental polymers, which is due to proper impregnation of fibres with polymer matrix. By using stick or stick net reinforcement, the strain at fracture of the material can be modified.

Joseph B. Dennison[49] (2000) conducted a study to investigate the effect of sequentially increasing light intensity on the polymerization shrinkage of 2 composites, a hybrid and a micro fill. Knoop hardness test was used to evaluate effectivenss of the cure with each intensity increase. 4 groups of 12 samples were measured for polymerization shrinkage by using a linometer. The authors concluded that curing composites for 10 seconds at 25% intensity, 10 seconds at 50% and 20 seconds at 100% significantly reduced polymerization shrinkage while not compromising depth of cure.

David S. Ehrenberg[25] (2000) Resin materials used for provisional crowns tend to develop enlarged marginal gaps over time. With the advent of new interim resin materials in dentistry that are used for longer clinical periods,controlled comparative analysis of the structural stability of these materials in the oral environment is required**..** This study analyzed marginal gap size changes resulting from occlusal loading and thermal cycling and related these results to material properties. There were significant differences between different brands of resin materials used for provisional crowns. Each must be evaluated individually for stability in the oral environment.

Ralph Gunner Luthardt[71] (2000) compared the handling, fitting, plaque adherence, gingivitis, color stability and subjective assessment of the provisional materials by the patient and the dentist for two auto polymerizing (Protemp, Luxatemp), I dual-curing (Provipoint), and one light initiated (triad-VLC)material for the manufacturing of temporary crowns and fixed partial dentures. They found that the advantageous mechanical properties of the light-curing and dual curing materials were clinically offset by disadvantages in handling.

Doray GP, Li D, Powers MJ[34] (2001) studied the color stability of provisional restorative materials after accelerated aging. Eleven provisional restorative materials, consisting of 4 acrylic resin and 7 resin composites were evaluated in the study. Baseline color measurements before aging were made on a reflection spectrophotometer. After making baseline color measurements, specimens were aged in an accelerated aging machine by exposure to a filtered xenon are at an irrandiance of 0.55 W/m ² /nm at 340nm. Color of specimens was measured after each aging interval using the reflection spectrophotometer. The results showed that seven of the eleven materials tested had perceptible color changes after accelerated aging of 60kj/m ². Six of the materials with perceptible color change were resin composites, and four of these resin composites had more severe clinically unacceptable color change. Only one of the material with perceptible color change was an acrylic resin.

Jacob John MDS, Shivaputrappa A[46] (2001) the purpose of this invitro study was to determine whether the flexural strength of commercially, available heat polymerized acrylic denture base material could be improved through reinforcement with 3 types of fibres, reinforced with glass, aramid or nylon fibres. The results were analyzed with l-way analysis of variance. All the reinforced specimens showed better flexural strength than the conventional acrylic resin. Specimens reinforced with glass showed the highest flexural strength followed by aramid and nylon.

Stober T, Gilde H, Len P[90] (2001) examined the color stability of seven resin based facing composite with a high content of inorganic filling material. Changes in color of test sample were determined after UV irradiation in a fast action UV instrument, sun set CPST, and after storage in a mouth rinse, tea, coffee, red

wine and a 0.1% turmeric solution. Color testing was done using a castor colorimeter. It was found that red wine and turmeric solution caused the most severe cases of discoloration. Tea, coffee, mouth rinse and UV irradiation caused invisible, or visible and to some extent clinically unacceptable.

Henry M. Young[41] (2001) Provisional crowns traditionally have been associated with problems such as poor occlusion, contour, fit, and finish. Fabrication procedures should be uncomplicated and predictable within a realistic time frame. The purpose of this study was to compare the quality of provisional restorations fabricated by dental students from 2 different materials (bis-acryl composite resin and PMMA) and identify the advantages and disadvantages associated with each material. Bis-acryl composite resin (Integrity) was significantly superior to PMMA (C&B Resin and Snap) as a provisional restorative material.

Debra R. Haselton[28] (2002) compared the flexural strength of 5 methacrylate-based resins and 8 Bis-acryl resins used to fabricate provisional crowns and fixed partial dentures. It was concluded that within the limitations of the study, flexural strengths were material than category-specific. Some, but not all, bi-acryl resins demonstrated significantly superior flexural strength over traditional methacrylate resins.

Wolfgang Buchalla[97] (2002) studied and evaluated the color and translucency changes in a hybrid and microfilled composite after light exposure with and without water storage. Tristimulus values were determined calorimetrically and suggested that the resin based restorative materials undergo measurable changes due to daylight exposure and the changes varied under the influence of water storage.

David R. Burns[24] (2003) The topic of provisional fixed prosthodontic treatment involves a multifaceted array of clinical activities, special knowledge, material selection, and management.Contemporary treatment incorporates both natural teeth and dental implants. This literature review provides a comprehensive summary of published reports on this topic. It characterizes clinical methods and provides clinicians with an understanding of the nature of materials used with this clinical activity. Dentistry continues to struggle with the limitations of existing materials available for fixed prosthodontic provisional treatment. Clinical techniques and indications are reasonably well characterized, but future research activities will need to focus on technological advancements to provide improved materials that demonstrate improved biocompatibility, ease of use and modification, and physical properties.

Musanje L, B.W. Darvell[63] (2003) the purpose of this study was primarily to establish whether artificial saliva at 37ºC is essential as a clinically relevant environment for testing filled, resin composite materials. The effect of other storage conditions was also investigated for comparisons and controls: desiccation, exposure to laboratory atmosphere, high humidity cabinet, saturated water vapor, and deionized water. Leaching appears to go at a greater rate in artificial saliva than in deiodinized water, although the effects on mechanical properties are not yet clear. On balance immediate immersion in artificial saliva at 37ºC is the preferred treatment for these materials, whatever time of testing is chosen, on the basis of risk of effects.

Schulze AK, Marshall JS, Ganksy AS, Marshall WG[81] (2003) conducted a study to investigate the color stability and microhardness of five chemically and five light curing composites as a function of accelerated aging from light exposure. It was found that each material showed a significant increase in hardness after aging treatment. No significant difference was found between the hardness changes in light cured and chemically cured materials. A significant correlation between hardness values and color changes could not be established. It was concluded that light curable materials may be more esthetically acceptable.

Senay Canny[83] (2003) compared the effect of current bleaching agents (10% carbamide peroxide and 10% hydrogen peroxide) on the color of light polymerized hybrid, macrofilled and polyacid-modified composites. Two-light-polymerized bybrid composites, one microfilled and 2 polyacid-modified composites were used and hybrid composited were the controls. The color of eight specimens were analyzed by the use of spectrometer before and after immersion in bleaching agents for eight hours each for fourteen days and were determined for each material and compared by the use of Kruskal-Wallis test, followed by the Mann-Whitney U test (P. <. 05). In comparison to 10% carbamide peroxide, 10% hydrogen peroxide caused more color changes in the composites tested.

Susanne S, Scherrer[91] (2003) the purpose of their study was to compare the flexural strength and the resistance to fatigue loading of composites and an acrylic resin for provisional and definitive restorations. 3 composites and 5 provisional restorations were subjected to mechanical tests and fatigue tests were conducted with the rotating-bending cantilever design. Monotonic flexural strength was determined in 3 point bending tests. Correlations between monotonic flexural strengthened resistance of fatigue loading were weak. Because fatigue tests are

considered more pertinent than monotonic tests as their predictive value, it is concluded that flexure strength data alone may not provide relevant information for long-term clinical performance. The materials resistance to fatigue loading should also be determined.

Sham KSA, Chu SCF, Chai J, Chow WT[87] (2004) measured the color stability of five provisional prosthodontic materials. Three different kinds of materials namely polyethyl methacrylate resins, polymethyl methacrylate resin and bisacryl methacrylate resin were tested for their color stability after dipping in distilled water and coffee for twenty days and after exposure to ultraviolet radiation for twenty four hours. The color change was measured using a colorimeter. The results showed that bisacryl methacrylate resins were more color stable in distilled water and on exposure to ultratiolet radition but were less color stable in coffee as compared to Plyethyl methacrylate resins and polymethyl methacrylates resins.

Tamer, A Hamza, Stemphen F.Rosenstiel[92] (2004) the aim of this study was to determine the fracture toughness and flexural strength of different types of provisional restoration resins reinforced with different commercially available fibres like fiber reinforcement, construct, fibreestick, ribbond, normal THM, ribbond triaxial or fibrenet. Unreinforced specimens served as control. Specimens were loaded into universal testing machine until fracture. Fibrestick and construct reinforcements showed a significant increase in mean fracture toughness over unreinforced controls for all resins tested. Similarly the mean flexural strength values were significantly increased by different combinations of fiber and resin ($P < 0001$). The authors concluded that addition of fibers to provisional resin increased both fracture toughness and flexural strength.

Vichi A, Ferrari M, Davidson LC[94] (2004) conducted a study to test the influence of exposure to water on the color stability of three different resin based composites. The samples were studied with a spectrophotometer equipped with an integrating sphere. For color determinations, a 50% gray card was used as background and the datas were recorded .After the initial measurements, the samples were stored for 30 days in a 60ºC water bath and then measured again under the same conditions. The results showed that all the materials showed a certain degree of discoloration due to aging in water. The authors concluded by saying that water acts as a discoloring agent to varying degrees for all the materials used.

Sakaguchi R.L, B.D. Wiltbank, N.C. Shah 80 (2004), The objective of this study is to compare four methods for measuring polymerization shrinkage strain of composites and to develop a rational basis for comparing data from different methods and laboratories. Methods used were Dilatometry, modified bonded disk, strain gage, and a new linear transducer method .Shrinkage strain magnitudes at 60 and 300 s for the 4 methods were statistically different. The modified bonded disk method measured the highest shrinkage values.

Cornelis J. Kleverlaan*, Albert J. Feilzer[21](2005), The aim of this study was to evaluate the shrinkage, contraction stress, tensile modulus, and the flow factor of 17 available dental resin composites. The volumetric shrinkage measurements were performed by mercury dilatometry, and the contraction stress and tensile modulus were determined by means of stress–strain analysis.The shrinkage contraction stress for Filtek z100, Aelite Flo, Flow it was too high for the amount of resin in the resin composite. This was rationalized by high polymerization rates, a flow factor and the nature of resin.

Debra R. Haselton[30] (2005) The purpose of this in vitro study was to measure the color change of 12 provisional prosthodontic materials after immersion in artificial saliva and artificial saliva–coffee solutions for 1, 2, and 4 weeks. Results indicated the presence of strong interaction between material and storage solution regardless of the aspect of color considered (P,.0001 for DE, DL*, Da*, and Db*). Coffee solution relative to saliva solution had the most significant impact on color change for Luxatemp, Protemp, and Temphase materials at 4 weeks, but the greatest overall color change for both coffee and saliva solutions was found for Provipont (DE = 9.40 coffee; 8.51 saliva) and the least overall color change for both solutions was found for Zeta CC (DE= 0.31 coffee; 0.23 saliva).

Ahmet Umut Guler[3] (2005) conducted a study to investigate the effect of different polishing methods on color stability of 2 and 3-component autopolymerized bis-acrylic composites and a methyl methacrylate based PR material upon exposure to staining ageint. Specimens were divided into 6 groups and different polishing methods were used, including pumice, diamond polishing paste, polishing discs and combination of these. Unpolished specimens served as control. Colors of all the specimens were measured with a colorimeter before and after exposure, and color changes were calculated. Authors concluded that methyl methacrylate-based PR material was found to be more color stable than the autopoylmerized and light polymerized composites tested. The use of diamond polishing paste after polishing with pumice significantly decreased the staining of methyl methacrylate and bis-acryl composites tested the highest color-change values were obtained in the groups polished with polishing discs, which wree found to be significantly different compared to values obtained with other opolishing techniques.

Guler UA, Yilmaz F, Kulumk T, Guler E, Kurt S[2] (2005) studied the effects of different drinks of stainability of resin composite provisional composite materials. The materials studied were light polymerized resin composite materials, bisacryl composite material, Micro hybrid resin composite and reinforced micro fill composite. The solutions used were water, coffee, coffee with sugar, tea with sugar, coffee with artificial creamer and sugar, cola, red wine or sour cherry juice. Color of all the specimens was measured before and after exposure with a colorimeter. It was found that for all the materials least change occurred in water, cola and sour cherry juice groups and highest color change occurred in red wine groups. The reinforced microfill composite material was found to be significantly more color stable than autopolymerized bisacryl, light polymerized composite material and micro hybrid material. The largest color difference was observed in the light polymerized composite material.

Debra R. Haselton RD, Arnold DMA, Dawson VD[30] (2005) measured the color change of twelve provisional prosthodonic materials after immersion in artificial saliva and artificial saliva-coffee solutions for 1, 2 and 4 weeks. The twelve different materials consisted of five polymethyl methacrylate resins and seven bisacryl composite resins. Ten specimens for each material were fabricated out of which five were stored in artificial saliva and five in a solution of artificial saliva and coffee. Color measurements were made using a colorimeter before immersion and after immersion at a time interval of 1, 2 and 4 weeks. It was found that all bisacryl composite resins exhibited significant color change after exposure to coffee solution.

