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Clinical Criteria For Successful Composite Restorations - A Review
Successful Composite Restorations- A Review

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ABSTRACT: Dental caries is one of the major problem despite the decrease in its prevalence worldwide and dental clinicians spend most of the time placing restorations to replace the lost dental structure due to the progression of caries. Dental composites in the last few decades have developed from an inferior resin material to a superior material of choice for restoration of highly aesthetic, anterior restorations and durable posterior in direct restorative dentistry. Most of the recent dental composite materials are either based on a light-curing technology or a dual mechanism of light- and self-curing technology. Many clinical methods have been proposed for the reduction of shrinkage stress such as curing light intensity, application of flowable resin liner, incremental layering techniques and indirect resin restoration. The curing of dental composites represents a very complex process. The dentist needs to be aware of the limitations and factors affecting this process. Clinical behaviour of composite restorations when placed using effective isolation with cotton rolls and aspiration, along with proper technique of curing greatly improves the longevity of this direct restoration.

Key Words : Polymerisation shrinkage, Cuspal Deflection, C Factor, Incremental composite build up, Bulk Fill technique

1. INTRODUCTION

Dental caries is one of the major problem despite the decrease in its prevalence worldwide and dental clinicians spend most of the time placing restorations to replace the lost dental structure due to the progression of caries[1]. Direct restorations provides reliable treatment for replacement of dental structure lost in affordable cost, minimal sound dental structure removal and also have a very good clinical performance when compared to indirect restorations [2]. Amalgam restorations were considered to be the best restorative material for posterior teeth. Composite restoration were suited only for anterior teeth due to its weak mechanical properties. Dental composites in the last few decades have developed from an inferior resin material to a superior material of choice for restoration of highly aesthetic, anterior restorations and durable posterior in direct restorative dentistry. With the increase in development of adhesive techniques, composite resin has become the material of choice for restoration of posterior tooth. Composite restoration also eliminates the potential toxicity of mercury released from amalgam restorations[3]. However these technique sensitive resin-based materials requires a detailed understanding of curing properties and the factors that affect this process. Most of the recent dental composite materials are either based on a light-curing technology or a dual mechanism of light- and self-curing technology. In case of light-curing materials, the dentist needs to ensure that amount of photons reach the bottom of the composite. If it not reaches then the composite will not achieve the properties necessary for long term survival.

ISOLATION

Saliva, blood, and other contamination after etching are considered to be one of the main causes of the failure of resin composite bonding. The most common methods of isolation include rubber dam and cotton rolls combined with aspiration by saliva ejector.

A rubber dam provides an ideal dry field for working during the entire treatment procedure.Such isolation is widely considered to reduce the failure of restorations thereby extending the life expectancy of restorations. Rubber dams are also a means of cross infection control by reducing the bacterial aerosol during cavity preparation and in combination with gloves, mask, eyewear, and other aids, an excellent barrier to prevent the spread of infectious disease in a dental clinic [4].

However, most private practitioners do not use rubber dam routinely. The reasons given for not using ideal isolation are many and varied, ranging from patient dislike to overall lack of perceived benefit by practitioners. Previous studies comparing sealants and restorations placed with and without rubber dam have all reported no significant differences for deterioration and survival[5]. However according to the guidelines for the use of resin composites in the restoration of posterior teeth continue to emphasize the importance of using rubber dams [6].

Influence of layering techniques

The polymerization shrinkage stress may cause the movement of cusps, debonding or enamel cracks[7] and also has the potential to result in microleakage, postoperative sensitivity and secondary caries [8]. Many clinical methods have been proposed for the reduction of shrinkage stress such as curing light intensity, application of flowable resin liner, incremental layering techniques and indirect resin restoration [9,10].

Versluis et al. [11]studied stress fields for different incremental filling techniques by using finite element analysis (FEA) and concluded that the incremental filling technique increased the deformation of the tooth restored leading to a highly stressed tooth-composite structure. Abbas et al. [12] showed, in cuspal deflection measurements using premolars, that multiple increments induced greater cuspal movement than a single increment. In contrast Lee et al. reported that incremental filling and indirect restoration decreased cuspal movement by 34.1% and 32.2%, respectively, compared to bulk filling[13]. Bulk filling technique has been broadly recommended in direct resin composite restoration despite the controversy over the advantages of incremental build-up of composites. This is because bulk filling technique is expected to decrease the C-factor (the ratio of bonded surface to unbounded free surface), thereby allowing some amount of flow to partially dissipate the shrinkage stress.

Curing Unit

Photo polymerization plays a fundamental role in a composite restoration because adequate polymerization is an important factor for optimization of the mechanical and physical properties and also clinical results of the composite material. A dentist therefore must use a light curing unit that renders sufficient energy for optimal composite polymerization. Varying the light intensity greatly influences the degree of conversion of monomer to polymer and also the depth of cure[14].

