

## Composites in Orthodontics - A Literature Review.

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**ABSTRACT:** The aim of this study is to do a literature review on the different types of composites used in orthodontic treatments. With the invention of bonding of orthodontic brackets to enamel 30 years ago, the speciality of orthodontics has changed dramatically. In recent years, light cured composite resins have been more commonly used in the field of orthodontics for the bonding of brackets to the teeth surfaces. Orthodontic bonding is one of many variables that dictate the outcome and efficiency of orthodontic treatment. The bond strength of a bonded orthodontic bracket must be able to withstand the forces of mastication along with the stresses exerted by the arch wires. And the bond strength should also allow the debonding of the bracket when required, without damaging the enamel. Recently flowable composites are more commonly used than the conventional Transbond XT, as it's less time consuming, reduces chances of errors which can lead to bonding contamination and reduces dental chair side time, and improved aesthetics. Flowable composite resins have multiple applications in dentistry other than bonding of orthodontic brackets. In the last five years, a plethora of low viscosity composite resins, flowable composites have been marketed.

**KEYWORDS:** Bonding; Debonding; Flowable composite; light cured composite; Orthodontic Brackets.

### I. INTRODUCTION:

Ever since Buonocore, in 1955 introduced a technology which eventually led to the concept of bonding resins to enamel has been applied in all fields of dentistry [1] along with the bonding of orthodontic brackets to teeth surfaces. [2]. Ten years later, in 1965, Newman described a technique for acid-etching enamel to enhance the mechanical adhesion of orthodontic brackets to the teeth.[3]. Prior to the introduction of the acid-etch bonding

technique by Buonocore, every tooth was banded in preparation for an orthodontic treatment. [4]. The ability to bond orthodontic brackets has reduced patient chair time, reduced band space that would need to be closed later, improved esthetics, and aided in improvement of hygiene, along with ease of placement and removal of brackets, reduced soft tissue irritation and gingival hyperplasia, minimal danger of decalcification.[5]. Since then several factors that affect the mechanical adhesion of orthodontic brackets to the teeth have been described. including the bonding of orthodontic brackets.[6] By the end of the 1970s, the bonding of orthodontic brackets had become an accepted clinical technique in orthodontics. [7]In recent years, different methods and materials are being developed for the bonding of orthodontic brackets, and many products are being made commercially available. Normally, a conventional adhesive system uses three different agents, for the process of bonding of orthodontic brackets to enamel surfaces such as an enamel conditioner, a primer solution, and an adhesive resin [8]

In the past the orthodontic brackets were welded to gold or stainless steel bands. The various advances in the field of adhesive technology have led orthodontists to incorporate adhesives, composite resins, and different types of bonding techniques into their daily clinical practices. [9]. The various generations of bonding systems have progressed from etching enamel to conditioning dentine, smear layer treatment, and altered handling properties of adhesive systems [10]. Fourth generation bonding systems consist of a three-step application; its also called as the total etch technique which consists of three steps which are : acid etching, use of a primer (to ensure maximum adhesion by improving monomer penetration into the etched enamel and

hydrophilic dentine substrate and to improve wettability of the tooth surface) and a resin-bonding agent. Self-etching primer (SEP) are products, which combine acid and primer. [11]. The fifth generation, Self-etching primers simplify the process of the bonding procedure, reduces the dental chair time and avoids the side-effects of acid etching. [12]. The contemporary two-step Self-etching primers and the recently developed one-step self-etching adhesive systems are new additions to an orthodontist's armamentarium. [13]. Although the ease of bonding has significantly improved due to direct bonding techniques and the availability of self-etching primers, the formation and prevalence of white spot lesions throughout the span of an orthodontic therapy continues to be a major concern for orthodontists. The decalcification of enamel and the formation of white spot lesions are common around orthodontic brackets. Gorelick et al found that in 5% of the patients who undergo fixed appliance treatment had at least one white spot lesion post orthodontic treatment, irrespective of whether teeth were bonded or banded. [6]. These lesions can develop as early as one month into treatment, causing an increasing concern of aesthetics.[14]. During the bonding procedure, most clinicians unintentionally leave behind an additional amount of adhesive around the orthodontic brackets, this commonly occurs because the shade of the adhesives used matches the shade of the enamel, which makes the differentiation between them difficult. [15]. Post orthodontic treatment, the main concern of orthodontists is to revert the enamel back to its original state. During the process of debonding of orthodontic brackets, it is difficult to delineate the adhesive from the enamel surfaces, which potentially leads to damage and loss of enamel surfaces. There is up to a loss of 5-150 micrometers of enamel after the debonding of brackets. [16].