Lee KY[102] (2005) conducted a study to measure the correlation between color-difference values calculated with CIELAB and CIEDE 2000 formulas after polymerization and thermo cycling of two resin composites. Color measurement was made for each specimen before polymerization and after polymerization. Color was remeasured after the polymerized samples were thermo cycled between 5 and 55ºC in distilled water for 3000 cycles with a dwell time of 15 seconds. Color was measured using a spectrophotometer and color difference by the CIELABformula was calculated and color difference by the CIEDE 2000 formula was calculated. It was found that there was significant correlation between color change values calculated by the two formulas after polymerization and thermocycling.

E.CAL, P. GUNERI[36] (2007) the purpose of this study was to evaluate the staining characteristics of mouth rinses on provisional acrylic resins. The staining potentials of a hybrid rinse, chlorhexidine gluconate rinse and a benzydamine hydrochloride rinse were investigated. Distilled water was used as the negative control. Color measurements were done with CIELAB system. All the test solutions produced perceptible staining on the provisional material. Hybrid rinse caused the highest staining and was followed by chlorhexidine gluconate rinse. The third highest staining was observed with benzydamine hydrochloride rinse. Where as control caused least staining.

Markus Balenhol[60] (2007) conducted a study to investigate the flexural strength and flexural modulus of temporary crown and bridge materials at different storage times and to identify possible correclations between the mechanical properties and the degree of conversion. 4 proprietary di-methacrylate-based t-c & bs were tested in a 3 point bending test at various storage times after mixing (at 37ºC dry / water) including thermocycling (5000 x 5-55ºC). FS and FM were very low

10 min after mixing for all material tested. The mechanical properties significantly depend on the time after mixing. The DC does only partially reflect the mechanical stability of a t-c & b material. Hence DC does not allow drawing conclusions about the mechanical properties equally for all materials.

Edward J. Givens[37] (2008) the purpose of the study was to test the marginal fit and color stability of three provisional restorative materials and a control. Two auto cure materials and one dual cure material were tested against SNAP, a polyethyl methacrylate control. A maxillary right central incisor invorine tooth was prepared for a full coverage ceramic crown, with a 1.5mm chamfer margin. For color stability, 10mm diameter x 2mm thick discs were fabricated and immersed clinically in tea for 1 week in a Tucillo / Nielsen apparatus. Color measurements were recorded for each specimen at baseline and after staining. The authors concluded that dual-cure temporary material exhibited significantly more discrepancy at the margin that the auto-cure bis-acryl materials or acrylic control. Protemp Garant exhibited clinically noticeable change in shade after 1 week in staining solution.

Markus Balenhol[59] (2008) studied the flexural strength and flexural **modulus** of four (3 bis acrylate and 1 PMMA) provisional crown and bridge materials at different storage times after mixing and using materials with different curing mechanism (dual curing v/s self curing) the specimens were stored for 10min, 2 hr, 16 hr, 24 hr, 72 hr. The materials were subjected to 3-point bend test at various times after mixing (37ºC dry / water) including thermocycling (5000 x, 5-55ºC). the chemical nature and curing mechanism significantly influenced the mechanical properties, however, the influence of the curing mechanism disappeared at progressive points in time after mixing. Flexural time and flexural modulus

significantly depend on the time after mixing. Composite resin based materials are preferred versus methacrylate resins due to more favorable mechanical properties. If a high mechanical strength is indispensable directly after fabrication of a provisional, a dual-curing provisional crown and bridge material is recommended.

Akio Izumida, Masanobu Yoda[4] (2008), studied about hard resins for crowns and bridges that are widely used for esthetic restorations. The objective of this study was to evaluate the mechanical properties of new commercial hard resins and to compare the results with those of the other hard resins previously investigated. PR and EP Epricord®: EP, Kuraray, Co., Ltd., Osaka, Japan and Prossimo PR GC, Co., Ltd., Tokyo, Japan) did not show dramatically better physical properties. However, the results of each examination in this study may be acceptable clinically. The results of each investigation changed according to the products used, and proper use for each case and application was suggested.

Chen Z.F Edmond[19] (2008) This article describes a technique for the fabrication of an immediate implant supported provisional restoration using a fractured natural tooth. The technique can be used with many implant systems and only simple materials and components are required.

Gabriela Queiroz de Melo Monteiroa[38] (2011), The purpose of this study was to evaluate polymerization shrinkage of resin composites using a coordinate measuring machine, optical coherence tomography and a more widely known method, such as Archimedes Principle. Two null hypothesis were tested: (1) there are no differences between the materials tested; (2) there are no differences between the methods used for polymerization shrinkage measurements.

MATERIALS AND METHODS

MATERIALS USED FOR THE STUDY

1. **TEMPSPAN -** is a dual cure system consisting of Bisphenol-A diethoxy methacrylate based material**.**
2. **PROTEMP 4** -is a chemically cured 2 component system, consisting of Bis – GMA based material.
3. **REVOTEK LC** -is a light cured single component composite resin consisting of Urethane dimethacrylate resins (UDMA).
4. Coffee powder (Nescafe, New Delhi, India)
5. Polishing – Tungsten Carbide, Pumice and diamond polishing paste
6. Artificial saliva
7. Distilled water

Instruments

1. Stainless steel mold used to prepare the specimens.
2. Standard weight – in Kilograms- 2.5 Kg weight is used.

Equipments

1. **Universal testing machine** (fig 13)

   Manufactured by Llyods company, England (Model **INSTRON** 3382) to test the Flexural strength and compressive strength samples.

2. **Knoops hardness tester** (fig 17)

   Model 420 MVD Walpert Wilson Instrument, to test the samples for microhardness.

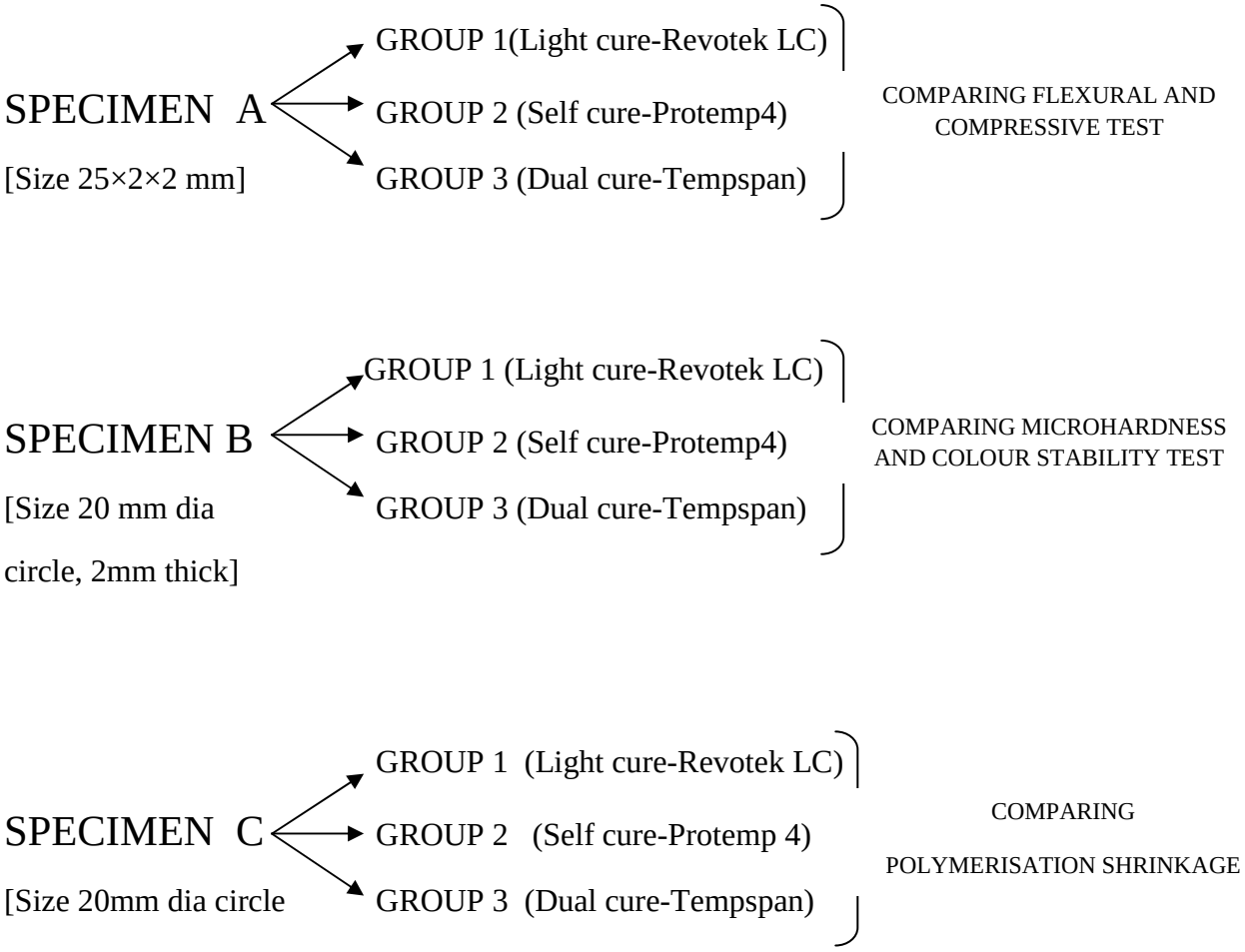
3. **Spectrophotometer** (fig 19)

   Minolta CM 3600d-Japan ,to test the samples for color analysis.

4. **Coordinate measuring machine** (fig 21)

   To test the specimens for Polymerisation shrinkage

FABRICATION OF SPECIMENS



FABRICATION OF SPECIMEN A- Used for calculating flexural and compressive strength. Specimen A size was standardized with 25mm x 2mm x 2mm (American national Standards Institute / American Dental Association specification no 27). (Fig 2).The specimens were fabricated for each material with use of stainless steel mould, which was Laser cut for the above mentioned dimension, sandwiched between 2 glass slabs. A weight of 2.5 kg was applied.

According to the above mentioned standardization three different materials were used to form three groups containing 10 samples each.

Specimen A Group 1 Light cure material – REVOTEK LC

Group 2 Self cure material – PROTEMP 4

Group 3 Dual cure material – TEMPSPAN

FABRICATION OF SPECIMEN B- Used for calculating colour stability and microhardness. Specimen B size was standardized with 20mm diameter cicles, 2mm thickness.(fig 4). The specimens were fabricated for each material with use of this stainless steel mould . The mould was placed on top of a glass slab. Vaseline was applied to the mould and onto the glass slab for easy separation of the specimen from the mould. The materials were mixed according to the manufacturers recommendations and loaded into the mould. Another glass slab with a plastic matrix was later placed on top of the mould.

Specimen B Group 1 Light cure material – REVOTEK LC

Group 2 Self cure material – PROTEMP 4

Group 3 Dual cure material – TEMPSPAN

FABRICAT ION OF SPECIMEN C- Used for calculating polymerization shrinkage. Specimen C were standardized with stainless steel plate 2mm in thickness. Six circles of 20mm diameter were machined to form the mold space. V shaped notches with a 2mm diameter at open end of V were made at 4 corners of the circles to help us in measuring the shrinkage in 2 dimensions (fig 6). The specimens were fabricated for each material with use of this stainless steel mould .The mould was placed on top of a glass slab. Vaseline was applied to the mould and onto the glass slab for easy separation of the specimen from the mould. The materials were mixed according to the manufacturers recommendations and loaded into the mould. Another glass slab with a plastic matrix was later placed on top of the mould.

Specimen C Group 1 Light cure material – REVOTEK LC

Group 2 Self cure material – PROTEMP 4

Group 3 Dual cure material – TEMPSPAN

METHODOLOGY

MEASURING FLEXURAL STRENGTH

All 3 group materials with 10 samples each of specimen A (total 30 samples) were fabricated to undergo flexural strength test using an Universal testing machine. The specimens were grossly trimmed using tungsten carbide bur and then polished with sandpaper and diamond abrasive polishing paste. After this the specimens were soaked in artificial saliva at 37˚C for 10 days.

Later all specimens were placed on top of the platform of the Universal Testing Machine (INSTRON, MODEL NO 3382, Lloyds', England) to undergo a 3 point bend test. The width of the 2 supporting pins, were 2mm in diameter and the third pin was also 2 mm in diameter. The pins supporting the specimen were placed at a distance of 10mm support separation. A load of 10 kN load cell at a crosshead speed of 0.75mm/min was applied. The force at fracture was recorded in Newton's and calculated in MPa with the use of testing machine software. Analysis of variance was applied to the data, and multiple comparisons were made with Duncan's multiple range test and paired t tests.

MEASURING COMPRESSIVE STRENGTH

All 3 group materials with 10 samples each of specimen A (total 30 samples) were fabricated to undergo compressive strength test using an Universal testing machine. The specimens were grossly trimmed using tungsten carbide bur and then polished with sandpaper and diamond abrasive polishing paste. After this the specimens were soaked in artificial saliva at 37˚C for 10 days. Later all specimens were placed on top of the platform of the Universal Testing Machine (INSTRON, MODEL NO 3382, Lloyds', England) to undergo a compression test.

The sample was placed on a flat platform and another flat metal plate attached to the machines loading cell was kept in such a way that it just touched the specimen without applying any amount of force on it. A load of 10 kN load cell at a crosshead speed of 0.75mm/min was applied. The force the sample could withstand till the start of deformation was recorded in Newton's and calculated in MPa with the use of testing machine software.Analysis of variance was applied to the data, and multiple comparisons were made with Duncan's multiple range test and paired t tests.