Quartz tungsten halogen (QTH) lamps, light emitting diodes (LED) units, plasma-arc lamps and argon-ion lasers are the four types of polymerization sources that have been developed. Halogen lights and LED units are exclusively being used regular clinical practice[15]. Halogen lights being a low cost technology, have been the most frequent source employed for polymerization of composite resin materials. Their broad emission spectrum allows the polymerization of all commercially available resin composite. However, their efficiency in converting electronic energy into light has been found to be low. Nearly 70% is transformed to heat and only 10% is converted to visible light, including the blue range desired for polymerization[16].Therefore, filters are required to reduce heat energy transformation which will affect the oral mucosa and provide further restriction of visible light into the narrower spectrum of photoinitiators. Out of the available visible light, due to the use of cut-off filters, a further 90% is wasted. Therefore, the final blue light is less than 1% of the total energy initially present. Light filters also degrade with time due to the high operating temperatures and proximity to the halogen bulb[14].

Several studies have indicated that many halogen units do not emit the minimum power output specified by the manufacturers. A lack of maintenance, such as failure to check the light curing units' irradiance or to replace the halogen bulb from time to time, maybe lead to this [15,16].

In 2001, in order to overcome the inherent disadvantages of halogen lamps, the first LED curing units were introduced into the dental market. They do not require filters to produce blue light and they convert electricity into light more efficiently than halogen.The advantages of the LEDs are they produce less heat therefore no cooling fan is required, they are smaller in size and cordless. Moreover, LEDs can operate for thousands of hours with a constant light output in power and spectra. Newer Light curing units deliver an intensity power higher than 400 mW/cm2 which allows a reduction of the exposure time recommended by the composite manufacturers[17].

Barghi N, Berry T, Hatton C studied intensity of curing lights in private dental offices and concluded that 30% of the curing units had power densities <199 mW/cm2 which were inadequate for curing composite resin[18]. The remaining lights displayed power densities between 200 and 349 mW/cm2 and were found to be adequate output for use with small increments of composite resin and increased curing time to ensure sufficient energy density.

Curing depth, light intensity and polymerization time

One of the largest challenges in the clinical practice is completely curing a composite restoration. The uppermost composite layer is cured immediately whilst the deeper areas are still reacting. Practitioners have to be aware of the fact that the energy is attenuated and dispersed with increasing material depth. There is therefore a risk that the monomer may not convert into a polymer.

The most important factors which affect the depth of cure of are shade and translucency of composite material . For example, the curing depth is lower if a dark and opaque composite is polymerized[19]. The light can penetrate more deeply with a light or translucent shade than with an opaque material. The same effect is achieved when shade A1 is compared with shade A3.5 or A4.

Polymerisation shrinkage

In the last three decades, adhesive dentistry has evolved remarkably, greatly due to the development, in the late 1950s, of Bis GMA-based composites [20]. The incorporation of new monomers (e.g. UEDMA, BisEMA), new initiation systems and filler technologies have significantly improved the physical properties of these materials expanding their use as direct and indirect restoratives. However, inspite of several researches on bonding mechanisms between composites and the dental substrate, clinical failure due to the disruption of the bonded interface remains a frequent occurrence [21].

Such interfacial defects may develop as a consequence of long-term thermal and mechanical stresses, or during the restorative procedure itself that is generated by composite polymerization shrinkage [22]. In fact, a direct relationship between polymerization shrinkage stress and marginal integrity has been demonstrated, in vitro, in Class V restorations [23] and in teeth restored with bonded porcelain inlays[24].Contraction stress in composite restorations occurs due to polymerization shrinkage taking place under confinement. The material’s viscoelastic behaviour, characterized by its flow capacity at early stages of the curing reaction and by the elastic modulus acquired during polymerization, has also been identified as another important factor in contraction stress development[25].

As both volumetric shrinkage and viscoelastic properties are influenced by the same variables, accessing their specific role on stress development is a difficult task. For example, composites with relatively high inorganic filler content present lower shrinkage values but higher stiffness, compared to materials with lower inorganic content[26]. With increasing degree of conversion of the polymer matrix, there occurs increase in elastic modulus and volumetric shrinkage simultaneously. The complexity of this issue is heightened by the fact that stress development is affected by reaction kinetics. As the composite’s plastic deformation (or viscous flow) is a time-dependent event, slower curing rates may provide extended periods where the material is able to yield to contraction forces before acquiring higher elastic modulus . In fact, reducing polymerization rates in composites has been shown to lower stress levels significantly [27].

2. CONCLUSION

The curing of dental composites represents a very complex process. The dentist needs to be aware of the limitations and factors affecting this process. Clinical behaviour of composite restorations when placed using effective isolation with cotton rolls and aspiration, along with proper technique of curing greatly improves the longevity of this direct restoration. Clinicians should understand the significance of light curing as unbound monomers are cytotoxic and less biocompatible.

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FIGURES

Figure 1: Polymerisation Shrinkage