Evaluation of Shear Bond Strength in Primary Molars, Polymerization Shrinkage and Flexural Strength of Self-adhesive Restorative Materials

Thesis

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بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ

﴿وَأَنزَلَ اللَّهُ عَلَيْكَ الْكِتَابَ وَالْحِكْمَةَ وَعَلَّمَكَ مَا لَمْ تَكُنْ تَعْلَمُ وَكَانَ فَضْلُ اللَّهِ عَلَيْكَ عَظِيمًا﴾

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Dedication

TO MOM AND DAD

Without the inspiration, drive and support you gave me, I might not be the person I am today

TO MY HUSBAND AND MY LOVELY CHILDREN

I'm thankful for all your support I love you all more than you can imagine

TO MY BROTHERS AND MY SISTER

I know you always got my back.

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Introduction

Preservation of primary teeth is important for the management of the developing dentition and in nurturing a positive attitude in pediatric patient toward dental health. [1]

Restoration of teeth needs to be durable as they are usually performed in early ages.[2] Those kind of restorations are usually performed using composite resin or glass ionomer cement (GIC). For the clinical success of composite resin, an effective bond between dental materials and tooth substrates is critical. The adhesive procedure preliminary to composite resin application involves conditioning/etching, priming, and bonding of the substrate. [3]

With their curious tongues and short attention spans, treating children can be taxing. A self-etching and adhesive flowable composite that canceled both the etching and bonding steps and the associated time expenditure is a real advantage.[4]

In addition, the overall reduction in the application steps is expected to reduce the probability of handling mistakes.[5] This aspect is particularly pertinent in pediatric dentistry, where less consuming of time procedures are desirable,[3] especially with uncooperative children. The simplification enabled by self-etch adhesives, not requiring acid conditioning and water rinsing steps,[5,6] is therefore a clinical advantage for the restoration of primary teeth.

Dentin bonding agents used during the early **90s** are still in use and are often referred to as a fourth generation of adhesives. These adhesives consist of a separate etchant, a separate primer, and a separate bonding resin. Two new systems evolved, one consisting of an acidic primer and a bonding resin referred to as a sixth generation adhesive systems and another in which the etchant, primer, and adhesive are combined into one single delivery system referred as seventh generation of adhesive. [7]

The advantages of the self-etching system include complete infiltration of the bonding agent into the demineralized dentin and a reduced number of clinical procedural steps.

In the last few years, due to increased use of composite resins for esthetic restorations, not only in anterior teeth but also in posterior teeth because of their enhanced resistance to the masticatory forces, the dentin/restoration interface has become of great interest. Extensive studies are being carried out in the research fields, microleakage evaluation, bond strength tests, and micromorphology analysis, by several researchers.[8]

Since the development of resin-based composites, these materials have undergone many changes towards ideal mechanical and clinical characteristics. Despite these improvements, overcoming polymerization shrinkage remains one of the main challenges.

Polymerization shrinkage of resin-based materials promotes deformation of the material. In clinical situations, these materials are bonded to cavity walls in such way that this deformation is restricted, leading to the development of stress. These stresses are concentrated at the adhesive interface, and can cause disruption of the interface and consequently gap formation, marginal leakage and discoloration, post-operative sensitivity and recurrent caries.[9]

Glass ionomer cement, when used as a base or liner, not only reduces the volume of the composite, but also prevents the composite resin from bonding with the dentin, thereby restricting the adhesion of the composite resin to the enamel. As a result, the stresses generated by the polymerization contraction of the composite is also reduced. [10]

Flowable composites are indicated not only as an intermediate layer, but also as a restorative material for minimally invasive cavities, fissure sealing and for resin composite restoration repair.

For those indications, specific mechanical properties are required. Analyzing results from an flexural strength test is an acceptable way to predict the behavior of the material submitted to masticatory forces.[9]

Laboratory in vitro tests play a very important role in providing the necessary information regarding the efficacy of new products in a short period of time and lesser cost, whereas clinical evaluations would provide information only after a long period of use. [11]

Thus the current study was designed with the aim to evaluate shear bond strength ,polymerization shrinkage and flexural strength of two recently introduced self -adhesive flowable composite and resin modified glass ionomer material.

Review of literature

Pediatric Dentistry and Restoration of Primary Teeth

The primary dentition, besides serving an obvious chewing function, acts as a guide for the eruption of permanent teeth. The primary dentition also stimulates the growth of the jaw and aids in digestion and phonation. Primary dental arches form the basis for the proper development of permanent dental arches.[12]

Preserving primary teeth until normal exfoliation is one of the most important factors in preventive and interceptive dentistry. Although in recent decades there has been a decrease in the frequency of oral diseases, it is likely that dental care or treatment of a teething child is considered to be low priority for parents and guardians because of the "temporary" nature of these teeth.[13] However, the consequences of tooth loss include pain and suffering, and these consequences are also associated with high costs in terms of both health systems and the family's economy.[14]

Dental caries has been identified as one of the leading causes of tooth loss in children around the world.[15] Different materials have been developed to restore teeth affected by caries and many techniques have been suggested for the restoration of function.[16]

The pediatric dentist who is presented with a patient with early childhood caries is faced with a difficult task of restoring the child's dentition to good health.[16] However, even a simple restorative treatment plan is likely to evoke anxiety in a pediatric patient and may prove to be a challenge to the clinician. Hence when choice of the restorative material is made, simplicity of clinical application of the material should be considered along with other properties of the restorative material.[17]