Further research into the self etching primers, resulted in the introduction of the sixth generation, single step bonding systems, which combined the SEP and the resin-bonding agent into a onestep formulation [17]. The sixth-generation bonding systems are designed in such a way that it's components are stored in two flasks until mixed for clinical use. Such component separation prevents the changes in the initializers as they are sensitive to acidity over time. [18]. These sixth generation agents were further researched such that a self-conditioning agent can be obtained with all the components mixed together

in a single flask, which led to the Seventh generation of the bonding systems, of which Xeno IV, is the most commonly and widely used for bonding of orthodontic brackets. The Xeno IV is a self-etching bonding adhesive system belonging to the seventh generation of bonding adhesive system that has high performances in terms of self-etching it binds by causing a bond to enamel and dentine, the bonding obtained is comparable with those obtained by the conventional adhesive systems with phosphoric acid conditioning. [19]. The unresolved question regarding whether the seventh generation of bonding adhesive systems can be used for the bonding of orthodontic brackets. Our extensive research expertise ranged from epidemiological studies to randomised clinical trials that have been published in reputed journals [20–29]. This knowledge was instrumental for us to review the types of composites used in orthodontics. The purpose of this study was to write a literature review on the different types of composites used in the field of orthodontics.

#### **History Of Bonding Adhesive Systems:**

**First and Second Generation:** They were developed in 1960-70. No acid etching was required, adhesion was in the smear layer. The first and second generation of the first and second generation adhesive systems had a weak bond strength.

**Third Generation:** This was developed in the year 1980. Acid etchings were introduced in this generation. Third generation adhesive system consisted of a separate primer. The 3rd generation has an increased bond Strength when compared to the previous generations. Marginal staining was present. [30]

**Fourth Generation:** Developed in the year 1990. This was based on the wet bonding concept.

**Fifth Generation:** Developed in the middle of 1990. This adhesive system has a combined primer & adhesive. High bond strength when compared to the previous systems.

**Sixth Generation:** Sixth generation adhesive systems were developed in 2000. These were the Self etching primers. The SEPs had reduced post-operative sensitivity. Unfortunately the bond strengths were lower than fourth & fifth generations adhesive systems. [31]

**Seventh Generation:** The seventh generation of adhesive systems was developed in the year 2002. It contains all the components in a single tube. It has a good bond strength and marginal seal.

**Eight Generation:** Developed in 2010, it contains nanosized fillers. Bond strength better than all generations. [32]

#### **FIBRE REINFORCED COMPOSITES:**

Fibre reinforced composites (FRCs) are most commonly employed in the manufacturing of aircrafts and spacecrafts. It also has its applications in the marine, automotive industries, construction of buildings. The medical application of FRCs include prostheses and bone plates for fixation of fractures. FRCs are composite materials made of a plastic material reinforced by fine thin fibres. [33]. In the field of dentistry, FRCs are used in the placement of splints, endodontic posts, fixed partial dentures and indirect restorations. Recently the arch wires used in orthodontic treatments which are normally made of cobalt-chromium, nickel-titanium are being substituted with FRCs. As FRCs offer good aesthetics and can also beat the masticating load. [34]

#### **FLOWABLE COMPOSITES:**

Acid-etch bonding is widely used in recent times. It is characterised by the formation of tag-like resin extension in the enamel surfaces. Flowable resins have low viscosity, created with the same particle size, but it has lesser filler content than traditional composites. [35]. Flowable resin composites are versatile and are being used in different fields of dentistry. Recently, the use of flowable composites, by increasing the resin content of traditional microfilled composites, have been used for the bonding of lingual retainers. [36]. The advantages of flowable composites is it does not require trimming needle tips on the application syringes allow direct and precise composite placement, the composite is not sticky, and it flows toward the bulk of the material rather than away from it. Since no trimming and polishing of the material are required the chair side time is greatly reduced. [37]. However, according to a few previous studies, the flowable composites have a lower shear bond strength (SBS) values when used for bonding metallic brackets than the conventional system. [38]. According to the research by Dong-Bum Ryou et al, it was concluded that wherein four flowable composites were compared to conventional composites, it was concluded that the flowable composite can be used for orthodontic brackets bonding after assessing the sheer bond strengths of each flowable composites. [39]. Though flowable composites have many advantages, according to the study by A. Vicente et

al, it was found that flowable composites had micro leakage. [40]. There are multiple previous studies, wherein composites are bonded with the use of primer and without the use of primer. Traditionally, the use of primer is essential for an immaculate bonding process to allow wetting of the enamel surfaces, and the penetration of the sealing into the enamel.

