Effect of different beverages and tooth brushing on some mechanical and physical properties of two different dental resin composites

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Dedicated to

My Dad

Who is missing by his body but always present by his soul, the one who raised me to be a hard worker and always encouraged me.

My Mom

Who supported and inspired me in every possible way and to whom I owe everything.

My Husband

My life partner and soulmate who is always there for me.

My Sisters

My support system and backbone.

My Nephew

My source of joy and hope.

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Bis-GMA: Bisphenol A glycidyl methacrylate.

TEGDMA: Tri-ethylene glycol dimethacrylate.

BPA: Bisphenol-A.

UDMA: Urethane dimethacrylate.

Bis-EMA: Ethoxylated bisphenol A dimethacrylate.

ORMOCER: Organically modified ceramic.

CQ: Camphorquinone.

PPD: 1-phenyl-1,2-propanedione.

OPPI: p-octyloxyphenyl-phenyl iodonium hexa-fluoroantimonate.

RDA: Relative Dentin Abrasion.

CCD: Charge-coupled device.

LVDT: linear variable differential transformer.

CIE: Commission Internationale de l'Eclairage.

PTFE: Polytetrafluoroethylene.

WS: Water sorption.

SL: Solubility.

VHN: Vickers hardness number.

Introduction

Dental resin composite restorations are widely used to cope with the increased esthetic demands among adults and even children.[1] Among the main success reasons of esthetic restorations; is the accuracy in shade selection, as well as the ability of the restoration to maintain that shade.[2] Staining of resin composite restorations is the main esthetic challenge affecting color stability of these restorations after long term use.[3]

Both intrinsic and extrinsic factors may have a role in staining of composite resin restorative materials.[4]

Resin matrix and filler particles of resin composites do not abrade with the same degree due to different degrees of hardness.[5] Conversely, an increased degree of smoothness and decreased surface porosity decrease the adherence of agents responsible for changing the color of resin composites, such as dental bio-films, tobacco, and food colorants.[6] Thus, it is very crucial to mention that there is a strong relation between surface roughness of resin composites and their shade stability.

Regarding the organic matrix, the main factor affecting the surface hardness is the degree of conversion. Moreover, the light curing method, the depth of cure and the composite shade can also influence the surface hardness of resin composites. Additionally, different filler types, sizes, as well as their concentration affect the surface hardness values.[7] Few studies had been conducted to correlate the surface hardness with surface roughness and hence color stability of resin composites.

Previous studies concerning color stability have shown that drinks (such as coffee, tea, red wine, and cola) and mouth rinses have different

degrees of staining effects on dental resin composite.[8] Most of these beverages are widely consumed by the population and can cause discoloration of resin composites.

Moreover, water sorption and solubility affect the strength, abrasion resistance, volume, and color stability of resin composites. Dental resin composites can undergo discoloration after immersion in water for extended periods of time. This discoloration may be attributed to resin matrix hydrophilicity and the degree of water sorption.[9]

Brushing and polishing though might remove material from the composite; they tend to remove the superficial staining partially or even completely. Thus, it enhances the color stability of dental resin composite restorations.[9, 11] But they might have adverse effects on other properties of dental resin composites.

The resin composites had been modified through different changes in filler technology, resin matrices and the filler/matrix bonding. Several attempts had been made to increase the filler content of posterior composites in order to obtain a strong restoration that can withstand the masticatory forces.[12]

Despite the great importance of evaluating different factors that influence surface roughness and shade stability of dental resin composites, yet there is still lack of enough evidence.[8, 11]

Hence our study was conducted to evaluate the effect of different beverages; with and without brushing; on surface hardness, surface roughness, solubility, water sorption as well as the color stability of dental resin composites.

Review of literature

1. Dental resin composites:

1.1. Introduction of resin composites:

The introduction of resin-based dental materials around the mid of the last century was a revolution in restorative dentistry.[13] Dental resin composites had undergone such an impressive evolution since their development in the early 1960s. In the 1970s, composites were used only for simple conservative adhesive procedures.[14] Nowadays dental resin composites are among the most frequently used dental materials for esthetic restorations in dental practices. This was attributed to their ability to bond to enamel and dentine, resemblance to tooth structures in color and mechanical properties, ease of chair-side applications as well as their relatively low cost.[15] Their use as esthetic restorative material in posterior stress bearing areas have been increasing due to their strong bonding to tooth structure and their acceptable mechanical properties.[16] They have been widely used as direct and indirect restorations, pit and fissure sealants, temporary crowns and bridges, as well as inlays and onlays.[17,18]

1.2. Composition of resin composites:

Dental resin composites consist of a polymeric matrix based on di-methacrylate monomers, inorganic fillers for polymer reinforcement, and a coupling agent (usually an organo-silane) to bond the two phases.[19] An initiator-accelerator system is also added to allow for the polymerization reaction to occur.[18]

For most commercial dental products, Bowen's monomer i.e.2,2-bis [4(2-hydroxy-3-methacryloxy propyloxy) phenyl] propane (usually called bis-GMA) has been most commonly used.[17] However, bis-GMA has a rigid molecular backbone and it is a very viscous liquid, therefore, diluent resin monomers such as tri-ethylene glycol di-methacrylate (TEGDMA) are usually used to facilitate the manufacturing process and enhance the clinical handling.[17] However, studies on the safety of this monomer had considered the possible release of Bisphenol-A (BPA) from the matrix and its adverse effects. Also, TEGDMA has a greater cytotoxic potential.[20] Urethane dimethacrylate (UDMA) has been proposed as a substitute for bis-GMA, it has a similar molecular weight but is less viscous. It is used either alone or in combination with other monomers.[21] A further advantage of UDMA is the higher flexibility and toughness of resin composites based on it. In addition, in-vitro studies had confirmed superior mechanical properties of UDMA based composites to composites based on bis-GMA.[22] Ethoxylated bisphenol-A-dimethacrylate (Bis-EMA) is a viscous monomer that is structurally analogous to Bis-GMA but without the two pendant hydroxyl groups. It can decrease water sorption of the resin, which subsequently permits its utilization to partially or completely substitute Bis-GMA in the recent formulation of dental composites.

A few resin composites present in the market are based on organic–inorganic hybrid materials. These materials are called “Ormocers” (organically modified ceramics) which are based on polycondensates prepared by hydrolytic condensation of suitable polymerizable tri-alkoxysilanes. The main purpose for incorporating inorganic part in the organic matrix is to raise the biocompatibility and wear resistance of the dental composites.