MEASURING MICROHARDNESS

All 3 group materials with 10 samples each of specimen B (total 30 samples) were fabricated to undergo microhardness testing using an Knoop hardness tester. The specimens were grossly trimmed using tungsten carbide bur and then polished with sandpaper and diamond abrasive polishing paste.

The specimens were later stored in artificial saliva solution which was renewed every other day. Baseline Knoop Hardness (KHN) was measured 24 hours after fabrication with a microhardness tester, (Model 420 MVD Walpert Wilson Instrument)

The specimen was placed on the platform of the tester and a 10gm indenter load was applied. The measurements were automatically calculated by the tester. Three baseline microhardness measurements were obtained from each specimen. Knoop hardness was again measured after 10 days.

Differences among group related to material and time were detected with 2-way analysis of variance (ANOVA), comparisons between specific means were made with Duncan's multiple range and paired t tests (alpha - .05)

EVALUATING COLOUR STABILITY

All 3 group materials with 10 samples each (total 30 samples) of specimen B were fabricated to undergo evaluation for colour stability using Spectrophotometer. The specimens were grossly trimmed using tungsten carbide bur and then polished with sandpaper and diamond abrasive polishing paste.

Preparation of Staining Solution

The staining solution was prepared in the following concentrations Coffee Nescafe, New Delhi, India): For preparation of coffee solution 2.8g of coffee was weighed in an electronic weighing machine and added to 150ml of boiling distilled water.

Immersion of Specimens in Staining Solution

To evaluate the color stability in coffee solution, 10 specimens of each group were immersed in coffee solution at 37°C. Color measurements were made before immersion (To) (i.e. the baseline measurements) 7 days (T7), and 10 days (T10) after immersion. The solution was changed every two days. The specimens were rinsed with distilled water for five minutes and blotted dry with tissue paper before color measurement. The following equation was used to measure colour stability,

$$\Delta E = (\Delta L^{*2} + a^{*2} + b^{*2})^{1/2}$$

Where ΔL^*, Δa^*, Δb^* are the differences in L*, a* and b* values before (T0) and after immersion at each time interval (T7, T10). Baseline Color measurement of all specimens were made using reflectance spectrophotometer (Minolta CM 3600d-Japan) with CIELAB system. The CIELAB color system characterizes color based on human perception. It designates color according to 3 spatial coordinates, L*, A*, B*, where L* represents the brightness (value) of a

shade, a* represents the amount of red-green color and b* represents the amount of yellow-blue color. Absolute color measurements are made in L*, a*, b* coordinates. For baseline color measurement ,each specimen was placed on the measuring head of spectrophotometer and covered with the black cover.

Before each measurement session the spectrophotometer was calibrated according to manufacturer recommendations by using the supplied white calibration standard. The spectrophotometer automatically calculated the mean color measurement of 10 specimens of each material. This measurement was taken as the baseline measurement for the corresponding material to evaluate the color change after dipping in coffee solution.The mean and standard deviation estimated from the specimens for each subgroup was statistically analyzed.

Mean values were compared by one-way analysis of variance (ANOVA). Multiple range test by Tukey-HSD procedure was employed to identify the significant groups at 5% level.

MEASURING POLYMERISATION SHRINKAGE

All 3 group materials with 10 samples each of specimen C (total 30 samples) were fabricated to undergo evaluation for polymerization shrinkage.The specimens were grossly trimmed using tungsten carbide bur and then polished with sandpaper and diamond abrasive polishing paste.

The specimens was placed on the platform of the tester. Four markings were made exactly at the centre, between V shaped extensions of the specimens. The measurements were automatically calculated by the tester, when the Ruby tip of the instrument was made to touch the specimens at the 4 points which were marked earlier. The instrument after touching those points recognizes it to be a circle and diameter of the circle is displayed.

Samples were tested 5 minutes, 10 minutes & 120 minutes after fabrication. Differences among group related to material and time were detected with 2-way analysis of variance (ANOVA); comparisons between specific means were made with Duncan's multiple range and paired t tests (alpha - .05).

PHOTOGRAPHS

Fig 1-Light cure material- REVOTEK LC

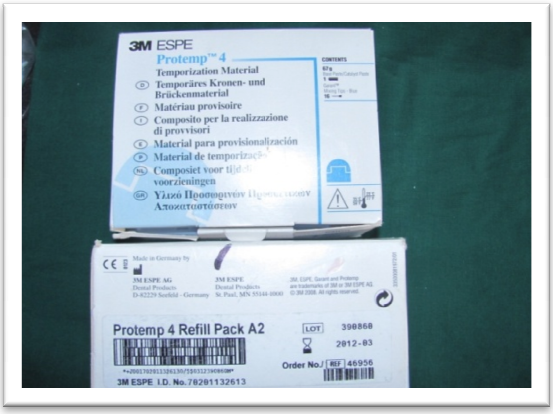


Fig 2-Self cure material-PROTEMP

Fig 3-Dual cure material-TEMPSPAN

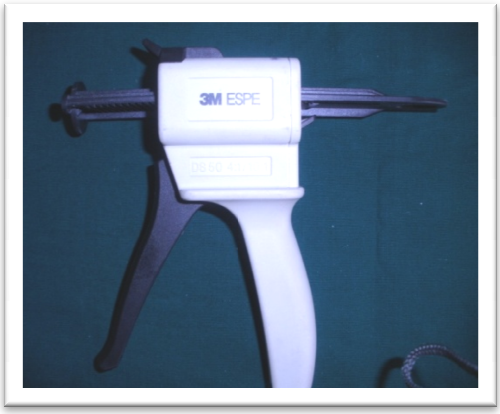


Fig 4-Dispensor Gun

Fig 5- Diamond polishing paste

Fig 6-Artifical salivary solution

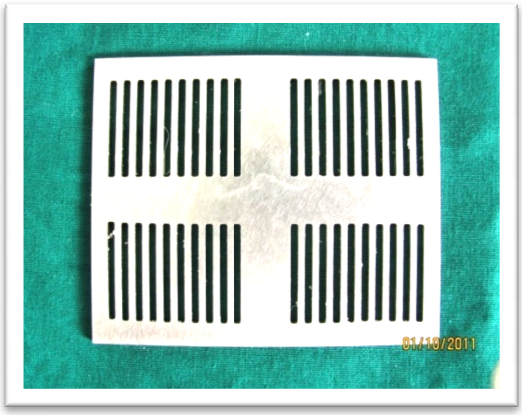


Fig 7- Stainless steel mold for Flexural strength and Compressive strength specimens

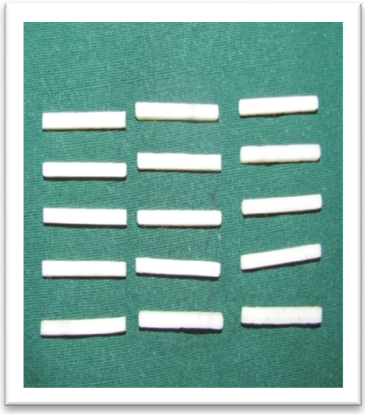


Fig 8- Specimen A samples

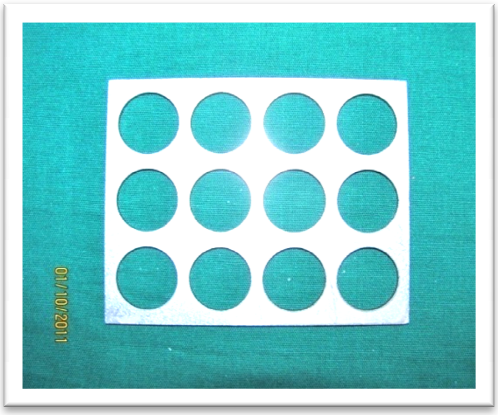


Fig 9- Stainless steel mold for Colour stability specimens

Fig 10-Specimen B samples

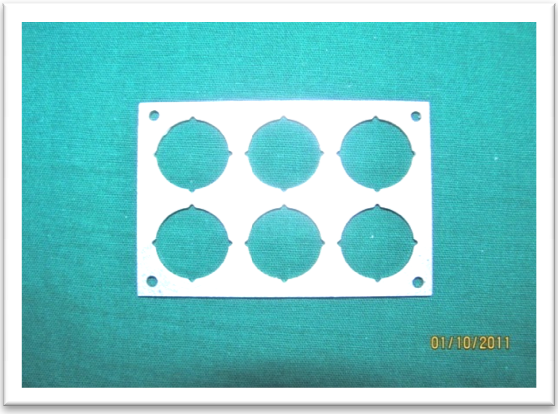


Fig 11- Stainless steel mold for Polymerisation shrinkage specimens

Fig 12 – Specimen C sample

Fig 13–Universal testing machine-Instron

Fig 14 –Sample on Instron platform

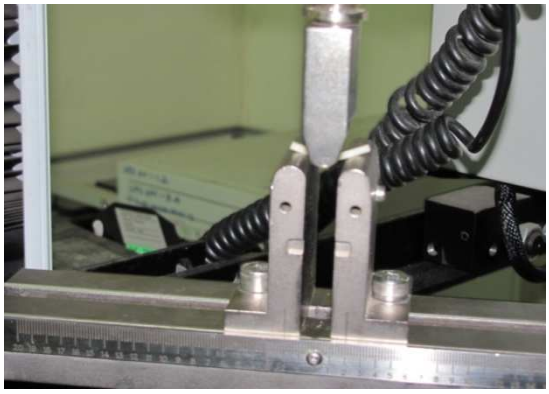


Fig 15–Sample under flexural load

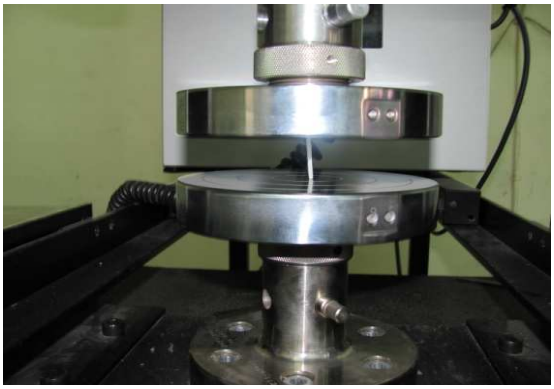


Fig 16–Sample under compressive load

Fig 17-**Knoops hardness tester** – (Model 420 MVD Walpert Wilson Instrument)

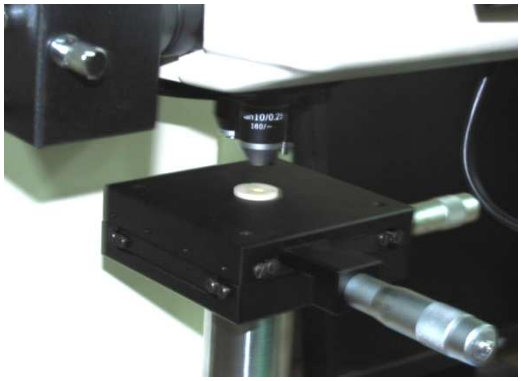


Fig 18-Sample being analysed

Fig 19-–Spectrophotometer unit

Fig 20 – sample evaluation

Fig 21- Coordinate measuring machine – TESA Micro Hite 3D

Fig 22- X,Y,Z coordinates of Coordinate Measuring Machine

Fig 23- Specimens on the instrument platform

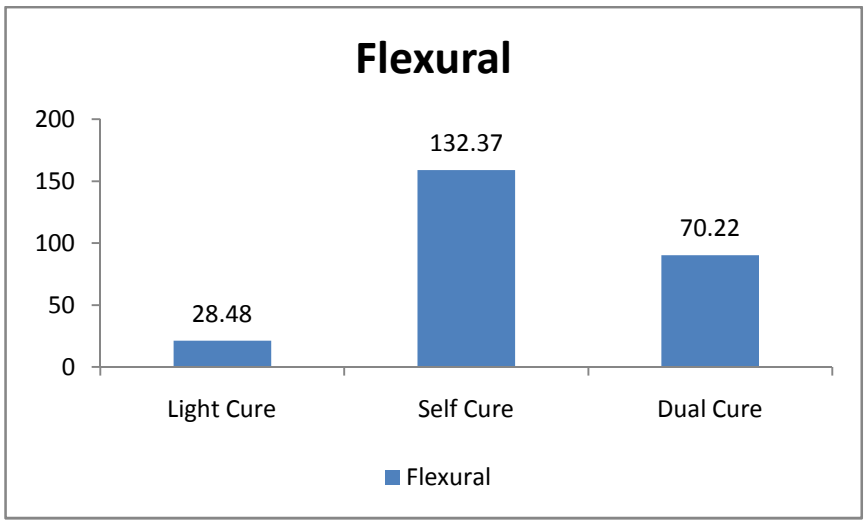
TABLE OF READINGS

FLEXURAL- READINGS

Specimen A with all 3 group of ten samples each (total 30 samples) were subjected to flexural strength testing using universal testing machine. The readings are tabulated as follows

