REVIEW ARTICLE

Reinforcement of Interim Fixed Partial Denture: A Review

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Abstract

Interim fixed partial denture (FPD) is an important phase of fixed prosthodontic treatment. The patient has to wait for certain days for the definitive prosthesis as laboratory work is involved into making of it. The interim FPD should provide sufficient durability to withstand the forces of mastication in that waiting period as a fractured interim restoration is damaging to the prosthodontic care and may lead to an unscheduled appointment for repair. It can be considerably difficult for the dentist as well as the patient to maintain the provisional prosthesis. Any damage to these interim fixed partial dentures may cause tooth movement and functional problems making the procedure tedious. It is important that provisional prosthesis shall fulfill the esthetical, mechanical, and biological requisites in order to make the treatment successful.

Keywords: Fiber reinforced composites, Fiber reinforced interim fixed partial denture, Fiber reinforcement, Glass fibers, Interim fixed partial denture, Polyethylene fibers, Provisional restoration.

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Introduction

Rehabilitation of partially edentulous patients has been done using fixed partial prosthesis since many decades, and it has been proven to be a well-established treatment protocol.[1] Fixed partial prosthesis treatment is done to cover a natural tooth either fully or partially as well as implant abutments. For the making of a final fixed partial denture, a clinician has to depend on the dental laboratory which might take about 7–10 days.[2] During this waiting period, as much of the tooth structure is removed during tooth preparation, and the teeth become smaller in size which is why it compromises the masticatory efficiency, occlusal harmony, and esthetics of a patient. Here, the role of a provisional or interim restoration is to be considered.[3]

The tooth should be protected from the oral environment after preparation so that it serves as a functional and esthetical restoration with occlusal stability in order to associate the definitive prosthesis with most favorable treatment outcome.[2] Interim fixed partial prosthesis shall mimic the final prosthesis independent of the material used for the restoration.[4] It plays a vital role as an esthetic and functional trial for the designing of the definitive prosthesis.

Importance of the provisional restoration is often overlooked, and it is considered that the final treatment would rectify the detrimental effects of a poorly fabricated transitional restoration. The interim coverage is especially critical for patients in cases like where a fixed restorative therapy is to be given along with periodontal therapy or where full-mouth rehabilitation is to be done.[5]

An interim restoration is important for the protection of pulp, restored abutment, prevention of migration of abutment, and for providing an environment for good periodontal health. It helps to esthetically enhance patient's confidence and reinforce oral hygiene of the patient. It is needed to evaluate the vertical dimension, aesthetics, speech, and masticatory function. One of the most salient features of provisional is that it aids in developing an occlusal scheme of patient prior to the final prosthesis.

The basic requirements of an interim restoration are that it should have good marginal adaptation, should be retentive and resistant to dislodgement during normal masticatory function, and be dimensionally stable. It should be biocompatible, easy to repair, esthetical, and comfortable for the patient. It must allow the maintenance of good oral hygiene. It has to be morphologically correct and physiologically acceptable. It should be durable and must withstand forces during masticatory function.[5]

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Discussion

Materials Used for Making an Interim Fixed Partial Denture

Various materials have been used for making an interim fixed partial denture over the years.

The quality of provisional restoration is dependent on the following:

- Good marginal integrity
- Adequate strength to withstand forces
- Adequate rigidity
- Ease of performing the procedure (either direct or indirect)[6]

During selection of a material for interim restoration, a clinician must consider the ease of manipulation, physical as well as mechanical properties (like rigidity, reparability, color stability, marginal integrity, polymerization shrinkage, and exothermic

reaction), and cost effectiveness of a material. Patient's approval and satisfaction are also necessary in this selection process.[2]

Materials commonly used are as follows:

Polymethyl methacrylates (PMMAs), polyethyl methacrylates (PEMA) or n-polybutyl methacrylates (PBMA), vinyl ethyl methacrylate resins, butyl methacrylate, urethane dimethacrylate resins (UDMA), epimine, metals, materials made of polycarbonate and bis-acryl composites, cellulose and plastic shells in form of preformed matrices, and bis-GMA composites.[2,6]

- PMMA (POLYMETHYL METHACRYLATES)
  PMMA was introduced in 1937 by Dr Walter Wright. It is the most common material used to fabricate interim fixed partial denture. The benefit of using PMMA is that it has an ease of processing, accurate fit, good marginal adaptation, and acceptable stability in the oral environment, and it is inexpensive. The reasons why there was a need for finding other materials than PMMA was the lack of enough strength and fracture due to fatigue or degradation of the material, exothermic polymerization, high polymerization shrinkage, and low wear resistance.[2]
- BIS-ACRYL COMPOSITES
  Bis-acryl composites were introduced to overcome the disadvantages of methacrylates. These are marketed as preloaded cartridges and are used with the help of an automixing tip. Bis-acryl composites contain bifunctional substrate in order to allow cross-linkage with one another which forms monomer chain cross-linkage. This cross-linkage causes increased toughness and impacts strength. They have inorganic fillers that help augment their abrasion resistance.[2]

