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Original article

Evaluation of flexural strength of resin interim restorations impregnated with various types of silane treated and untreated glass fibres

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ABSTRACT

Background: Flexural strength is an important mechanical property that determines the long-term prognosis of interim restorations. Studies are lacking regarding the effect of silanation of the various types of glass fibre impregnation on the flexural strength of resin interim restorations.

Methods: A customized metal die was milled to simulate the prepared abutments of a three-unit fixed dental prosthesis. A total of seventy five samples of interim fixed dental prostheses were prepared using autopolymerizing tooth colour acrylic resin. Unidirectional and woven forms of glass fibres (Stick and Stick Net), which were silane treated and untreated were used to reinforce the resin matrix. Fifteen samples were prepared for each group along with unreinforced group serving as control. The flexural strength was evaluated with universal testing machine.

Results: The means and standard deviations of flexural strength for different groups were 13.90 ± 2.96 (control), 61.58 ± 5.26 (unidirectional fibres), 30.89 ± 3.60 (woven fibres), 112.05 ± 5.51 (silane treated unidirectional fibres) and 73.85 ± 4.10 (silane treated woven fibres) respectively. The mean flexural strength of silane treated unidirectional fibres (112.05 MPa) was highest and statistically highly significant ($P < 0.0001$) compared to all other groups.

Conclusions: Within the limitations of the current study, flexural strength of the reinforced PMMA interim fixed dental prosthesis was significantly higher ($P < 0.0001$) when compared to the unreinforced PMMA interim fixed dental prosthesis. The use of silane treated unidirectional glass fibres is an effective method of reinforcing interim fixed restorations made of PMMA resins.

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Introduction

Interim or provisional restorations are integral part of fixed prosthodontic practice. Generally, there is a waiting period before the delivery of the definitive prosthesis due to the extensive laboratory procedures involved. An interim restoration made up of either acrylic or composite is provided to the patient during this interim phase. The interim restorations should fulfil biological, mechanical, and aesthetic requirements to be considered successful.[1] Achieving these requirements depends on important properties of resins, including polymerization shrinkage, wear resistance, colour stability, compressive strength, tensile strength and flexural strength. Flexural strength is defined as force per unit area at the point of fracture of a test specimen subjected to flexural loading[2] .The flexural strength of interim prostheses is a critical property, particularly in long-span interim prostheses with short height pontics and connectors and also when the patient exhibits parafunctional habits such as bruxism or clenching. Flexural strength is also important, when these restorations are worn over a long period of time to assess the results of periodontal, endodontic, temporomandibular joint dysfunction therapies and during the restorative phase of implant reconstructive procedures. The maintenance of these interim prostheses can present considerable difficulty for both the patient and the dentist. Not only can repair procedures be time consuming, but also breakage of these restorations can lead to tooth movement and functional and aesthetic problems.[3,4]

The most commonly used material for fabricating these interim restorations is polymethyl methacrylate. The lack of sufficient strength of this material has led to various methods of reinforcement of the interim restorations fabricated from polymethyl methacrylate. The concept of using fibres to reinforce an interim restoration appears to have an acceptable success rate. Investigations have shown that carbon fibres produce a significant increase in the flexural strength of polymers; however, their black colour limits their use for provisional restoration.[5] Surface treatment of the fibres used for reinforcement has shown conflicting results. The transverse strength did not improve significantly when polyethylene fibres without the surface treatment were used. However, the use of plasma-treated polyethylene fibres showed a significant increase in strength.[6] Glass fibres have been used in either continuous or woven form as a strengthening material.[7] Use of silanised glass fibres as a means of reinforcement is promising due to their good adhesion to the polymer matrix, high aesthetic quality, and increased strength of the resulting composite.[8] Other researches have shown that the position, quantity, and direction of the fibres and the degree of adhesion between the fibres and the polymer affect the degree of reinforcement.[9–16]

There has been a lack of concrete information regarding the quantitative analysis of the effect of various types of silane treated and untreated glass fibre impregnation on the flexural strength of resin matrix. The purpose of this study was to analyze the change in flexural strength of the provisional restorations by impregnation with various types of silane treated and untreated glass fibres.

Materials and method

A metal die of brass (Fig. 1) was made to simulate the prepared abutments of a three-unit fixed dental prosthesis (FDP). A custom impression tray was fabricated to fit the metal die. A wax pattern was fabricated using modelling wax (S-U-Modelling wax, Schuler-Dental, Germany) for a three-unit fixed dental prosthesis on the metal master die. The wax pattern had a connector dimension of 5 mm height × 5 mm width with a sanitary pontic having a clearly demarcated central fossa (to be later used for placing the steel ball for testing the flexural strength). The three-unit metal FDP casting was done with Co–Cr alloy (Wironium plus, Bego, Germany) using an induction casting machine (Fig. 2). The three-unit metal fixed dental prosthesis was placed on the master die. Block-out of all the dead space below the three-unit fixed dental prosthesis on the master die was carried out with putty rubber base impression material to prevent locking of the main impression material and to ensure standardization of the under surface of the pontic and the connector dimensions. Impression was made with polyvinyl siloxane impression material (Betasil®, Mueller-Omicron Dental, Germany) using the custom metal tray to yield a master index to be later used for fabrication of interim prosthesis samples in resin. Sluiceways were provided in the index for the escape of excess resin material.

The tooth coloured polymethyl methacrylate (PMMA) acrylic resin (DPI–Dental Products of India Ltd, Mumbai, India) was used to make the interim prosthesis samples. The samples were fabricated with the polymer to monomer ratio as per manufacturers recommended ratio of 3:1 by volume. A total of seventy five samples were made and divided into five groups of 15 samples each, depending on the method of reinforcement, i.e. Group 1: unreinforced group; Group 2: reinforced with Untreated unidirectional glass fibres; Group 3: reinforced with Untreated woven glass fibres; Group 4: reinforced with Silane treated unidirectional glass fibres; and Group 5: reinforced with Silane treated woven glass fibres.

For Group-1 the resin mixture was poured into the master index which was then placed on the metal die under pressure using a metal clamp for 15 min. The sample was retrieved from the master index and the excess was trimmed and

Fig. 1 – Master die.