#### **TOTAL ETCH COMPOSITES:**

Light-cured orthodontic composite resin has been widely used in bonding of orthodontic brackets. [41]. However, the curability of light-cured resin when light waves are diffused through metal, ceramic, or resin brackets are inconsistent, as it depends on factors like etching time, curing time, penetration capacity of the resin. Several factors might affect the bond strength of the brackets, which eventually leads to debonding of the brackets, these factors are the acid etching and drying time, adhesive application mode and time and photoactivation time. [42]. The photoactivation time of composites is particularly important because under polymerization may result in early bracket debonding. . Classically, the teeth surfaces are etched using 37% of phosphoric acid which leads to micro mechanical adhesion of the composite resin to the tooth surface. [43] Light cured composites can be broadly of two types, conventional type (Transbond XT) and the flowable composite. In 1988, in order to overcome the moisture sensitivity problems associated with composite resins RM-GIC were developed.[44]. Light-activated RMGICs had the positive features of conventional glass ionomers, combining them with the mechanical and physical properties of composites, controlled setting reaction, greater initial strength and hardness, and reduced sensitivity to moisture.[45]. Unfortunately, it was observed that the sheer strength of composites to be greater than RMGICs by SE Owens et al. [46]. According to KS Kumar et al, flowable composites such as Admira flow can be used as an alternative for Transbond XT. [47]. Until today, the conventional bracket bonding system which is most commonly employed for the orthodontic bonding is the Transbond XT. It consists of an acid gel, a primer, and an adhesive paste. As it is commonly used, Transbond XT has become the gold standard as it has a good shear bond strength, as Shear bond strength is the main factor concerned in the evolution of the bonding materials in orthodontics.[48]. In a study by, NR Krishnaswamy et al, when light cured composites

were used on both anterior and posterior dentitions, the posterior were more susceptible to a higher failure rate than the anterior teeth. [49].

#### **SELF ETCHING PRIMER:**

The self etching primers belong to the sixth generation of adhesive systems. Self etching systems produce high durability when bonded to dentin. While the total etching systems exhibit high bond strength even on uncut enamel along with excellent marginal integrity. Self etching primers were created 20 years ago. The self etching primer system consists of an aqueous solution of acidic monomers.[50]. The pH of SEPs is relatively higher than that of the ortho phosphoric acid. It contains water which acts as the medium for ionisation. Since there is no separate etching process, there is a reduced postoperative sensitivity. [51]. It combines the etchant and primer into a single application. The earlier generations had different applications for etching and primer application thus increasing the working time. Though self etching primers exhibit adequate shear bond strength to beat the masticatory load. The SBS of the self etching primers were comparatively lower than its predecessors, the fourth and fifth generation adhesive systems such as Transbond XT.[52]. The SEPs bond better to dentin than to enamel, hence additional etching of enamel with ortho phosphoric acid must be done prior to self etching. But this etching should be confined to only the enamel surface as additional etching of the dentin creates an “over etch”. [53].

#### **Seventh Generation Of Bonding Adhesive System:**

The seventh generation bonding adhesive system has the etchant, primer and adhesive in one single application tube. Developed in the early 2002. It's a single bottle self etching system. [54]. The seventh generation despite its short working time has the lowest initial and long term bond strengths among all adhesives on the market. According to a research by S. Sharma et al, the bond strength of seventh generation was lower than the fourth generation Transbond XT. [55].

#### **Eighth Generation Of Bonding Adhesive System:**

The eighth generation of bonding adhesive system was introduced by the Voco America in the year 2010. It consists of nano sized fillers. [56]. The average size of the nano sized filler particles is

12 nanometre. The nanoscale size increases the penetration of resin monomers into the tooth structures. [57]. Hence, improving the mechanical properties of the bonding systems. They also have a longer shelf life, better enamel and dentin bond strength and stress absorption. [58].

#### **II. CONCLUSION:**

An increasing demand for orthodontic treatments and other aesthetic procedures led to the development of newer products of adhesive bonding systems. Bonding of orthodontic brackets to the enamel surfaces remains as the most paramount aspect of an orthodontic treatment. As frequent debonding of brackets can cause loss of patient compliance and increase in treatment duration. Although newer and better types of bonding adhesives are present, expertise of the clinician remains as the most important aspect of any successful orthodontic treatment.

#### **CONFLICT OF INTERESTS:**

None declared.

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