SPECIMEN A	GROUP 1	GROUP 2	GROUP 3
SAMPLES	Light cure	Self cure	Dual cure
1	26.19137	121.9501	68.82778
2	21.57911	129.0546	77.96288
3	28.50491	135.2219	65.31237
4	25.56706	127.0401	70.85462
5	33.29041	106.2244	75.67683
6	22.70566	132.0921	68.4831
7	35.62076	149.0438	71.8735
8	37.05691	158.2091	78.2071
9	25.84362	132.4769	54.7403
10	21.57911	129.0546	77.96288

COLOUR GRAPHIC REPRESENTATION OF THE MEAN OF THE FLEXURAL STRENGTH VALUE CHANGES OF 3 GROUPS AT DIFFERENT TIME INTERVAL MEASUREMENTS

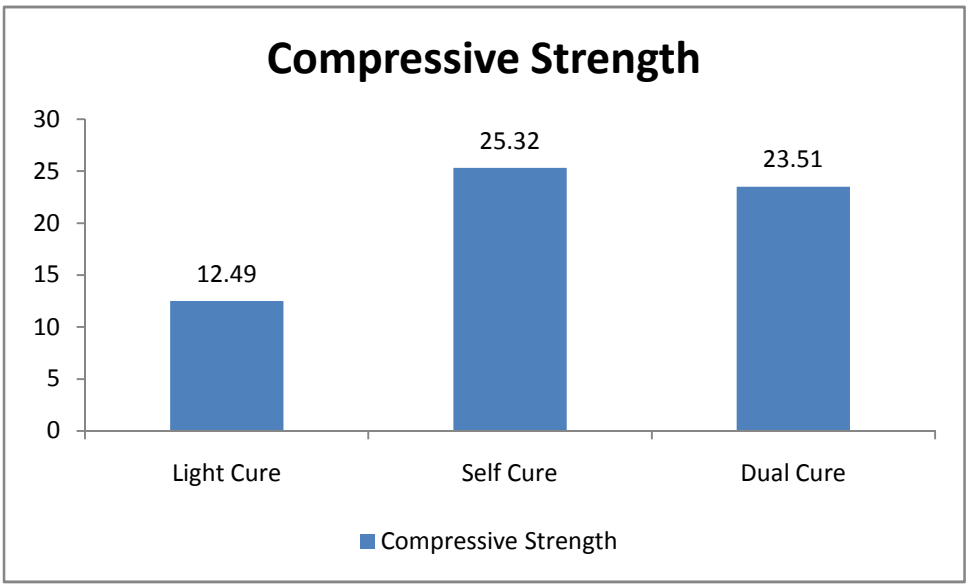


COMPRESSIVE STRENGTH

Specimen A with all 3 group of ten samples each (total 30 samples) were subjected to compressive strength testing using universal testing machine. The readings are tabulated as follows

SPECIMEN A	GROUP 1	GROUP 2	GROUP 3
SAMPLES	Light cure	Self cure	Dual cure
1	19.1771	24.11673	24.75511
2	8.50726	24.53717	17.15621
3	16.04461	36.62242	27.38691
4	9.34074	13.97753	20.20485
5	13.60918	29.74461	13.34171
6	14.18653	15.1197	20.77218
7	9.15516	28.19418	25.36552
8	10.71157	16.34115	24.55018
9	12.40925	33.11136	27.62508
10	11.72572	31.4576	13.95376

COLOUR GRAPHIC REPRESENTATION OF THE MEAN OF THE COMPRESSIVE STRENGTH VALUE CHANGES OF 3 GROUPS AT DIFFERENT TIME INTERVAL MEASUREMENTS



MICRO HARDNESS READINGS

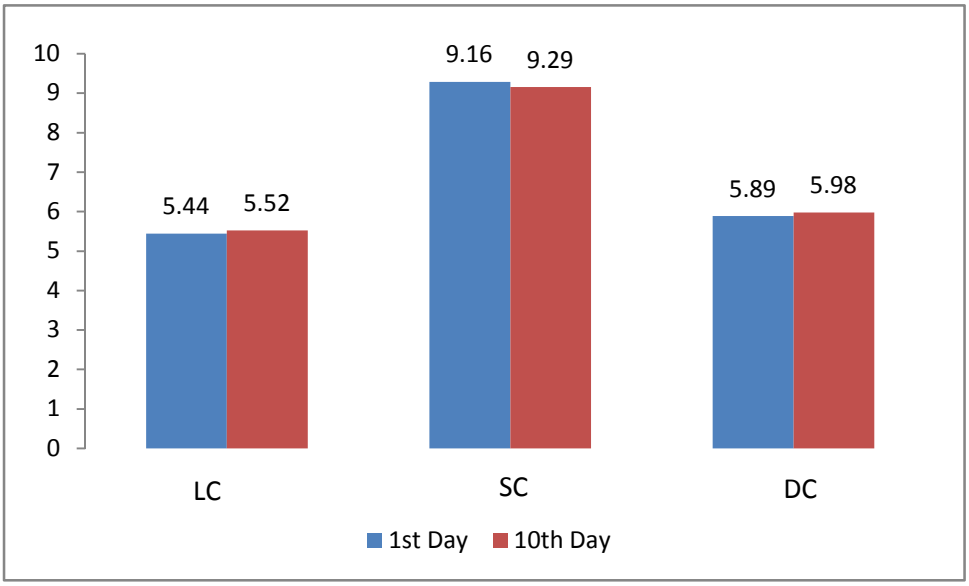
Specimen B with all 3 group of ten samples each (total 30 samples) were subjected to micro hardness testing using knoop hardness tester. The readings are tabulated as follows

SPECIMEN B		24 hours	10th day
Group 1 Light cure	Sample 1	5.1	5.3
	Sample 2	5.3	5.6
	Sample 3	5.5	5.6
	Sample 4	5.2	5.5
	Sample 5	5.4	5.2
	Sample 6	5.8	5.4
	Sample 7	5.6	5.4
	Sample 8	5.6	5.8
	Sample 9	5.5	5.6
	Sample 10	5.4	5.8

SPECIMEN B		24 hours	10th day
Group 2 Selfcure	Sample 1	9.1	9.4
	Sample 2	9.2	9.6
	Sample 3	9.7	9.5
	Sample 4	9.6	8.7
	Sample 5	9.5	8.9
	Sample 6	8.7	9.1
	Sample 7	8.7	9.7
	Sample 8	8.9	9.6
	Sample 9	9.1	9.5
	Sample 10	9.1	8.9

SPECIMEN B		24 hours	10th day
Group 3 Dual cure	Sample 1	5.8	6.2
	Sample 2	6.4	6
	Sample 3	5.5	5.4
	Sample 4	6.5	6.4
	Sample 5	5.9	5.5
	Sample 6	5.7	6.5
	Sample 7	5.7	6.5
	Sample 8	5.4	5.9
	Sample 9	6.1	5.7
	Sample 10	5.9	5.7

COLOUR GRAPHIC REPRESENTATION OF THE MEAN OF THE MICROHARDNESS VALUE CHANGES OF 3 GROUPS AT DIFFERENT TIME INTERVAL MEASUREMENTS



COLOUR STABILITY

Specimen B with all 3 group of ten samples each (total 30 samples) were subjected to colour analysis using spectrophotometer immediately after sample fabrication. The same 30 samples were subjected to colour analysis after 7 days and after 10 days. The readings are tabulated as follows

Samples	Base	Base	Base	7 days	7 days	7 days	10 days	10 days	10 days
	Dual Cure	Light cure	Self cure	Dual Cure	Light cure	Self cure	Dual Cure	Light cure	Self cure
1	3990.731	5992.953	5165.914	3564.367	4721.129	5720.052	3617.295	4745.124	5896.733
2	3951.208	5760.118	5372.347	3383.271	4745.054	5505.808	3540.112	4790.243	5590.984
3	3901.351	6007.437	5003.021	3411.608	4743.311	5783.219	3514.764	4770.577	5827.391
4	4004.594	5792.816	5242.149	3444.567	4721.129	5705.878	3473.547	4746.365	5839.299
5	4020.721	5907.772	5010.828	3518.611	4926.717	5315.176	3547.893	4975.268	5390.977
6	4011.193	5885.281	4986.368	3544.635	4800.109	5624.179	3616.902	4907.688	5662.112
7	3942.779	6029.38	5230.744	3566.813	4723.3	5739.893	3579.66	4807.562	5766.638
8	3925.457	5942.391	5109.176	3388.712	4762.813	5608.598	3418.23	4810.242	5672.551
9	3981.489	5919.098	5265.536	3578.659	4838.079	5615.211	3671.401	4861.897	5646.645
10	3953.327	6003.639	5154.106	3542.851	4594.749	5642.769	3607.959	4636.217	5735.806

Specimen B with all 3 group of ten samples each (total 30 samples) were subjected to colour analysis using spectrophotometer

BASE – LIGHT CURE

Samples	L	a	b	△E
1	2.14	-1.87	1.57	3.246752
2	2.59	-1.84	1.68	3.593898
3	2.88	-1.81	1.25	3.623948
4	2.09	-1.39	1.01	2.705605
5	2.37	-1.48	0.89	2.932473
6	2.77	-1.5	1.01	3.308021
7	1.54	-1.58	1.25	2.535843
8	1.87	-1.52	1.22	2.701055
9	1.65	-1.56	1.21	2.572975
10	1.2	-1.58	1.23	2.334374

7 DAYS – LIGHT CURE

Samples	L	a	b	△E
1	2.63	-0.32	2.59	3.705051
2	0.6	-0.33	3.05	3.125924
3	1.17	0.08	2.18	2.475419
4	0.81	-0.16	1.16	1.423833
5	3.34	-0.37	2.72	4.323297
6	2.97	-0.49	3.06	4.292389
7	2.83	-0.89	2.89	4.14163
8	0.99	-0.04	3.1	3.254489
9	2.57	-0.54	1.25	2.908436
10	2.94	-0.55	2.62	3.976242

10 DAYS – LIGHT CURE

Samples	L	a	b	△E
1	2.78	-1.97	1.12	3.5866
2	2.25	-1.51	2.01	3.373826
3	3.5	-1.62	2.45	4.569125
4	3.82	-1	2.89	4.893312
5	3.97	-0.91	1.65	4.394485
6	2.97	-1.37	1.5	3.598305
7	1.53	-1.92	1.12	2.698463
8	3.01	-1.56	1.91	3.891247
9	3.25	-1.88	1.01	3.888059
10	1.12	-1.25	1.02	1.964001

BASE – SELF CURE

Samples	L	a	b	△E
1	2.82	-0.09	3.55	4.534644
2	2.57	-0.3	2.48	3.584034
3	2.46	-0.45	2.36	3.438561
4	1.53	-0.063	1.91	2.448054
5	2.7	-2.51	2.07	4.227884
6	2.54	-2.01	2.8	4.281553
7	2.57	-2.53	2.9	4.627721
8	2.16	-0.51	3.12	3.828851
9	0.68	-2.38	3.91	4.627624
10	1.12	-1.8	3.01	3.681644

7 DAYS –SELF CURE

Samples	L	a	b	△E
1	3.12	-1.67	3.5	4.977278
2	1.5	-1.67	2.57	3.412301
3	1.91	-1.97	2.68	3.835544
4	1.01	-2.12	2.57	3.481293
5	1.12	-2.51	2.68	3.838867
6	2.36	-2.01	2.25	3.830431
7	3.87	-2.53	2.01	5.041617
8	3.52	-0.51	1.91	4.037152
9	2.12	-1.68	2.78	3.878814
10	2.5	-2.16	2.5	4.143139

10 DAYS –SELF CURE

Samples	L	a	b	△E
1	2.03	-1.45	2.09	3.254458
2	0.91	-1.63	3.55	4.010923
3	3.67	-1.8	2.48	4.78114
4	3.16	-2.05	2.36	4.444963
5	0.68	-2.38	1.33	2.809929
6	2.12	-1.8	3.21	4.247176
7	3.8	2.23	1.6	4.687526
8	3.21	2.94	1.5	4.604096
9	1.97	3.28	3.61	5.260361
10	2.08	1.09	5.12	5.632841

BASE – DUAL CURE

Samples	L	a	b	△E
1	2.73	1.57	1.44	3.46286
2	3.28	1.4	2.3	4.243631
3	2.01	1.59	1.54	2.98995
4	2.9	1.66	1.81	3.800224
5	3.01	1.69	1.97	3.974557
6	3.85	1.48	1.8	4.500322
7	2.29	1.57	2.1	3.481235
8	2.06	1.23	2.6	3.537867
9	3.48	1.35	2.81	4.672152
10	2.31	1.48	2.4	3.645065