Pediatric dental practice requires a restorative material that can be quickly and easily placed with a reliable adhesion to tooth structures. A dislodged filling is an inconvenience to both patient and dentist. The present day composite, compomer and resin modified glass ionomer have become popular restorative materials for primary anterior and posterior teeth. In some countries composites and glass ionomer cements are the materials of choice for primary teeth.[18]

The reason for the increased use of composites and glass ionomer in pediatric dentistry is the growing demand from parents to provide esthetic restorations to their children.[18] Another reason is the improvement of the properties and clinical handling of tooth color materials along with continuing concern over the toxicity of dental amalgam led to questioning the desirability of continued use of dental amalgam in children.[19]

The increasing demand for aesthetic restorative treatment has totally transformed the practice of pediatric dentistry. Until 10 years ago, the use of amalgam was a standard procedure in the restoration of carious primary teeth. Because of the introduction of adhesive restorative materials, the treatment of caries has changed. [20]

In paediatric dentistry, there is a great need to develop adhesive systems with fewer application steps to reduce the number of clinical steps and to reduce the application time. So major benefit of these materials would appear to be simplicity of application.[21]

In thinking of restorative objectives for children, one must consider several general categorical objectives. Sealing the cavity, preventing further tooth destruction, rendering the tooth and the tooth-restoration interface caries resistant, aesthetic and ease of use in a clinical scenario must be included. Glass ionomer cements and Composite Resins possess properties which make them almost ideal for the required purpose in pediatric patients.[22]

Glass Ionomer Cements

Glass ionomer cement systems have become important dental restorative and luting materials for use in preschoolers, children and teenagers. These materials form chemical bonds to tooth structure, are biocompatible, release fluoride ions for uptake by enamel and dentin, and are able to take up fluoride ions from dentifrices, mouthwashes, and topically applied solutions.[23]

An ideal restorative material in children requires minimal cavity preparation, have adequate strength and wear properties, be easy to place with a certain amount of adhesion to tooth structure, and not be moisture sensitive during placement and setting.

Glass ionomer cement (GIC) seems to meet most of these requirements along with particular advantages like ability to leach fluoride, coefficient of thermal expansion similar to tooth, chemical bonding to enamel and dentin, dimensional stability, insolubility in oral fluids at intraoral temperatures, excellent biocompatibility, better esthetics and less sensitivity to dentin moisture making it highly appropriate for use in children. [24]

Glass ionomers are the only true self-adhesive materials as they can adhere to both enamel and dentin by a specific glass-ionomer interaction.[25]

Glass ionomers were invented in **1969** and reported by **Wilson** and **Kent in the early 1970s**.[26]
The typical compositions of the GIC are fluoroaluminosilicate glass powder and an aqueous solution of polyacrylic acid. The acid–base reaction between the fluoroaluminosilicate glass and the polyacrylic acid is initiated by mixing the powder and the liquid.[27]

Originally, Conventional glass ionomer materials were difficult to handle, exhibited poor wear resistance, and were brittle. Advancements in conventional glass ionomer formulation led to better properties, including the formation of resin-modified glass ionomers.[28] It were introduced to help overcome moisture sensitivity and low early mechanical strength associated with Conventional glass ionomer cements while maintaining their clinical advantage.[29]

Resin-modified glass ionomer cement (RMGIC) was developed by **Mitra (1991).**[30] The setting reaction is said to be a dual mechanism Acid-base reaction begins on mixing the material, followed by a free radical polymerization reaction which may be generated by either photoinitiators or by chemical initiators or both.[31]

Vitrabond (now spelled "Vitrebond"), a resin-modified glass ionomer base/liner, was introduced by 3M Dental Products Division. Polyacid component includes a photopolymerizable resin which hardens the material substantially when a visible light beam is applied. Once the resin component has been cured, the glass ionomer hardening reaction continues, protected from moisture and over drying by the hard resin framework. Light-hardening in about 40 seconds makes Vitrebond a practical and valuable dentin replacement.[32]

Schulman A. et al (2001) [33],compared the shear bond strength of a conventional glass-ionomer cement, a resin modified glass-ionomer, a composite resin and three compomer restorative materials. They concluded that the compomer restorative materials show higher shear bond strength than conventional glass-ionomer and resin modified glass-ionomer, but less than composite resin.

Prahakar A R et al (2001) [18]**,** published the results of a study to compare the difference in shear bond strength between Composite, Compomer and Resin modified glass ionomer cement in primary and permanent teeth. They found that in case of primary teeth resin modified glass ionomer exhibited significantly higher shear bond strength as compared to composite and compomer, whereas on permanent teeth composite demonstrated a significantly higher shear bond strength than that of the resin modified glass ionomer and compomer, whereas compomer gave poor shear bond strength in both primary and permanent teeth.

Piwowarczyk A and Lauer HC (2003) [34],studied the effect of water storage on flexural strength (FS) and compressive strength (CS) of 12 luting cements .The materials examined were two zinc phosphate cements , two glass ionomer cements , three resin-modified glass ionomer cements , four resin cements and one self-adhesive universal resin cement. They found that Resin cements had the highest flexural and compressive strengths, followed by self-adhesive universal resin cement. These materials were statistically stronger than resin-modified glass ionomer cements, glass ionomer cements and zinc phosphate cements.