Introduction

Fixed prosthodontic treatment needs indirect construction of the definitive prosthesis in the dental laboratory. While the definite prosthesis fabrication has been finished, a provisional restoration is necessary simulating the definite restoration in the shape and position. The requirements for satisfactory provisional restorations differ only slightly from the definitive treatment they precede.

The terms provisional, interim, or transitional have been routinely used interchangeably in the literature. The term temporary, is controversial and is considered a wrong term by some, because provisional restorations serve many functions, and “temporary” treatment may be interpreted as one of lesser importance or value.

Time of using the conventional short term Provisional restoration materials from the preparation of the teeth to the final restoration accomplishing usually is well tolerated by the teeth, but if used for longer time, it may cause tooth sensitivity and potential pulp damage. In special cases, provisional treatment has to function for extended intervals and provide long-term tooth protection and stability while the definitive treatment is accomplished. The duration between preparation of teeth and cementation of final restorations can vary from a few days for straightforward cases (short term), to several weeks (medium-term) or even, in the case of complex reconstruction, several months (long-term). The longer provisional restorations are in the mouth, the greater are the requirements of material from which they are made.

Long-term provisional restoration is used in long term Extensive prosthodontic treatment, such as Occlual vertical dimension raising, alveoloplasty, tissue augmentation, dental implant, and orthodontics.

Many modifications are tried to improve physical, optical, and mechanical properties of the provisional restoration. The Methods of reinforcing interim fixed dental prostheses have included metal wire, cast metal reinforcement, processing of acrylic resins, and reinforcement with various types of fibers such as carbon, polyethylene, glass and rubber [1]etc, or modification of fabrication method as direct, indirect fabrication and milling from CAD/CAM resin blocks[2].

Review of Literature

Provisional restoration is one of the main dental applications of polymeric biomaterials. PMMA resin is the oldest group of polymer-based direct temporary materials. In 1932 Imperial Chemical Industries developed polymethyl methacrylate (PMMA) as a clearer and more durable form of safety glass in cast sheet form. The earliest time that resins were used for the purpose of provisional restoration was around 1937, and it was in the form of heat-cured acrylic resins such as Biolon. The material popularity increased so fast that, by 1946, 95% of the denture bases were fabricated with it [3-5].

This was followed by autopolymerizing polymethyl methacrylate resins such as Alike, Trukit, Neopar, Jet, Coldpac, Temp Bridge resin, and Duralay circa 1947[6-9]; vinyl polyethyl methacrylate materials such as Snap and Trim in 1960s[10] ;ethyl imine derivatives such as Scutan in 1969[7-11]; and composite in 1980 (Protemp, VisioGem, and Triad)[12, 13].

The biggest improvement of polymer base restorative materials came in the late 1950s and early 1960s. First, Dr. Rafael Bowen started fundamental work on the use of high molecular weight epoxy and methacrylate derivates that incorporated inorganic filler loading. The introduction of a high molecular weight, dysfunctional monomer (known as bis-GMA or Bowen’s Resin) greatly facilitated the commercial development of materials containing inorganic fillers: composites. Bis-acrylic resins are hydrophobic materials similar to bis-GMA. [4]

The visible light polymerized resins were introduced in the 1980s. These materials require the addition of urethane dimethacrylate. Visible light energy and a comphoroquinone/ amine photo initiator initiate the polymerization of the urethane dimethacrylate material. The incorporation of filler material (microsilica) reduces the polymerization shrinkage.[14]

The provisional restoration has many functions. A good provisional restoration will protect pulpal tissue and sedate prepared abutments, as well as protect teeth from dental caries, prevent abutments migration, and provide comfort and function. It can be used in checking the path of insertion of the prepared abutments. Provisional restoration is important tool used during the patient’s oral hygiene reinforcing period. It also used in providing anchorage for orthodontic brackets during tooth movement. It can be used in reconstructing and evaluating an occlusal scheme before definitive treatment allowing the evaluation of vertical dimension, phonetics, and masticatory function. In addition to that the provisionals can be used in simulating the form and function of the planned definitive prosthesis to evaluate the therapeutic effectiveness of a specific treatment plan before beginning of the definitive procedures. This pre-definitive step is called mock up. Esthetics is so valuable specially in the anterior zone. Provisional restoration can compensate the deteriorated esthetics due to tooth preparation and the edentioulous spaces until the finishing of the definite prosthesis in the dental lab.

