FIBER REINFORCED ACRYLIC RESIN USED IN DENTAL MEDICINE – A MINI NARRATIVE REVIEW

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ABSTRACT

The absence of one or multiple teeth can be remedied through the utilization of removable partial dentures, which possess a similar aesthetic quality to natural teeth and generally present a less intrusive and more cost-effective alternative to other tooth replacement options. Removable partial dentures serve as an excellent esthetic remedy for lost teeth and a suitable interim solution prior to the implementation of more extensive periodontic treatments. The denture base not only functions as a cornerstone for the denture, providing stability and retention within the mouth but also must be created from biocompatible materials, poses no risk in the oral cavity and to closely resemble the patient's natural gum color and shape.

Keywords: dental medicine, removable denture, fiber reinforced

INTRODUCTION

The oral health system has known numerous changes in recent years (Murariu et al, 2020). In accordance with patient's wishes, social-economic situation and the morphologic and functional characteristics of the prosthetic field, a therapeutic tratment and the materials are choosing (Bulancea et al, 2019).

Fiber-reinforced polymethyl methacrylate denture base represents a category of denture base materials that has been enhanced through the incorporation of fiber reinforcement. In the quest for this objective, a plethora of fibers, including glass fibers, carbon/graphite fibers, aramid fibers, nylon fibers, polyethylene and polypropylene fibers, have undergone assessment (Nejatian et al., 2019). In comparison to the neat acrylic resin, the fiber-modified one displayed a coarser pattern on the fractured surfaces, which may imply that the presence of fibers deflects the trajectory of crack propagation, leading to a more dynamic fracture mechanism of the polymethyl methacrylate resin (Gonçalves et al., 2020). While the pure polymethyl methacrylate denture showcased a prototypical brittle response, the fiber-modified polymethyl methacrylate resins exhibited a pliable retort combined with voids, indicative of considerable shear deformation during the fracturing process (Gonçalves et al., 2020). In totality, despite the absence of direct reinforcement in the mechanical potency of the PMMA resin, the integration of electro spun fibers exhibited auspicious prospects for the amelioration of the fracture behavior of PMMA resins, transforming them into more pliant materials, although this impact might hinge on the composition of the fibers (Gonçalves et al., 2020).

Carbon fiber-reinforced polymer was introduced into denture bases are endowed with remarkable elastic characteristics and extraordinary endurance; however, during press forming, it deforms its structure, particularly delamination and porosities. Donadei et al conducted an investigation about pre-consolidated flat laminates, commonly known as "blanks," consist of carbon fiber that is reinforced with polyetheretherketone into the factors responsible for the deconsolidation of the blank during infrared heating, specifically focusing on the evolution of water and solvents and the release of residual stresses (Donadei et al., 2018). The imperfections found in the final composite were linked to poor blank quality, which occurred as a result of the residual stresses that developed during the autoclave consolidation of the blank laminate (Donadei et al., 2018). Conform with what (Donadei et al., 2018) says as well, to minimize defects in the final press formed product, an treatment-strategy has been proposed to reduce deconsolidation and void content in heated blanks .

This proposed treatment had no negative effect on the structure's porosity, while greatly reducing the residual stresses and improving the quality of the blank after infrared heating .

Additionally, upon analysis of the data by Jagger et al, it was determined that the introduction of fibers led to a reduction in doughing time, although the manipulation and setting times were inconsistently affected (Jagger et al, 1999). Notably, there was a significant discrepancy in transverse strength between the different materials and with increasing amounts of chopped polymethyl methacrylate fibers, there was a simultaneous reduction in the modulus of rupture and the modulus of elasticity (Jagger et al, 1999). In the year 2001, the aforementioned writer persisted in conducting a series of trials regarding the incorporation of surface-modified, chopped, continuous carbon filaments into acrylic resin. On this occasion, the absence of reinforcement can be traced back to the unidirectional characteristics imbued in the matrix by the filaments (Jagger et al., 2001). Chopped fibers allocate the load between themselves and the matrix, whereas continuous 8 fibers undertake the mechanical load, and it is the matrix that conveys the load to the fibers (Jagger et al., 2001). Upon investigation, it was established that heat-polymerized acrylic resin fortified with carbon fibers exhibited a moderate level of cytotoxicity, which led to an approximate 20% decline in the growth and propagation of gingival fibroblasts (Jülide et al, 2006).