Reasons why composites are considered better material than any other material are its good strength, wear resistance, low exothermic reaction, and reduced tissue toxicity. Also, it is esthetically superior and has a good bond of restoration to the abutment teeth.[7] But as there is no perfect material available, there are certain disadvantages of composites as well, like the material is quite expensive and brittle and has less polishing ability.[2]

Reinforcement of the Fixed Interim Partial Restoration

Fracture of acrylic resin dentures or fixed temporary prosthesis is a common clinical finding. A dimensionally stable, strong, and accurate fit interim restoration is important for the treatment of partially edentulous patients. Fracture of interim leads to discomfort to the patient, extra appointment, and excessive time period for treatment. Thus, fracture resistance of interim fixed partial denture material is an important factor and should be considered before selecting a material for provisional restoration for its clinical success.[8]

The concept of fiber reinforcement was first applied to denture acrylics in the 1960s for improving the fracture resistance. Recently, reinforcement is used for composite resins as well as acrylics which helps in overcoming the low resilience and fracture resistance of the material. Fiber reinforcement is basically the incorporation of thin fiber filaments which is a foreign material into a base resin.[9]

Fibers are available as woven, twisted, and loose in the form of cloth (tape or rope), mat, roving, and knytex. These fibers are manufactured as pre-impregnated with resin and nonimpregnated. In pre-impregnated with resin types of fibers, the fiber bundle is prewetted with a low viscosity resin in a controlled manufacturing process in the laboratory. These are mainly used in the manufacture of indirect bridges. In nonimpregnated, the fibers are wetted using a low viscosity unfilled resin chairside only. These are mostly made up of woven fiber bundles.[10]

The fiber properties to be considered are as follows:

- Weight: The more the weight of the fiber incorporated, the more resistance is provided to the material.
- Strand direction: It can either be unidirectional, bidirectional, or multidirectional. The fibers will resist the forces in the direction parallel to the fiber direction. The unidirectional fibers would improve properties in a single direction and are useful in area where the direction of highest stress is predictable (like pontic regions in fixed partial dentures). Multidirectional are useful where it is difficult to predict direction of highest stress, for example, full-crown restorations. Therefore, bidirectional/multidirectional is considered better than unidirectional as they will resist load in a single direction only.
- Weave: The weave of the fibers affects the flexibility of the fiber. It can be of two types: open and modified twirl.
- Fiber composition
- Position of the fiber in the restoration: It has been controversial so as to which area is the best area to resist forces in a fixed partial restoration. Some studies suggest that reinforcement can be done in the occlusal half of the restoration to have the highest resistance,[11] whereas few others suggest that is should be placed in the areas of highest tensile forces between the pontic and the abutment and the tissue surface of the bridge.[12]

The reinforcement of materials leads to decrease in the crack propagation through the material, and it increases the fracture resistance, tensile strength, and flexural strength.

Materials Used for Reinforcement of Fixed Interim Partial Restorations

Initially wire was used for the reinforcement of acrylic resins. It is one of the most common reinforcing techniques and includes use of solid metal forms that can be embedded into the prosthesis. The increase in strength by the incorporation of a lingual bar/stainless steel wire was thought to be not much clinically significant by some, whereas in another study, it was found that if at least 50% of the cross section of the prosthesis is occupied by metal, it could be effective. Chromium-cobalt has a reinforcing action and can be used to strengthen acrylic resins. Wires can be used in different form: flat, braided, mesh, or two-strand wire. It can also be used in different diameters. Also, greater the dimension of the wire used, more the strength of the specimen was observed.[13]

After wire, fibers came into use for reinforcement of materials. The first ones to be used were carbon and Kevlar. In 1970s, carbon was used to reinforce acrylic resins. Over the period of time, high-density polyethylene, glass, and polypropylene of 10–20 microns were used more than the earlier mentioned fibers as they were superior in appearance.[9]

Pre-impregnated carbon fibers available nowadays are unidirectional C-Post (Bisco). Non-impregnated available Kevlar unidirectional fibers are Fibreflex (Biocomp). Carbon, even though has great rigidity, is not much used nowadays due to its black color which is why improved esthetics were seen by the use of glass and polyethylene fibers.