Gingival re-contouring with a provisional implant restoration is a non-surgical and non-procedure-sensitive method to enhance tissue healing and reach the optimal gingival contour prior to definitive restoration fabrication. Implant restoration with the optimal emergence profile should provide superior esthetic and functional results. The use of a provisional restoration as an impression coping is one of the methods to make an impression of the soft tissue around the implant. The objective of this technique is to identify the crown margin using a custom abutment and capture the soft tissue around the implant at the same time.

The dentist must carefully understand the esthetic needs of the patient and what he expect the final result to be. In the same time he must explain to the patient restorative treatment limitations, so Mock up or provisional simulation of the final result which aids in communication between the dentist and patient is so valuable. These restorations can often be used before any irreversible treatment to preview potential esthetic outcomes and discuss the limitations of specific restorative treatment. In other situations, provisional restorations can be fabricated and readily modified after tooth preparation but before fabrication of the definitive restoration. In these cases, the provisional can be modified until the satisfaction of the patient, then the modified provisional restoration acts as the blueprint for the final restoration fabrication.

Provisional restorations evaluate the potential consequences from the occlusal scheme alteration and the occlusal vertical dimension raising in patients with malocclusion or with severely worn teeth before the fabrication of the definitive restoration with the new occlusal correction modification.

The basic requirements of ideal provisional restoration are: resist dislodgment during normal masticatory forces application ,adapt accurately to the preparation margins, strong and durable, nonirritant to the pulp and the gingival tissue, without surface porosity, low dimensional change, high esthetics, simulate the normal tooth contour, easily maintained by the oral hygiene measures, color stable, and resist plaque accumulation.

Materials commonly used to fabricate provisional restorations are polymethyl methacrylate, polyethyl methacrylate, bis-acryl composite, Bis-GMA Composite Resins and Urethane Dimethacrylate Resins.

Autopolymerizing polymethyl methacrylate (PMMA) first appeared around 1940[6, 8]. Polymethyl methacrylate (PMMA); asynthetic polymer of methyl methacrylate, was formerly the most popular material because of its high strength, color stability, and ease of repair[15].However, PMMA generates significant heat on polymerization[16-18], which may cause pulpal and surrounding tissue discomfort[19], and polymerization shrinkage may deform the restorations[14, 20]. Because of these disadvantages, bis-acryl composite resins have replaced PMMA as the most frequently used interim material.

Ethyl methacrylate; introduced in the 1960s [21],overcomes some of the disadvantages of the methyl methacrylates but does not provide some of the advantages of that group. As with the methyl group, ethyl methacrylates have good polishability and offer good stain resistance[22, 23]. However, they may be better suited than methyl methacrylates when the provisional needs to remain intraorally for longer periods of time[24]. Additionally, they have a much lower exothermic setting reaction and will be kinder to the pulp and more comfortable to the patient when larger volumes are being cured intraorally[18, 19]. Another benefit of the ethyls over the methyls is they have much lower setting shrinkage[25]. Unfortunately, the surface hardness and fracture toughness of these materials and their transverse strength is lower than their methyl cousins and durability in high-stress areas or long pontic segments will be lower[26].