Aramid fiber is also called Kevlar nanofiber beads, which possess remarkable features such as high adsorption capacity, low cytotoxicity, and excellent blood compatibility, hold tremendous potential for various biomedical applications, including hemoperfusion (Peng et al., 2016). Notably, the beads exhibit an enhanced capacity to adsorb human degradation waste, in addition to displaying exceptional blood compatibility characteristics as per (Peng et al., 2016), such as reduced ratio's hemolysis, extended suppresses coagulant activation, clotting times,restricted platelet activation, and impeded blood-related inflammatory activation. The implementation of aramid fiber reinforcement was found to exhibit inferior transverse strength when contrasted with the specimens fortified with glassfibers (Kumar et al., 2016). This outcome can plausibly be attributed to the distinctive plated configuration of aramid fibers, wherein molecules are arranged in a radial manner resembling sheets, thereby leading to a reduced robustness (Kumar et al., 2016).

Glass fibers applied into traditional polymethyl methacrylate resin due to its flexural strength, fracture loads and wear resistance. The flexural strength value was found to be highest for 1% E- glass, and subsequently, for 2% E-glass (Apimanchindakul et al., 2022).

The implementation of one monomer liquid plus a silane coupling agent and in the glass fibers pre-treatment, which were subsequently used to reinforce conventional heat cure denture base resin, led to a significant enhancement in flexural strength (Kannaiyan et al., 2020). In addition, the reinforcement of glass fibers to reinforce conventional denture base resin displayed a remarkable level of statistical significance when compared to high-impact denture base resin that remained unenhanced, particularly in terms of the flexural strength values (Kannaiyan et al., 2020). The application of pre-impregnated E-glass fiber nets and polymer pre-impregnated E-glass unidirectional fibers is an effective approach to fortify the integrity of acrylic resin complete dentures, particularly in situations where considerable occlusal forces are anticipated (Goguţă et al., 2011). Dentures that have been strengthened with glass fibers have also demonstrated enhanced resistance to wear, surpassing that of standard acrylic dentures (Goguţă et al., 2011). Denture bases composed of polymethyl methacrylate reinforced with dental fiberglass exhibited the most substantial capacity to resist fracture, while dentures that were not reinforced with unmodified acrylic resin demonstrated the weakest ability to withstand fracturing (Rana et al., 2021). However, the application of glass fiber reinforcement releases more cytotoxic than the unreinforced acrylic resin (Jülide et al, 2006).

Nylon fibers have been demonstrated to accelerate the structural pliancy of the resin utilized for denture bases, thus mitigating its proneness to brittleness (Kannaiyan et al., 2020). The boosting of monomer liquid-treated nylon fibers to reinforce conventional heat cure resin resulted in a notable 10 improvement in flexural strength values (Kannaiyan et al., 2020). However, Kumar et al found out that the incorporation of nylon fiber reinforcement into the PMMA resin resulted in a reduction in transverse strength when compared to the conventional PMMA resin that lacked reinforcement (Kumar et al., 2016).

Polyethylene and polypropylene fibers are tested and mixed with polymethyl methacrylate to soar the flexural strength. At the minimum addition of 1% PE, a group displayed the weakest flexural strength, whereas a marginal increase in the incorporation of E-glass/polyethylene fibers at 1%, Polyethylene fibers at 2%, and E-glass/polyethylene fibers at 0.5% resulted in comparatively moderate flexural strength values (Apimanchindakul et al., 2022). The acceleration in flexural strength resulting from the addition of 2% ultra-high-molecular-weight polyethylene filler may be attributed to the efficacy of the surface modifications and the irregular morphology of the particles, leading to the occurrence of micromechanical interactions between the resin and the matrix (Apimanchindakul et al., 2022).

As per (Natarajan & Thulasingam, 2012), when compared to Splint-It, a glass fibre reinforcement, The Ribbond, a type of polyethylene fibre reinforcement, where found to produce stronger results in the heat-cure and self-cure PMMA resin. 11 Conversely, in self-cure bis-acryl composite, the glass fiber reinforcement, Splint-It, proved to be more potent of the two when juxtaposed against the polyethylene reinforcement, Ribbond (Natarajan & Thulasingam, 2012).

Conform by (Natarajan & Thulasingam, 2012), they have notice that, both types of reinforcement—glass (Splint-It) and polyethylene fibre (Ribbond)—exhibited the highest levels of flexural strength in bisacryl composite resin, whereas the heat-cure and self-cure PMMA resins followed in decreasing order.

CONCLUSIONS

In recent years, acrylic resins based on PMMA had undergone considerable improvements in characteristics and modifications in manufacturing processes. The increase of the mechanical and biological qualities, as demonstrated by experimental evidence, has rendered the denture base more resilient and less fragile, enhancing its durability and longevity. The incidence of denture stomatitis can be diminished by preventing the colonisation of pathogenic microorganisms such as bacteria and fungi. The reduction in the frequency of allergic and adverse reactions to denture resin materials can potentially improve the quality of life of dentures wearing patients.

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