Polyethylene is a naturally occurring crystalline polymer drawn at a temperature below its melting point for producing fibers. The

favorable properties of polyethylene are that it is biocompatible and ductile, has low density, and can be drawn into monofilament fibers and woven into fabrics. The main advantage is that it is of natural tooth color and hence provides good esthetics.[14] The available fibers nowadays are preimpregnated: Splint-it (Jeneric/Pentron)—polyethylene weave-type chairside fibers; nonimpregnated: connect (Kerr)—polyethylene braid-type; DVA fibers (dental/ventures)—polyethylene unidirectional type; and Ribbond (Ribbond)—polyethylene leno weave type. Ribbond (Ribbond Inc., Seattle, Washington, USA) is a polyethylene fiber which is open weave with the threads twisted in pairs.[10]

The problem with all polyethylene fibers is that there is inadequate adhesion of the ultra-high molecular weight polyethylene (UHMWPE) to the polymer matrix. Attempts have been made to do surface treatments with plasma, flame, chemical, or radiation to increase the adhesion, but none was found to enhance it much.[6]

Glass fibers are considered one of the best options for reinforcement now. These are available as two types: E glass and S glass. E glass is the most economical and widely used fiber. These have better potential of reinforcement despite the difficulty of achieving adequate impregnation of fibers. Glass fibers are considered superior to other fibers as they have long-term stability against water and high impact strength and provide high fatigue resistance. There are some problems faced while using these fibers like fraying and spreading of the fibers while placement of nonimpregnated fibers, difficulty in manipulating of non-impregnated fibers, inadequate impregnation, and void formation in the restorative material in case of increased concentration.[15] The glass fibers available in the market are as follows:

- Preimpregnated: Fibrekor (Jeneric/Pentron), Vectris pontic (Ivoclar)—Lab purpose unidirectional glass fibers. Vectris (Ivoclar; Schaan; FL) is a glass fiber which is preimpregnated with Bis-GMA which allows cross-linking with the overlying composite structure. Vectris frame and single (Ivoclar), everStick net (Stick Tech Ltd)—Lab purpose mesh glass fibers. Stick (Stick Tech Ltd; Turku; Finland) is a preimpregnated glass fiber with light curing monomer which cross-link during polymerization of the overlying composite, forming a multiphase polymer network.[10] Splint-it (Jeneric/Pentron), everStick (Stick Tech Ltd)—Chairside unidirectional glass fibers. Splint-it (Jeneric/Pentron)—Chairside mesh glass fibers.
- Nonimpregnated: Fibre-splint (Polydentia Inc.)—glass weave type, GlasSpan (GlasSpan)—glass braid type. GlasSpan (GlasSpan, Exton, Pennsylvania, USA) is a braided open weave glass fiber which is nonimpregnated and has a system of fibers composed of silane etched glass. It is available as a 4-mm tape or 2-m and 3-mm rope.[9]

Fiber Reinforced Composites

Fiber reinforced composites (FRCs) have a lot of industrial and aerospace applications as they have good strength and are light in weight and noninflammable. In dentistry, they can be used for both direct and indirect restoration.

FRCs can be used for various clinical applications like that for immediate replacement (transitional or long-term interim fixed partial dentures), fixed bridges (anterior or posterior), posttrauma splinting, single indirect restoration (inlay, onlay, and partial or full veneer crowns), direct composite restoration, fixed orthodontics retainers, and for repair or reinforcement of dentures.[10]

FRCs have some major advantages of single visit immediate replacement, affordable treatment cost and being a metal free restoration. It has better esthetics and can be repaired readily, suitable for young and elderly patients and also appropriate for transitional as well as long-term treatment. Wear of opposing teeth is less in comparison with metal ceramic restoration. FRCs can be used with minimal or no tooth preparations and can be easily produced without the need of investing and casting.[16]

Drawbacks of FRCs include lack of enough rigidity for long-span bridges and potential wearing of the overlying veneer composite in patients with significant parafunction, and space required is greater in posterior occlusal situations in comparison with metal occlusal surfaces.

Conclusion

The use of fiber reinforced restorations in dentistry is increasing, as their potential for extending the range of possible treatment needs met by acrylic resins and resin-based composites is being realized. An appreciation of the critical factors of the fibers which have an effect on the properties of the provisional restorations will assist the practitioners and dental technicians in designing and delivering high-quality treatments. This will further maximize the success rate and longevity of these new materials. It is likely that research with new materials not yet used in biomedical applications will further extend the potential of the temporary materials used for interim fixed partial dentures. The pace of change in this field is so rapid that the future is very encouraging.

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