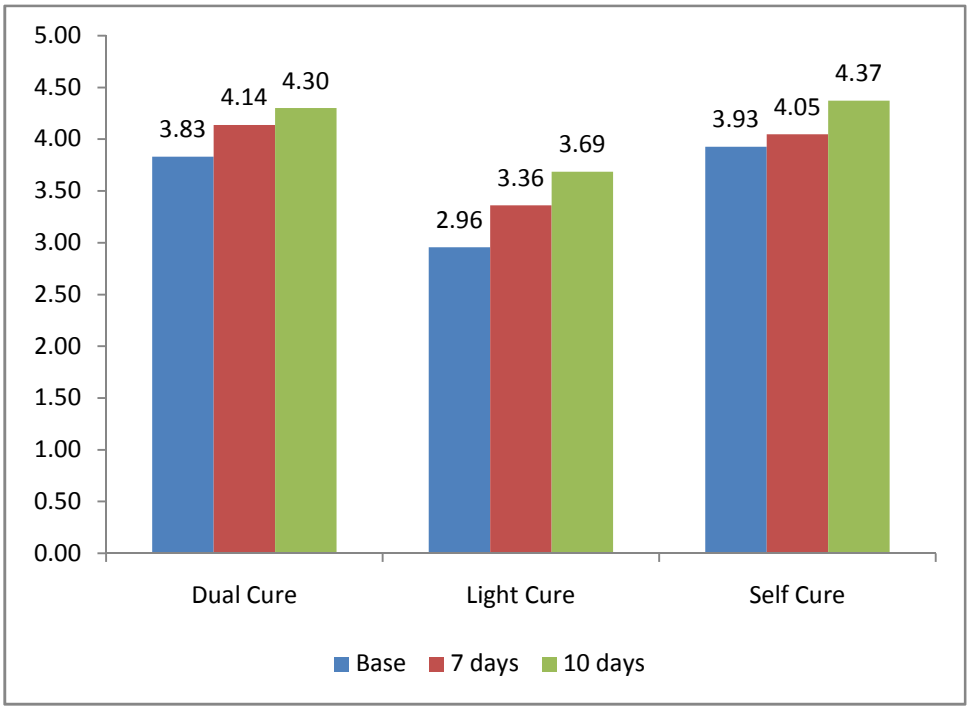
7 DAYS – DUAL CURE

Samples	L	a	b	△E
1	3.94	-0.63	3.02	5.004088
2	4	-0.71	2.09	4.56861
3	2.81	-0.09	2.1	3.509159
4	3	-0.3	2.37	3.834958
5	4.5	-0.45	2.2	5.029165
6	3.94	-0.063	2.12	4.474591
7	3.91	-0.89	1.01	4.135251
8	1.06	-0.71	2.65	2.941122
9	3.12	-0.61	2.12	3.821112
10	3.37	-0.63	2.16	4.052086

10 DAYS – DUAL CURE

Samples	L	a	b	△E
1	2.66	-2.97	2.73	4.832122
2	2.1	-1.2	3.29	4.083393
3	1.32	-2.47	3.41	4.412641
4	2.66	-2.97	1.73	4.346194
5	4.59	-1.84	0.06	4.945432
6	3.26	-2.07	2.18	4.434512
7	2.03	-2.42	3.75	4.90304
8	2.77	-2.24	1.45	3.846167
9	3.1	-1.88	2.38	4.336911
10	0.94	-1.2	2.43	2.868536

COLOUR GRAPHIC REPRESENTATION OF THE MEAN OF THE COLOUR CHANGES OF 3 GROUP DIFFERENT TIME INTERVAL MEASUREMENTS



POLYMERISATION SHRINKAGE

Specimen c with all 3 group of ten samples each (total 30 samples) were subjected to evaluation of polymerization shrinkage using coordinate measuring machine. Readings are tabulated as follows,

VOLUME OF SPECIMEN – LIGHT CURE (GROUP 1)

Samples	5 mins	10 mins	120 mins
1	724.6436	628.1361	622.8797
2	713.4286	624.4176	618.3414
3	721.6	653.7143	653.3485
4	717.0024	659.6539	651.8286
5	721.2979	688.7918	686.7874
6	722.2286	569.5222	617.893
7	722.4853	692.6463	669.1143
8	715.5783	715.3143	693.183
9	725.9171	681.4201	681.4201
10	713.8844	662.466	661.8629

DELTA V – LIGHT CURE (GROUP 1)

Samples	5 mins	10 mins	120 mins
1	-0.0005	13.3175	14.04287
2	1.547172	13.83065	14.66916
3	0.419519	9.787717	9.838198
4	1.053991	8.968052	10.04794
5	0.461213	4.947039	5.223636
6	0.332776	21.40619	14.73104
7	0.297346	4.415118	7.662524
8	1.250507	1.286944	4.341055
9	-0.17624	5.964332	5.964332
10	1.484272	8.579988	8.66321

VOLUME OF SPECIMEN – SELF CURE (GROUP 2)

Samples	5 mins	10 mins	120 mins
1	724.6436	653.1098	629.2002
2	685.1639	658.6807	658.0215
3	678.1594	661.3178	659.3284
4	703.753	678.8571	678.5429
5	691.9976	655.8683	652.1038
6	723.9238	657.6522	652.7186
7	727.0481	681.0571	677.5001
8	715.125	668.6629	653.4165
9	685.1639	656.2606	622.7383
10	704.5854	645.9489	625.7241

DELTA V – SELF CURE (GROUP 2)

Samples	5 mins	10 mins	120 mins
1	-0.0005	9.871141	13.17066
2	5.447686	9.10236	9.193326
3	6.414299	8.738437	9.012977
4	2.882397	6.318014	6.361385
5	4.504631	9.490458	10.00997
6	0.098834	9.244294	9.925122
7	-0.33232	6.014415	6.505284
8	1.313065	7.724817	9.828812
9	5.447686	9.436321	14.06239
10	2.767532	10.85934	13.65035

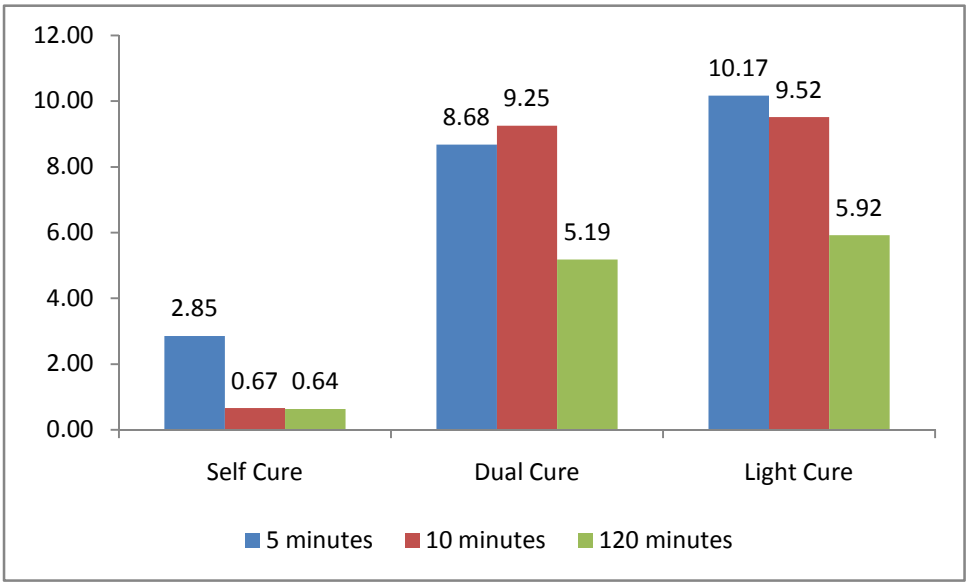
VOLUME OF SPECIMEN – DUAL CURE (GROUP 3)

5 mins	10 mins	120 mins
724.6436	690.1714	688.2857
722.7333	684.4579	684.4579
731.0113	653.7143	653.7143
716.3656	706.6242	694.5714
730.1949	688.4158	687.7891
713.4286	712.0024	689.7327
722.4853	675.686	672.7185
699.6907	695.1858	687.5976
725.9171	687.9758	687.3503
713.8844	676.4063	670.8413

DELTA V – DUAL CURE (GROUP 3)

5 mins	10 mins	120 mins
-0.0005	4.756648	5.016875
0.263126	5.545114	5.545114
-0.87923	9.787717	9.787717
1.141865	2.486178	4.14945
-0.76658	4.998922	5.085405
1.547172	1.743979	4.817185
0.297346	6.755632	7.165143
3.442992	4.06467	5.111835
-0.17624	5.05965	5.14596
1.484272	6.656227	7.424199

COLOUR GRAPHIC REPRESENTATION OF THE MEAN OF THE POLYMERISATION SHRINKAGE VALUE CHANGES OF 3 GROUPS AT DIFFERENT TIME INTERVAL MEASUREMENTS



STATISTICAL ANALYSIS

MATERIAL GROUPS

Group 1 Light cure-Revotek

Group 2 Self cure-Protemp

Group 3 Dual cure-Tempspan

ANALYSIS FOR FLEXURAL STRENGTH

In this study the Flexural strength values of provisional composite restorative materials were calculated at 10 days after immersing in artificial saliva using a **Universal testing machine** –Manufactured by Llyods company, England (Model **INSTRON** 3382).The mean, standard deviation and test of significance of mean values of the three materials were tabulated and comparison was done within each group as well as between the groups.

Mean, Standard Deviation and Test of significance of mean changes between groups I, II and III at $10^{th\ day}$ of testing

Students paired t-test was used to calculate the p-value

Sample	Mean	S.D.	p value
LC	28.48	5.58	0.00 (Sig)
SC	132.37	14.94	0.00 (Sig)
DC	70.22	7.29	0.00 (Sig)

Using ANOVA there is significant difference among the groups at $p<0.001$.

GROUP 1 Light cure-Revotek- The mean and standard deviation is 28.48±5.58 which is statistically significant at $p<0.001$.

GROUP 2 Self cure-Protemp- The mean and standard deviation is 132.37±14.94 which is statistically significant $p<0.001$.

GROUP 3 Dual cure-Tempspan - The mean and standard deviation is 70.22±7.29 which is statistically significant at $p<0.001$.

FLEXURAL STRENGTH-POST HOC TEST FOR MULTIPLE COMPARISON BY TUKEY HSD METHOD

Group (I)	Group (J)	Mean Difference (I-J)	Significance
SELF CURE	LIGHT CURE	137.88	0.00 (Significant)
	DUAL CURE	68.81	0.00 (Significant)
LIGHT CURE	SELF CURE	-137.88	0.00 (Significant)
	DUAL CURE	69.07	0.00 (Significant)
DUAL CURE	SELF CURE	-68.81	0.00 (Significant)
	LIGHT CURE	-69.07	0.00 (Significant)

Using post hoc multiple comparison,Tukey HSD method, we found significant difference between Protemp, Revotek LC and Tempspan at $p < 0.001$.

Group 1- Multiple comparisons of flexural strength were made, Self cure- Protemp showed statistically significant difference in values from Revotek LC and Dual cure Tempspan at $p < 0.001$.

Group 2- Multiple comparisons of flexural strength were made, Light cure- Revotek showed statistically significant difference in values from Self cure- Protemp and dual cure Tempspan at $p < 0.001$.

Group 3- Multiple comparisons of flexural strength were made, Dual cure Tempspan showed statistically difference in values from Revotek LC and Self cure Protemp at $p < 0.001$. The mean difference between three groups showed statistically significant differences. At 10 days after immersion, Light cure-Revotek showed greater flexural strength than Dual cure-Tempspan which in turn is found to be lesser than the flexural strength values of Self cure-Protemp. Thus Protemp shows greater flexural strength values.

ANALYSIS for Compressive strength

In this study the Compressive strength values of provisional composite restorative material were calculated at 10 days after immersing in artificial saliva using a **Universal testing machine** –Manufactured by Llyods company, England (Model **INSTRON** 3382)

The mean, standard deviation and test of significance of mean values of the three materials were tabulated and comparison was done within each group as well as between the groups.

Mean, Standard Deviation and Test of significance of mean changes between group I, II and III at $10^{th\ day}$ of testing

Students paired t-test was used to calculate the p-value

Sample	Mean	S.D.	p value
Group1LC	12.49	3.37	0.00 (Sig)
Group2 SC	25.32	7.95	0.58 (NS)
Group3 DC	23.51	6.42	0.00 (Sig)

Using ANOVA there is significant difference among the group at $p < 0.001$.

Group 1- The mean and standard deviation is 12.49 ± 3.37 which is statistically significant at $p < 0.001$.

Group 2- The mean and standard deviation is 25.32 ± 7.95 which is statistically not significant at $p < 0.001$.

Group 3- The mean and standard deviation is 23.51 ± 6.42 which is statistically significant at $p < 0.001$.

COMPRESSIVE STRENGTH-POST HOC TESTS FOR MULTIPLE COMPARISON BY TUKEY HSD METHOD

Group (I)	Group (J)	Mean Difference (I-J)	Significance
SELF CURE	LIGHT CURE	12.83	0.00 (Significant)
	DUAL CURE	1.81	0.58 (NS)
LIGHT CURE	SELFCURE	-12.83	0.00 (Significant)
	DUAL CURE	11.02	0.00 (Significant)
DUAL CURE	SELF CURE	-1.81	0.58 (NS)
	LIGHT CURE	-11.02	0.00 (Significant)

The mean difference between three groups showed statistically significant differences. At 10 days after immersion, Light cure-Revotek showed greater compressive strength than Dual cure-Tempspan which in turn is found to be lesser than the compressive strength values of Self cure-Protemp. Thus Protemp shows greater compressive strength values.

ANALYSIS for polymerization shrinkage

In this study the Polymerisation shrinkage change of provisional composite restorative material was compared at 5, 10 &120 minutes after sample preparation using a **Coordinate measuring machine.**

The mean, standard deviation and test of significance of mean values of the three materials were tabulated and comparison was done within each group as well as between the groups.