Vinyl ethyl Methacrylate is another alternative to the methyl methacrylates. These are also referred to as PVEMA acrylics, as they fall into the same broad group as the ethyl methacrylates. This group of provisional material is also available as a powder and liquid formulation and is self-curing. The liquid consists of predominantly vinylethyl methacrylate and other chemicals and the powder is predominantly a polymer and benzoyl peroxide. These materials are available in various tooth colors. Vinylethyl methacrylate provisional materials, as with the methyl and ethyl versions of methacrylates, may be added to by addition of more of the same material and, the best adhesion will occur to a clean surface that has been wetted by the monomer liquid. [27]

Bis-acryl Composite provisional resins were introduced with an aim to overcome the negatives of the methacrylates. This group of provisional materials was presented as paste&paste materials. These are dispensed from preloaded syringes or cartridges and mixed through an automix tip. This provides consistent mixtures with no air incorporation into the final mix. Bis-acryl resins have very low exothermic setting reactions, unlike the methacrylates, and are kinder to the underlying pulpal tissue [17, 18, 27, 28]. Additionally, they have low shrinkage, providing good marginal fit with good transverse strength and abrasion resistance [29, 30] However, these materials are more brittle than the methacrylates and, because of the thick oxygen-inhibited layer present on the surface upon setting, they are less stain-resistant than the material previously discussed.[31] Also, because of dissimilar chemistry, flowable composite or dentin adhesives do not readily bond to the Bis-acryl material, making repair or modification difficult [15, 32, 33]. Another negative to these materials is the limited shades available. Some manufacturers have introduced color modification materials to match these materials. The Bis-acryls are more costly than the methacrylates, but may be better indicated for anterior temporaries than the methacrylates because of their improved esthetics[27].

Bis-GMA Composite provisional resins are a further extension of an attempt to eliminate the problems associated with both methacrylates and Bis-acryl materials. They provide good marginal fit, as did the Bis-acryls, and even lower shrinkage and exothermic setting[34]. Upon setting, a thin oxygen- inhibited layer is present and they show good polishability.[34] These materials are less brittle than the Bis-acryls and show good fracture resistance in pontic areas.[34]As their chemistry is similar to the traditional composites used for restorations, these can be repaired with flow able composites.[34] When larger portions are to be added, coating the surface of the Bis-GMA provisional with a dentin adhesive and light-curing permits hybrid composites to be used for reshaping the provisional restoration.[34] As with the Bis-acryl materials, these are more expensive than the methacrylates

Urethane Dimethacrylate composite Resin Recently have been introduced to improve the mechanical properties of interim restorations in the area of toughness and flexibility[35]. Previous studies have shown that urethane composite resins are tougher because of the flexibility of the urethane linkages within thepolymer matrix[36, 37].Polymers made with low molecular weight urethane dimethacrylates have similar or slightly less water sorption than polymers prepared from Bis-GMA[38, 39] but significantly more water sorption than polymers made with nonhydroxylated Bis-GMA analogs such as ethoxylatedbisphenol A glycol dimethacrylate (Bis-EMA)[39-41]. Excess water sorption at the surface of the polymer canlead to hydrolytic degradation of the resin polymer matrix and a decrease in mechanicalproperties.[42]

1. Mechanical properties:-

Many studies on the resins used for provisional restorations compared the mechanical properties of methacrylate and composite-based resins; however, the results were controversial.[43-45]

Wang et al. (1988) [43] tested Four acrylic resins and two composite resins for fabricating provisional fixed prosthodontic restorations to determine temperature change during polymerization, surface hardness, marginal fit, wear resistance, transverse strength, transverse repair strength, surface roughness and polishability, color stability, and stain resistance. While certain materials exhibited advantageous properties in one or more of the tests, no one material was superior to the others in all tests.

Osman, Y. and C. Owen (1993)[44] tested five autopolymerizing provisional resin materials; Caulk temporary bridge resin (polymethyl methacrylate) materials, G-C Unifast temporary resin (Polymethyl methacrylate), Protemp (composite material), Scutan (epimine material)and Snap (Polyethyl methacrylate). 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 the Snap poly(ethyl methacrylate) material. This material also displayed a large standard deviation because of the effect of two of 11 specimens, which displayed markedly lower values. This finding requires further investigation. In addition to that in decreasing order, the fracture resistance of the other materials was as follows: the poly(methyl methacrylate)materials Caulk Temporary

Bridge resin and G-C Unifast Temporary resin, the Protemp composite material and the Scutanepimine material.