ANOVA between 5 mins, 10 mins and 120 mins of Self Cure

Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Rows	81.03043	9	9.003381	2.520755	0.045395	2.456281
Columns	299.0429	2	149.5215	41.86282	1.7E-07	3.554557
Residual	64.29061	18	3.571701			
Total	444.364	29				

Since the F value between rows (2.520755) is greater than the critical value, the null hypothesis is rejected and it is concluded that there is a significant difference between rows. Similarly since the F value (41.86282) is greater than the critical value, it also falls in the rejection region and the null hypothesis is rejected and it is concluded that there is a significant difference between columns

ANOVA between 5 mins, 10 mins and 120 mins of Light Cure

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	270.3039	9	30.03377	3.143713	0.018475	2.456281
Columns	506.9761	2	253.488	26.53325	4.29E-06	3.554557
Residual	171.9648	18	9.553598			
Total	949.2448	29				

Since the F value between rows (3.143713) is greater than the critical value, the null hypothesis is rejected and it is concluded that there is a significant difference between rows. Similarly since the F value (26.53325) is greater than the critical value, it also falls in the rejection region and the null hypothesis is rejected and it is concluded that there is a significant difference between columns.

ANOVA between 5 mins, 10 mins and 120 mins of Dual Cure

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	37.21126	9	4.134584	1.46956	0.232382	2.456281
Columns	164.0939	2	82.04693	29.16203	2.26E-06	3.554557
Residual	50.64273	18	2.813485			
Total	251.9479	29				

Since the F value between rows (1.46956) is less than the critical value, the null hypothesis is accepted and it is concluded that there is no significant difference between rows. However, since the F value (29.16203) is greater than the critical value, it also falls in the rejection region and the null hypothesis is rejected and it is concluded that there is a significant difference between columns.

POST HOC TESTS FOR MULTIPLE COMPARISON BY TUKEY HSD METHOD

Days	Group (I)	Group (J)	Mean Difference (I-J)	Significance
5 minutes	DUAL CURE	LIGHT CURE	-1.49207	0.00 (Significant)
		SELF CURE	-7.3177	0.00 (Significant)
	LIGHT CURE	DUAL CURE	-1.49207	0.00 (Significant)
		SELF CURE	-5.82563	0.00 (Significant)
	SELF CURE	DUAL CURE	-7.3177	0.00 (Significant)
		LIGHT CURE	-5.82563	0.00 (Significant)
10 minutes	DUAL CURE	LIGHT CURE	-0.26804	0.00 (Significant)
		SELF CURE	-8.85139	0.00 (Significant)
	LIGHT CURE	DUAL CURE	-0.26804	0.00 (Significant)
		SELF CURE	-8.58335	0.00 (Significant)
	SELF CURE	DUAL CURE	-8.85139	0.00 (Significant)
		LIGHT CURE	-8.58335	0.00 (Significant)
120 minutes	DUAL CURE	LIGHT CURE	-0.73941	0.00 (Significant)
		SELF CURE	-5.28947	0.00 (Significant)
	LIGHT CURE	DUAL CURE	-0.73941	0.00 (Significant)
		SELF CURE	-4.55005	0.00 (Significant)
	SELF CURE	DUAL CURE	-5.28947	0.00 (Significant)
		LIGHT CURE	-4.55005	0.00 (Significant)

ANALYSIS FOR MICROHARDNESS

In this study the microhardness change of provisional composite restorative material was compared at 24 hours and at 10 days after immersing in artificial saliva through a microhardness tester (**Knoop hardness tester**). The mean, standard deviation and test of significance of mean values of the three materials were tabulated and comparison was done; within each group as well as between the groups.

FOR GROUP I, II AND III AT 24 HOURS

Students paired t-test was used to calculate the p-value

FOR GROUP I, II AND III AT 10^{TH} DAY

Students paired t-test was used to calculate the p-value

Mean, Standard Deviation and Test of significance of mean changes between group I, II and III at 24hours and $10^{th\ day}$ of testing

Group	24 hours Mean±SD	10 days Mean±SD	Change Mean±SD	P value
Light cure	5.44±0.21	5.52±0.20	0.08±.01	0.389268 (NS)
Self cure	9.16±0.35	9.29±0.36	0.13±.01	0.422029 (NS)
Dual cure	5.89±0.38	5.98±0.41	0.09±.03	0.605997 (NS)

Group 1- The mean and standard deviation is 0.08±01 which is not statistically significant at $p < 0.001$.

Group 2- The mean and standard deviation is 0.13±01 which is not statistically significant at $p < 0.001$.

Group 3- The mean and standard deviation is 0.09±03 which is not statistically significant at $p < 0.001$. The change in mean value of Microhardness reveals that Self cure-Protemp has a greater change in mean value, when compared to other two groups.

POST HOC TESTS FOR MULTIPLE COMPARISON BY TUKEY HSD METHOD

Days	Group (I)	Group (J)	Mean Difference (I-J)	Significance
24 HOURS	SELF CURE	LIGHT CURE	3.85	0.00 (Significant)
		DUAL CURE	0.45	0.00 (Significant)
	LIGHT CURE	SELF CURE	-3.85	0.00 (Significant)
		DUAL CURE	3.4	0.00 (Significant)
	DUAL CURE	SELF CURE	-0.45	0.00 (Significant)
		LIGHT CURE	-3.4	0.00 (Significant)
10 DAYS	SELF CURE	LIGHT CURE	3.64	0.00 (Significant)
		DUAL CURE	0.46	0.00 (Significant)
	LIGHT CURE	SELF CURE	-3.64	0.00 (Significant)
		DUAL CURE	3.18	0.00 (Significant)
	DUAL CURE	SELF CURE	-0.46	0.00 (Significant)
		LIGHT CURE	-3.18	0.00 (Significant)

Using post hoc multiple comparison, Tukey HSD method, we found significant difference between Protemp, Revotek LC and Tempspan at $p < 0.001$.

Group 1 (24hours and 10 days)- Multiple comparisons of Microhardness were made, self cure Protemp showed statistically significant difference in values from Revotek LC and dual cure Tempspan at $p < 0.001$.

Group 2 (24hours and 10 days) - Multiple comparisons of Microhardness were made, Revotek LC showed statistically significant difference in values from self cure Protemp and dual cure Tempspan at $p < 0.001$.

Group 3 (24hours and 10 days) - Multiple comparisons of Microhardness were made, dual cure Tempspan showed statistically difference in values from Revotek LC and self cure Protemp at $p < 0.001$.

The mean difference between three groups showed statistically significant differences. At 10 days after immersion, Light cure-Revotek showed greater hardness than Dual cure-Tempspan which in turn is found to be lesser than the hardness values of Self cure-Protemp. Thus Protemp shows greater hardness values.

ANALYSIS FOR COLOR STABILITY

Color stability for Group I, Group II and Group III materials of Specimen B were measured at baseline (that is before immersion in the coffee solution), 7^{th} day and 10^{th} day after immersion in the coffee solution. The readings were recorded. The mean, standard deviation and test of significance of mean values of the three materials at three different immersion days were tabulated and comparison was done within each group as well as between the groups.

FOR GROUP I, II, AND III

Students paired t-test was used to calculate the p-value

Table . Color - Mean, Standard Deviation and Test of significance of mean changes between group I, II and III at baseline, 7^{th} day and 10^{th} of testing.

	GROUPS	**MEAN**	**SD**	**SIGNIFICANCE**
BASE	DUAL CURE	3.830786	0.519944	0.00 (Significant)
	LIGHT CURE	2.955494	0.459399	0.00 (Significant)
	SELF CURE	3.928057	0.681555	0.00 (Significant)
7 DAYS	DUAL CURE	4.137014	0.655794	0.01 (Significant)
	LIGHT CURE	3.362671	0.925445	0.01 (Significant)
	SELF CURE	4.047644	0.552781	0.01 (Significant)
10 DAYS	DUAL CURE	4.300895	0.614603	0.18 (NS)
	LIGHT CURE	3.685742	0.874195	0.18 (NS)
	SELF CURE	4.373341	0.852445	0.18 (NS)

According to the Table, the mean value of light cure within 24 hours (2.955494) is less than the mean value of dual cure and self cure. Thus it is concluded that the light cure is more stable than the other two groups.

According to the Table, the mean value of light cure after 7 days (3.362671) is less than the mean value of dual cure and self cure. Thus it is concluded that the light cure is more stable than the other two groups.

According to the Table, the mean value of light cure after 10 days (3.685742) is less than the mean value of dual cure and self cure. Thus it is concluded that the light cure is more stable than the other two groups.

Table : POST HOC TESTS FOR MULTIPLE COMPARISON BY TUKEY HSD METHOD

Days	Group (I)	Group (J)	Mean Difference (I-J)	Significance
Base	DUAL CURE	LIGHT CURE	0.875	0.00 (Significant)
		SELF CURE	0.097	0.00 (Significant)
	LIGHT CURE	DUAL CURE	0.875	0.00 (Significant)
		SELF CURE	0.973	0.13 (NS)
	SELF CURE	DUAL CURE	0.097	0.00 (Significant)
		LIGHT CURE	0.973	0.13 (NS)
7 DAYS	DUAL CURE	LIGHT CURE	0.774	0.04 (Significant)
		SELF CURE	0.089	0.06 (NS)
	LIGHT CURE	DUAL CURE	0.774	0.04 (Significant)
		SELF CURE	0.685	0.75 (NS)
	SELF CURE	DUAL CURE	0.089	0.06 (NS)
		LIGHT CURE	0.685	0.75 (NS)
10 DAYS	DUAL CURE	LIGHT CURE	0.615	0.09 (NS)
		SELF CURE	0.072	0.09 (NS)
	LIGHT CURE	DUAL CURE	0.615	0.09 (NS)
		SELF CURE	0.688	0.83 (NS)
	SELF CURE	DUAL CURE	0.072	0.09 (NS)
		LIGHT CURE	0.688	0.83 (NS)

At the baseline measurement, Dual cure-Tempspan,Self cure- Protemp and Revotek LC are statistically significant at $p < 0.001$.

At the 7^{th} day of the color analysis Tempspan, Protemp and Revotek LC are statistically significant at $p < 0.001$. However Revotek and Protemp showed statistically insignificant difference.

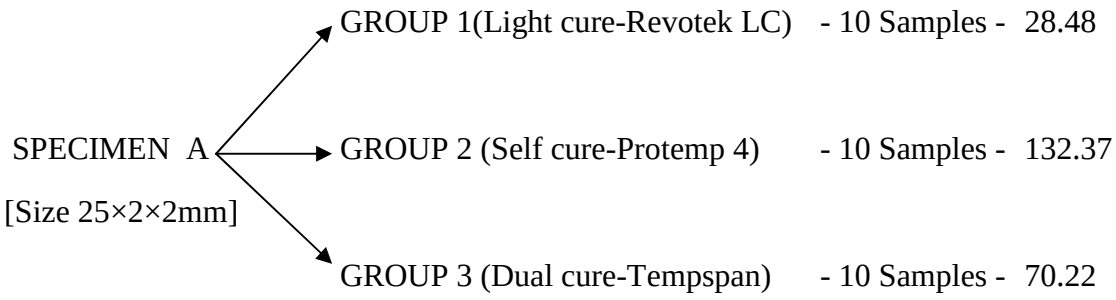
At the 10^{th} day of the color analysis the color difference between Tempspan ,Protemp and Revotek was statistically not significant at $p < 0.001$.

RESULTS

RESULTS FOR FLEXURAL STRENGTH

10 samples each from Group 1, Group 2 and Group 3 of specimen A, underwent a 3 point bending test using a Universal testing machine-INSTRON. The results obtained were tabulated and graphs were made. After statistical analysis, the following inference was obtained,.

MEAN VALUES OF FLEXURAL STRENGTH



All 3 material groups of 10 samples each, underwent a 3 point bending test using a Universal testing machine-INSTRON.As per the obtained results it shows that **Group 2(self cure-Protemp 4) has more flexural strength values compared to Group 3 followed by Group 1.**

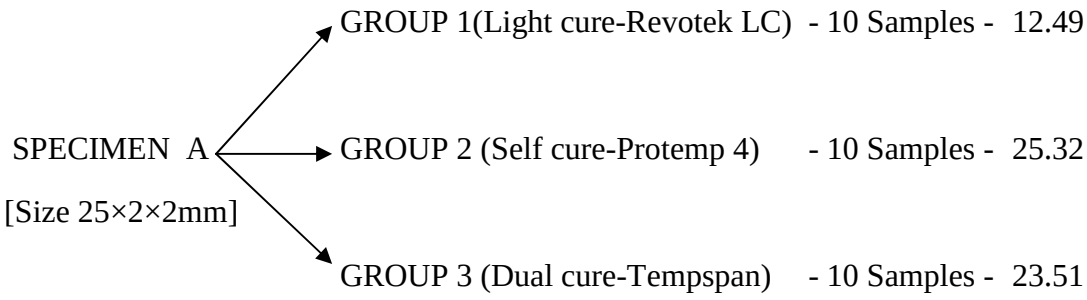
Group 2 > Group 3 > Group 1

RESULTS FOR COMPRESSIVE STRENGTH

10 samples each from Group 1,Group 2 and Group 3 of specimen A, underwent a compression test using a Universal testing machine-INSTRON. The results obtained were tabulated and graphs were made. After statistical analysis, the following inference was obtained,

MEAN VALUES OF

COMPRESSIVE STRENGTH



All 3 material groups of 10 samples each, underwent compression test using a Universal testing machine-INSTRON.As per the obtained results it is shows that **Group 2(self cure-Protemp 4) has more flexural strength values compared to compared to Group 3 followed by Group 1.**

Group 2 > Group 3 > Group 1

RESULTS FOR MICROHARDNESS

10 samples each from Group 1,Group 2 and Group 3 of specimen B, underwent microhardness testing using a Knoop Hardness Tester. The results obtained were tabulated and graphs were made. After statistical analysis, the following inference was obtained.

MEAN VALUES OF MICROHARDNESS

SPECIMEN B [Size 20mm dia circle, 2mm thick]

	1st Day	10th Day
GROUP 1(Light cure-Revotek LC) 10 Samples	5.44	5.52
GROUP 2 (Self cure-Protemp 4) 10 Samples	9.16	9.29
GROUP 3 (Dual cure-Tempspan) 10 Samples	5.89	5.98

All 3 material groups of 10 samples each, underwent microhardness testing using a Knoop Hardness Tester. As per the obtained results it is shows that **Group 2(self cure-Protemp 4) has more flexural strength values compared to compared to Group 3 followed by Group 1.**

Group 2 > Group 3 > Group 1

RESULTS FOR COLOUR STABILITY

10 samples each from Group 1,Group 2 and Group 3 of specimen B underwent colour analysis testing using Spectrophotometer at different immersion periods. The results obtained were tabulated and graphs were made. After statistical analysis, the following inference was obtained,

MEAN VALUES OF COLOUR STABILITY

SPECIMEN B [Size 20mm dia circle, 2mm thick]

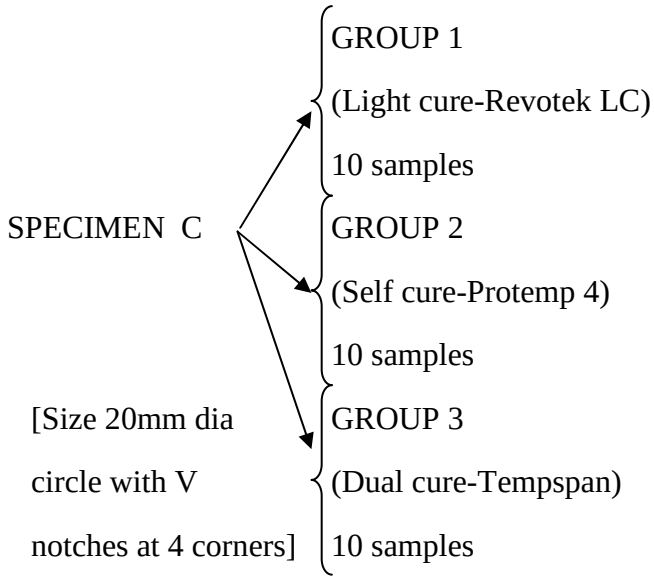
	Base	7 Days	10 Days
GROUP 1(Light cure-Revotek LC) 10 Samples	2.96	3.36	3.69
GROUP 2 (Self cure-Protemp 4) 10 Samples	3.93	4.05	4.37
GROUP 3 (Dual cure-Tempspan) 10 Samples	3.83	4.14	4.30

All 3 material groups of 10 samples each, underwent colour evaluation after different immersion periods in a staining solution. Spectrophotometer was the instrument used for the analysis. As per the obtained results it shows that **Group 1(Light cure-Revotek LC) showed least colour changes and hence it is more colour stable compared to Group 3 followed by Group 2.**

Group 1< Group 3< Group 2

RESULTS FOR POLYMERISATION SHRINKAGE

10 samples each from Group 1,Group 2 and Group 3 of specimen C, underwent analysis for polymerization shrinkage at 3 different time intervals using a Co-ordinate measuring machine. The results obtained were tabulated. and graphs were made. After statistical analysis, the following inference was obtained,



MEAN VALUES OF POLYMERISATION SHRINKAGE

	At 5 min	At 10 min	At 120 min
GROUP 1 (Light cure-Revotek LC) 10 samples	10.17	9.52	5.92
GROUP 2 (Self cure-Protemp 4) 10 samples	2.85	0.67	0.64
GROUP 3 (Dual cure-Tempspan) 10 samples	8.68	9.25	5.92

All 3 material groups of 10 samples each, underwent test for Polymerisation shrinkage at different time intervals after sample fabrication. Coordinate Measuring Machine was the instrument used for measuring the shrinkage values of the samples. As per the obtained results it shows that **Group 2(Self cure-Protemp4) shows less shrinkage values compared to Group 3 followed by Group 1.**

Group 2< Group 3< Group 1

DISCUSSION

DISCUSSION

Provisional crowns/ interim restorations are essential part of treatment in fixed prosthodontics .Provisional restorations must satisfy biologic and esthetic needs as well as mechanical requirements, such as resistance to functional loads, resistance to removal forces and maintenance of abutment alignment[(104)]. The definitive prosthesis is subsequently made on the basis of the inference recorded from the provisional restoration, whose occlusion can be shaped and carved in accordance with the patient's stomatognathic dynamics[(66)]

With regard to its significance in rehabilitations, the provisional restoration should satisfy the following requirements, that is to protect the pulpal tissue and sedate prepared abutments, protect teeth from dental caries, provide comfort and function, evaluate parallelism of abutments, prevent migration of the abutments, improve esthetics, provide an environment conductive to periodontal health, evaluate and reinforce the patients oral home care, provide anchorage to orthodontic brackets during tooth movement, aids in developing occlusal scheme before definitive treatment, evaluation of vertical dimension, phonetics, masticatory function and assists in determining the prognosis of questionable abutments during prosthodontic treatment planning [(24)].

An ideal provisional must fulfill biological, mechanical, morphological, psychological and esthetic requirements, such as good marginal adaptation, retention and resistance to dislodgement during normal masticatory function, strength and durability, non-irritating, non porous and dimensionally stable. It should also be comfortable, highly color stable, maintain physiological contours, embrasures and occlusion, highly polished, easy to remove and replacement by the dentist [(27, 11)].

Provisional crowns and fixed partial dentures are typically fabricated from one of many available methacrylate or bis-acrylate resins, each having slightly different proprietary chemistry and properties. Regardless of specific chemistry, dental polymers tend to undergo adsorption of liquids with which they are in contact.[39] Therefore, the color change over time, when subjected to various media such as coffee and tea and medicaments, such as chlorhexidine and whitening agents[30].

The basic requirement of a provisional restoration is that it should have adequate working time, , easily mixed, repaired, biocompatible with the pulp and soft tissues, dimensionally stable, color stable, resist wear etc [7].

Auto polymerizing resins have been used to fabricate provisional restorations by various methods[41]. With the introduction of composite based materials; which may be chemical, light or dual cured, acrylic resins have lost their popularity[99,41]. Composites are used over acrylics because of the chemical irritation and allergic reactions to acrylics caused by methyl methacrylate monomer over the amine accelerator, causing the composites to gain popularity over the acrylics[99,105].

Discoloration of provisional materials creates an esthetic problem and lead to patient's confidence level going down. In spite of the addition of chemical stabilizers to decrease the chemically induced color changes, provisional restorative materials are prone to absorption of liquids, so staining can easily produce color changes. Although many studies have evaluated the color stability of resin based provisional restorative materials, their results are conflicting. Haselton RD, Arnold DMA, Dawson VD[30] compared four types of Polymethyl methacrylates and eight Bis-acryl composites from different manufactures. They found that one of the Polymethyl methacrylate material was less color stable than the Bisacryl composite

resin ,whereas the other three Polymethl methacrylate materials were more color stable than Bisacryl composite resins. In a study done by Koumjian J and Firtell D[45] an auto polymerizing methyl methacrylate resin (Cold Pack) was less color stable than Bisacryl composite (**Protemp**) whereas two other auto polymerizing methyl methacrylates (Trukit and Duralay) were more color stable than Bisacryl composite (**Protemp**). Thus color change is not categorical but rather material specific.

Ana M Diaz-Arnold in their study demonstrated that bis-acrylic-type resin composite exhibited higher microhardness and greater surface integrity than the methacrylate resin materials[7].

Polymerization shrinkage plays a major role in the fit of provisional restoration. Volumetric shrinkage was 6% for Poly methyl methacrylate and 1.0% to 1.7% for composites[104]. Hence composites allow better marginal fit than poly methyl methacrylate because of less contraction due to polymerization[104]. The main disadvantage of composites are that,they are brittle in nature, which puts limit to their use but certainly not over acrylics.

Flexural strength of provisional materials is important particularly ,when the patient must use the provisional restoration for an extended period, when the patient exhibits para functional habits, or when long span prosthesis is planned[29]. Ireland et al tested the modulus of rupture (flexural strength) of provisional materials and found bis-acryl to have the highest flexural strength[61]. Research by Osman et al showed that 2 methyl methacrylate provisional materials had higher flexural strength than composite material[101]. Study by Wang RL and Moore KB found no differences between methyl methacrylate and composite provisional materials[96].

Debra R. Haselton, Ana M, in their study on testing the flexural strength of 5-methyl methacrylate based resins and 8-bis acrylic based resins used for provisional crowns and fixed partial dentures demonstrated that flexural strengths vary greatly among provisional materials[29].

Henry M Young, Charles T Smith compared the quality of 2 different materials (bis-acrylic composite resin and PAMMA) and identified the advantages and disadvantages of each material. They concluded that bis-acryl composite resin (integrity) was significantly superior to PAMMA (C & B resin and snap) as a provisional restorative material[41]. Marcus Balkenhol, Meike Christina Mautner after conducting a study which was aimed to investigate the flexural strength (FS) of provisional crown and bridge materials at different storage times using different curing mechanisms (dual curing v/s self curing) concluded that composite resin based materials are preferred v/s methacrylate based resins due to more favorable mechanical properties[59].

Different type of materials are available for fabrication of provisional restorations. They can be pre-fabricated or custom made. Prefabricated restorations such as clear celluloid shells, polycarbonate crown forms, metal crowns are readily available, while provisional can be custom made from material such as polymethyl methacrylate, polyethylmethacrylate, polyvinyl methacrylate, bis-acrylic composite resin and visible light cured (VLC) urethane dimethacrylates[29,66].

Clinicians choose a product based mainly on its ease of manipulation, health, cost and esthetics, of which health and esthetics are the prime importance[29]. Good strength, hardness and color stability can attain these needs. Presently there is no provisional material that meets optimal requirements for all situations[96].

So in this study 3 specimen groups were selected based on specimen size.

SPECIMEN A- Specimen A size was standardized with 25mm x 2mm x 2mm according to American national Standards Institute / American Dental Association specification no 27 was used for calculating flexural and compressive strength.

SPECIMEN B-. Specimen B size was standardized with 20mm diameter cicles, 2mm thickness was used for evaluating colour stability and microhardness. **SPECIMEN C- Specimen C** were standardized with stainless steel plate 2mm in thickness was used for calculating polymerization shrinkage. Six circles of 20mm diameter were machined to form the mold space. V shaped notches with a 2mm diameter at open end of V were made at 4 corners of the circles to measure the shrinkage in 2 dimensions.

Based on type of material used, 3 groups namely, Group1-Light cure(Revotek LC), Group 2-Self cure(Protemp4) and Group 3-Dual cure(Tempspan) were choosen and were subjected to undergo 5 testings namely Flexural strength, Compressive strength, Microhardness, Colour stability and Polymerisation shrinkage to find out, which group satisfy the requirements needed for fabrication of provisional restorations.

Flexural strength

Flexural strength is defined as the force per unit area at the point of fracture of a test specimen subjected to flexural loading[(103)]. Flexural Yield Strength is reported instead of flexural strength, for materials that do not crack in the flexure test. An alternate term is modulus of rupture. Flexural strength is a combination of tensile and compressive strength tests and includes elements of proportional limit and elastic modulus measurements [(66)]. Flexural strength of provisional materials is important, particularly when the patient must use the provisional restoration for an

extended period, when the patient exhibits parafunctional habits, or when long span prosthesis is planned [29]. Flexural strength also known as modulus of rupture, bend strength or fracture strength, is measured in terms of stress and is thus expressed in terms of units of pressure (or stress, the two being equivalent). The value represents the highest stress experienced within the material at its moment of rupture. In a bending stress highest stress is reached on the surface of the sample.

The flexure test method measures behavior of materials subjected to simple beam loading. It is also called a transverse beam test with some materials. Flexure testing is often done on relatively flexible materials such as polymers, wood and composites. There are two test types; 3-point flex and 4-point flex. In a 3-point test the area of uniform stress is quite small and concentrated under the center loading point. In a 4-point test, the area of uniform stress exists between the inner span loading points (typically half the outer span length).

Flexural strength, also known as modulus of rupture, bend strength, or fracture strength, is measured in terms of stress, and thus is expressed in Pascal's (Pa) in the S I system. The value represents the highest stress experienced within the material at its moment of rupture. In a bending test, the highest stress is reached on the surface of the sample.