These results differ from those reported by **Gegauff et al. (1987)** **[46]** that evaluated the fracture-resistance of six commercially available resins. Fracture toughness was used to compare two poly (methyl methacrylate)s, two poly (R' methacrylate)s, an epimine, and a composite. The effect of curing the resin in a pressure pot was also investigated. He found that theepimine and two poly (methyl methacrylate) resins demonstrated the greatest fracture toughness whereas poly (R' methaerylate) had the lowest. But they claimed that it can be explained by the difference in test method used; the study by Gegauff et al placed the test specimens in tension only.

Ireland et al. (1998) **[45]** recorded and compared the flexural elastic moduli and moduli of rupture of four Materials; apolymethyl methacrylate resin (Jet temporary crown and bridge resin), a light-polymerizing provisional restorative material(Triad VLC), a dual-polymerizing provisional restorative material (Provipont DC), and a resin made from a 50:50 mixture of two polymethyl methacrylate polymers (Jet temporary crown and bridge resin and Jet orthodontic resin) polymerized with the Jet monomer, after 24 hours, 30 days, and 60 days of water storage at 37° C. They found that Provipont DC resin exhibited significantly higher flexural elastic moduli and moduli of rupture values at the 24-hour test time. However, Provipont DC resin exhibited the greatest decrease in these values over time. Hence Because of the controlled conditions under which the laboratory fabricated test specimens were made, it is difficult to correlate in vitro performance to clinical performance of restorations fabricated intraorally. However, Provipont DC resin exhibited mechanical property values at the 24-hour time period that were higher than the poly-methyl methacrylate materials tested. Provipont DC material 30-day mechanical property values were higher than all the 24-hour and 30-day polymethyl methacrylate material values and all 60-day values, except the Jet material 60-day flexural elastic modulus. This value was similar to that of the Provipont DC 30-day group. The decrease in values for these Provipont DC properties over time in water storage should be considered if the restoration must remain in clinical function for an extended time.

Other compared the fracture resistance of provisional materials made of PMMA to those made of composite resin. Almost all of them confirmed that although composite resin material had higher flexural resistance than PMMA materials, composite resin was a brittle material and its fracture resistance was lower than that of PMMA.[47-49]

Yilmaz, A. and S. Baydas (2007) [47] Compared the fracture resistance of polycarbonate crowns, prefabricated by the manufacturer (3M Polycarbonate Crown), and the temporary crowns, fabricated in the dental laboratory environment, were fabricated using bis-acryl composite (Protemp II), autopolymerizing PMMA resin (BISICO Temp S), and heat-polymerized PMMA resin (Major C&B-V Dentine). The results showed that autopolymerizing acrylic resin (BISICO Temp S) had a lower strength value than polycarbonate crowns. However, it showed that the highest strength value among other materials.

Kim, S.-H. and D.C. Watts (2007)[50]evaluated in vitro the edge-strength of polymer-based provisional crown and fixed partial denture materials at increasing distances from an edge. Three dimethacrylate-based provisional crown and fixed partial denture materials (Protemp 3 Garant, Luxatemp, and fast set Temphase) and one monomethacrylate-based one (Trim) were selected. Seven disk-shaped specimens of 12 mm in diameter and 2.5 mm in thickness for each material were fabricated and stored at 37 ◦C and 80% relative humidity for 1 month. The edge-strength was measured by using a CK 10 testing machine at a distance of 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, and 1.0 mm from the edge of the specimen. All experiments were carried out in triplicate at each distance at 23 ± 1◦C. The data were statistically analyzed using one-way ANOVA and the multiple comparison Scheffe test at the significance level of 0.05. Trim showed severe deformation without chipping during loading at all distances. Protemp 3 Garant showed indentation at over 0.8 mm from the edge, and for Luxatemp and fast set Temphase over 0.6 mm from the edge without chipping. At 0.5 mm from the edge, the highest values were displayed by Protemp 3 Garant, approximately three times those of fast set Temphaseand Luxatemp. The strengths of fast set Temphase and Luxatemp were not significantly different ($p > 0.05$). Linear regression between the distance from the edge to 0.7 mm and strength values of Protemp 3 Garant produced a correlation coefficient, $R = 0.99$. Hence he concluded that the dimethacrylate-based provisional materials tested were stronger in edge strength than the monomethacrylate-based one which showed severe deformation without fracture