For a rectangular sample under a load in a 3 pt bend setup:

$$= \frac{3FL}{2bd^2}$$

- F is the load (force) at the fracture point
- L is the length of the support span
- b is width of the sample
- d is thickness of the sample

The flexural strength is expressed in modules of rupture (MR) in psi (MPa). When a 3-point flexure test is done on a brittle material like ceramic or concrete,it is often called modulus of rupture (MOR). This test provides flex strength data only, not stiffness modulus .The flexural strength specimens which were prepared according to the American national standards number 27 were mounted on the universal testing machine (INSTRON 3382) to undergo a 3-point bend test. C1341-00 is the Standard Test Method for Flexural Properties of Continuous Fiber-Reinforced Advanced Ceramic Composites. The principle behind the machine is its mechanical testing of materials and combination of materials (e.g. bondings) in tension, compression, shear or peeling can be done with Instron.

Instron 3382 Series load capacity 5kN in equipped with a long travel extensometer and 0 to 25mm extensometer. The Instron 3382 electromechanical test instrument can test a wide range of materials in tension or compression. The load frame is designed to secure a test specimen between the rigid frame base and the moving crosshead.

The drive system moves the crosshead up to apply a tensile load on a specimen, or down to apply a compressive load on the specimen. The applied load is measured by a load transducer (load cell) mounted between the specimen and the crosshead. The load cell converts forces into an electrical signal that the control system measures and displays. Accuracy of stress is: 0.5% of measured stress the deformation speed is: 0 to 1 m/min. It is used in the determination of E-modulus, yield stress and strain of all types of materials by measuring stress-strain-curves measurement of fracture toughness.

In the present study, 10 samples each of Group1(Light cure-Revotek LC), Group 2 (Self cure-Protemp4) and Group3(Dual cure-Tempspan) of specimen A were subjected to undergo a 3 point bending test using Universal Testing Machine-INSTRON. The results obtained were tabulated and statistical analysis was done which revealed that Group 2 material-Self cure(Protemp4) has more flexural strength than Group 3 followed by Group 1.

COMPRESSIVE STRENGTH

For this test the samples were placed on a flat platform and another flat metal plate attached to the machines loading cell was kept in such a way that it just touched the specimen without applying any amount of force on it. Then a load of 10 kN load cell at a crosshead speed of 0.75mm/min was applied. The force the sample could withstand till the start of deformation was recorded in Newton's and calculated in MPa with the use of testing machine software.

In the present study, 10 samples each of Group1(Light cure-Revotek LC), Group 2(Self cure-Protemp4) and Group3(Dual cure-Tempspan) of specimen A were subjected to undergo compression test using Universal Testing Machine-INSTRON. The results obtained were tabulated and statistical analysis was done which revealed that Group 2 material-Self cure(Protemp4) has more compressive strength than Group 3 followed by Group 1.

Microhardness

Hardness is the resistance of the material to plastic deformation typically measured under an indentation load[(103)]. There are various provisional composite restorative materials available for the clinicians in the market.

The material should have good mechanical property to stay in the oral cavity; if the treatment is planned for a longer duration. There are few studies done to check the mechanical properties of the provisional material, but very limited studies have been done using the knoops microhardness hardness tester. Gegauff and Rosenstiel used a Barcol-type indenter to evaluate the potential change in hardness caused by the use of various luting agents on provisional resins. No study has been done to investigate the surface hardness of the newer materials[7]. Surface hardness can be used as an indicator of density, and it can be hypothesized that a denser material would be more resistant to wear and surface deterioration.

Hardness can be measured by various other hardness testers like the Vickers hardness tester, Shore hardness testers, Rockwell hardness tester, and Brinell hardness tester. The Knoop hardness test is a microhardness test-a test for mechanical hardness used particularly for very brittle materials or thin sheets, where only a small indentation may be made for testing purposes.

A pyramidal diamond point is pressed into the polished surface of the test material with a known force, for a specified dwell time, and the resulting indentation is measured using a microscope.

The test was developed by Fredrick Knoop and colleagues at the national Bureau of standards (now NIST) of the USA in 1939, and is defined by the ASTM D 1474 standard. The advantage of the test are that only a very small sample of material is required, and that it is valid for a wide range of test forces. The main disadvantages are the difficulty of using a microscope to measure the indentations (with an accuracy of 0.5 micrometer), and the time needed to prepare the sample and apply the indenter.

The indenter used is a rhombic-based pyramidal diamond that produces an elongated diamond shaped indent. Knoop tests are mainly done at test forces from 10g to 1000g, so a high powered microscope is necessary to measure the indent size. Because of this, Knoop tests have mainly been known as microhardness tests. The newer standards more accurately use the term micro indentation tests. The magnifications required to measure Knoop indents dictate a highly polished test surface. To achieve this surface, the samples are normally mounted and metallurgically polished. Therefore Knoop is almost always a destructive test.

In the present study, 10 samples each of Group1(Light cure-Revotek LC), Group 2(Self cure-Protemp4) and Group3(Dual cure-Tempspan) of specimen B were subjected to undergo microhardness testing using Knoop hardness tester. The results obtained were tabulated and statistical analysis was done which revealed that Group 2 material-Self cure(Protemp4) has more microhardness values than Group 3 followed by Group 1.

Color stability

Color is the sensation induced from light of varying wavelengths reaching the eye[(103)]. Composites are used because of their improved physical and handling properties. But the main disadvantage is that they discolor easily, resulting in esthetic problem. The methods that have been used for measuring the color are the visual method and the instrumental method[(45)]

Discoloration can be evaluated visually and by instrumental techniques (spectrophotometer and colorimeter)[(75)]. Color evaluation by visual comparison has been shown to be unreliable as a result of inconsistencies in color perception specifications among observers. Visual color assessment is dependent on the observer's physiologic and psychologic responses to radiant energy stimulation.

Inconsistencies may result from uncontrolled factors such as fatigue, aging, emotions, lighting conditions, previous eye exposure, object and illuminant position and metamerism. Since instrumental measurements eliminate the subjective interpretation of visual color comparison, colorimeters and spectrophotometers have been most commonly used to measure color change in dental materials[101].

Spectrophotometers have been shown to be more accurate in measuring the color change than colorimeters. Colorimeter generally uses three to four silicon photodiodes; that have spectral correction filters that closely simulate the standard observer functions. These filters act as analog function generators that limit the spectral characteristics of the light that strikes the detector surface. They cannot exactly match the standard observer functions with filters ; while retaining adequate sensitivity for low light levels[15]. Thus, the absolute accuracy of filter calorimeters is considered inferior to scanning devices such as Spectrophotometer. Spectrophotometers contain monochromators and photodiodes that measure the reflectance curve of a product's color every 10nm or less [**15**]. In short, a colorimeter provides an over all measure of the light absorbed, while a spectrophotometer measures the light absorbed at varying wavelengths. Because of the apparent advantages of spectrophotometer over colorimeter and visual method, color change in this study was measured using spectrophotometer.

In the present study, the CIELAB system was used for color measurement. According to Okubo S. and Kanawati A. the use of CIELAB system is recommended for dental purposes[75]. Various studies have reported different thresholds of color difference values above which the color change is perceptible to the human eye. These values ranged from ΔE equal to 1, between 2 and 3[2] greater than or equal to 3.3[2] and greater than or equal to 3.7[75]. Values of ΔE between 0

and 2 were imperceptible, values of ΔE in the range of 2 to 3 were just perceptible, values from 3 to 8 were moderately perceptible and the values above 8 were markedly perceptible[2]. A ΔE value of 3.7 or less is considered to be clinically acceptable[75].

In the present study, 10 samples each of Group1 (Light cure-Revotek LC), Group 2(Self cure-Protemp 4) and Group3 (Dual cure-Tempspan) of specimen B were subjected to undergo analysis for colour stability using Spectrophotometer. The results obtained were tabulated and statistical analysis was done; which revealed that Group 1 material-Light cure(Revotek LC) is more colour stable than Group 3 followed by Group 2.

POLYMERISATION SHRINKAGE

The purpose of this study was to evaluate polymerization shrinkage of resin composites using a coordinate measuring machine. For coordinate measuring machine measurements, composites were applied to a cylindrical S.S mold (20 mm ×2 mm), polymerized and removed from the mold. The difference between the volume of the mold and the volume of the specimen was calculated as a percentage.

Despite the major developments in new restorative materials, all resin-based composites present a certain degree of volume reduction due to the polymerization reaction. Assuming that these materials are bonded to prepared dental cavities, this volume contraction will lead to internal stress generation, which in turn, compromises the mechanical and chemical stability of the restoration and may lead to the loss of marginal integrity[38]. As a consequence, marginal leakage of saliva and its components will occur resulting in post-operative sensitivity, discolored margins, recurrent caries and fractures of the restoration margins.

These clinical consequences are the main reasons for restoration substitution, and explain; why polymerization shrinkage is recognized as the main limitation of these materials. Many studies have been conducted to evaluate polymerization shrinkage of resin composites. The results indicate that the volume contraction is dependent on the filler concentration, polymerization characteristics, volume and cavity design, restorative procedure and light intensity used for photoactivation. In addition, polymerization shrinkage has a strong influence on stress generation and most of these tensions are developed in the first few seconds after irradiance. The characterization of the shrinkage behavior and the polymerization reaction itself are an important aspect in the development of new restorative materials.

The primary goal of coordinate measuring machines (CMMs) is to obtain the Cartesian coordinates of points on a solid surface . A CMM is composed of four interconnected rigid parts, three mobile and one fixed base. A CMM with a fixed working table and a mobile bridge is the most common type. In this type of CMM, the object to be measured is placed on the fixed granite table and the operator dislocates each of the three mobile parts along the three axes using a joystick in the following sequence: the bridge (along the OX axes), the car (along the OY axes) and the probe column (along the OZ axes). Finally, a ruby probe touches a specific point on the object. Each part of the machine has a built-in guide rail, so that the relationship between the axes allows a point to be located in all three planes with one check. The resulting data are mathematically processed in a computerized system to provide dimensional and geometrical measurements of any kind of object with high precision.

The dimensions of the mold and the specimens (diameter and height) were then used to determine their volumes according to the following equation

$$V = \pi r2h$$

where *V* is the final volume, π is a mathematical constant equal to 3.14, *r* is the radius, and *h* is the height of the cylinder. Polymerization shrinkage (*V*) in % was calculated according to the differences between the volume of the mold and the specimen, using the following equation:

$$V = \frac{Volmold - Volspecimen}{Volmold} \times 100\%$$

where -*V* is the volume variation as a percentage (%), Volmold, is the volume of the mold, and Volspecimen is the volume of the specimen.[38]

In the present study, 10 samples each of Group1(Light cure-Revotek LC), Group 2(Self cure-Protemp4) and Group3(Dual cure-Tempspan) of specimen C were subjected to undergo evaluation for polymerization shrinkage using a Coordinate measuring machine. The results obtained were tabulated and statistical analysis was done which revealed that Group 2 material-Self cure(Protemp4) less polmerisation shrinkage values than Group 3 followed by Group 1.

SUMMARY AND CONCLUSSION

SUMMARY AND CONCLUSION

The aim of the study was to compare the properties of three composite provisional crown and bridge materials. Samples from provisional materials were prepared to check five different properties namely

- Flexural strength,
- Compressive strength,
- Microhardness,
- Colour stability and
- Polymerization shrinkage

A standardized procedure was adopted for the preparation of test specimens. According to specimen size ,3 groups were categorized namely

SPECIMEN **A**- Used for calculating flexural and compressive strength. Specimen A size was standardized with 25mm x 2mm x 2mm (American national Standards Institute / American Dental Association specification no 27).

SPECIMEN **B-** Used for calculating colour stability and microhardness Specimen B size was standardized with 20mm diameter cicles, 2mm thickness

SPECIMEN **C-** Used for calculating polymerization shrinkage.

Specimen C were standardized with stainless steel plate 2mm in thickness. Six circles of 20mm diameter were machined to form the mold space. V shaped notches with a 2mm diameter at open end of V were made at 4 corners of the circles to help us in measuring the shrinkage in 2 dimensions.

According to types of materials used, it was categorized into 3 groups namely,

Group 1 Light cure material – REVOTEK LC

Group 2 Self cure material – PROTEMP 4

Group 3 Dual cure material – TEMPSPAN

10 samples from each of the 3 groups were subjected to five different property testings. From the results obtained,

1) **Group 2 Self cure material – PROTEMP 4 has more flexural strength.**
2) **Group 2 Self cure material – PROTEMP 4 has more compressive strength.**
3) **Group 2 Self cure material – PROTEMP 4 has more microharness.**
4) **Group 1 Light cure material – Revotek LC is more colour stable.**
5) **Group 2 Self cure material – PROTEMP 4 exhibits least shrinkage.**

1. When provisional restoration is to be given in the **esthetic region** then urethane dimethacrylate based material (**Revotek LC**) can be used.

2.When the provisional restoration has to be placed for a **longer span of time** then chemically cured bis-GMA based material (**Protemp 4**) can be used.

3. If a provisional long span bridge has to be placed then chemically cured Bis-GMA based material (**Protemp 4**) can be used.

It was inferred from the study that no one material was superior in all five tested parameters. Although these products are made from similar materials, variation in formulation including the cross-linking agents, appear to have resulted in variations in the performance. Further investigation is required to elucidate the nature of product differences and the way in which these materials respond to the oral environment.

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