Fahmy, N.Z. and A. Sharawi (2009) [48] Studied the Effect of Two Methods of Reinforcement on the Fracture Strength of Interim Fixed Partial Dentures. Three resin materials are used in the test; duralay (PMMA), Protemp (Bis-GMA) and Snap (PEVMA). The three resin groups were further divided into three subgroups depending on their reinforcement. Two materials were used for reinforcement: ametallic mesh (316-000-00 Dentaurum) and ultra-high modulus polyethylene fibers (UHMPE, DVA Reinforced polyethylene fiber, Dental Ventures of America, Riverside, CA) .Specimens were loaded compressively, and the load required to fracture the specimens was recorded in Newton. The results showed that Initially, Duralay resin had higher fracture resistance values than Protemp II and Snap. Fiber and mesh reinforcements increased the fracture resistance of Snap. No statistically significant difference was evident among the fracture resistances of the three mesh-reinforced resin FPD restorations. The three resins had similar moduli. Fiber and mesh reinforcement increased the modulus of Duralay resin but did not change that of Protemp and Snap. Fiber and metal mesh reinforcements may alter the fracture strength and modulus of some, but not all, provisional resins.

Ha et al. (2010)[51] investigated the diametral tensile strength of polymer-based temporary crown and fixed partial denture (FPD) materials, and the change of the diametral tensile strength with time. One monomethacrylate-based temporary crown and FPD material (Trim) and three dimethacrylate-based ones (Protemp 3 Garant, Temphase, Luxtemp) were investigated.20 specimens (Ø 4 mm × 6 mm) were fabricated and randomly divided into two groups (Group I:

Immediately, Group II: 1 hour) according to the measurement time after completion of mixing. Universal Testing Machine was used to load the specimens at a cross-head speed of 0.5 mm/min. The data were analyzed using one-way ANOVA, the multiple comparison Scheffe′ test and independent sample t test ($\alpha = 0.05$). He found that Trim showed severe permanent deformation without an obvious fracture during loading at both times. There were statistically significant differences among the dimethacrylate-based materials. The dimethacrylate-based materials presented an increase in strength from 5 minutes to 1 hour and were as follows: Protemp 3 Garant, Temphase, and Luxatemp. Protemp 3 Garant showed the highest value. Hence he concluded that the dimethacrylate-based temporary materials tested were stronger in diametral tensile strength than the monomethacrylate-based one. The diametral tensile strength of the materials investigated increased with time.

Oliva, and G.S., (2010) [52] Evaluated the four mechanical properties considered to be pertinent to their clinical performance: flexural strength, flexural modulus, fracture toughness and microhardness of Groups of two chemically activated acrylic resins (Jet Acrylic and Snap) and 4 composite, one dual cure (Luxatemp Solar), one Chemically activated (Protemp Plus) and two light activated (Protemp Crown and Radica) Six groups of samples, 2 groups from methacrylate based and 4 groups from composite based materials were fabricated. Samples from each group were evaluated for microhardness (n=10), flexural strength and flexural modulus (n=20) according to ISO 4049, and fracture toughness (n=20) according to ISO 13586. Ten samples for flexural strength, flexural