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Flowable Composites in Daily Orthodontic Practice - A Review

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Abstract: With the advancement of adhesive materials and application techniques, orthodontists can now use these materials for various purposes in their regular practice. The scope, limitations, and effectiveness of using flowable composite in the daily orthodontic practice have been discussed. In comparison to other alternative procedures, this paper highlighted several uses of flowable composite in orthodontics that could save both effort and chairside time, as well as stock. Searching without restrictions has been done by two researchers in different databases like PubMed Central, Science Direct, Wiley Online Library, The Cochrane Library, Google Scholar, and Research Gate, and hand searching until October 2021. Following data extraction and excluding the duplicated articles, only 19 full-text articles assessed the uses of flowable composite in orthodontics were considered in this review. In conclusion, flowable composites have been used in various conditions either as a major adhesive material for the orthodontic brackets and lingual retainers (with some limitations) or as an auxiliary attachment and bite raising device. New uses have been added to the previous ones to help orthodontists improve their outcomes. Improving this material's physical, mechanical, and biological properties may increase its orthodontic uses in the future. Augmenting the strength and reducing the micro leakage will add more flowable composite to orthodontic bracket adhesive materials.

Keywords: flowable composite, orthodontics, bonding, adhesive.

日常正畸实践中的可流动复合材料 - 回顾

摘要：随着粘合剂材料和应用技术的进步，正畸医生现在可以在日常实践中将这些材料用于各种目的。已经讨论了在日常正畸实践中使用可流动复合材料的范围、局限性和有效性。与其他替代程序相比，本文重点介绍了可流动复合材料在正畸学中的几种用途，这些用途可以节省工作量和就诊时间以及库存。两名研究人员在考研中心、科学直接、威利在线图书馆、科克伦图书馆、谷歌学术和研究门等不同数据库中进行了无限制搜索，并进行了手动搜索，直到2021年10月。在提取数据并排除重复文章后，本综述仅考虑了19篇评估可流动复合材料在口腔正畸学中的应用的全文文章。总之，可流动复合材料已在各种条件下用作正畸托槽和舌侧保持器的主要粘合材料（有一些限制）或作为辅助附件和咬合提升装置。新用途已添加到以前的用途中，以帮助正畸医生改善他们的结果。改善这种材料的物理、机械和生物学特性可能会增加其在未来的正畸用途。强度并减少微渗漏将为正畸托槽粘合剂材料添加更多可流动的复合材料。

关键词: 流动性复合材料，正畸，粘合，粘合剂。

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1. Introduction

Advances in material science have aimed to improve the quality of bonding materials, curing modes, dispensing systems, handling features, bond strength, and procedure simplicity [1]. Composite resins have been commonly employed in dentistry since the early 1990s. They are divided into five groups based on the type and content of filler: Micro filled, Nano filled, Packable, Hybrid, and Flowable [2]. Flowable composite resin is a form of traditional composite resin created by maintaining the particle size of traditional hybrid composites while decreasing filler content and increasing resin content to reduce resin viscosity [1].

Flowable composites have a filler content of 37–53 %, which is lower than normal composite resins, which have a filler content of 50–70 %. The viscosity of this group of restorative materials has been substantially reduced due to the reduction in filler content, allowing them to be injected with a syringe into difficult-to-reach regions of the oral cavity [3].

Those materials were used as universal adhesives in various dental procedures for various reasons, such as their ease of application without using a special applicator with low viscosity. In particular, micro-mechanical bonding capacity to various surfaces, such as tooth and acrylic resin surfaces, mechanical contact with orthodontic wires and retentive features, and radio-opacity [1, 4].

The purpose of this review article is to examine how flowable composite resins are used in daily orthodontic treatments.

2. Materials and Methods

Searching without restrictions has been done by two researchers in different databases like PubMed Central, Science Direct, Wiley Online Library, The Cochrane Library, Google Scholar, and Research gate, in addition to the hand searching until October 2021. Following data extraction and excluding the duplicated articles, only 19 full-text articles assessed the uses of flowable composite in orthodontics were considered in this review (Fig. 1).

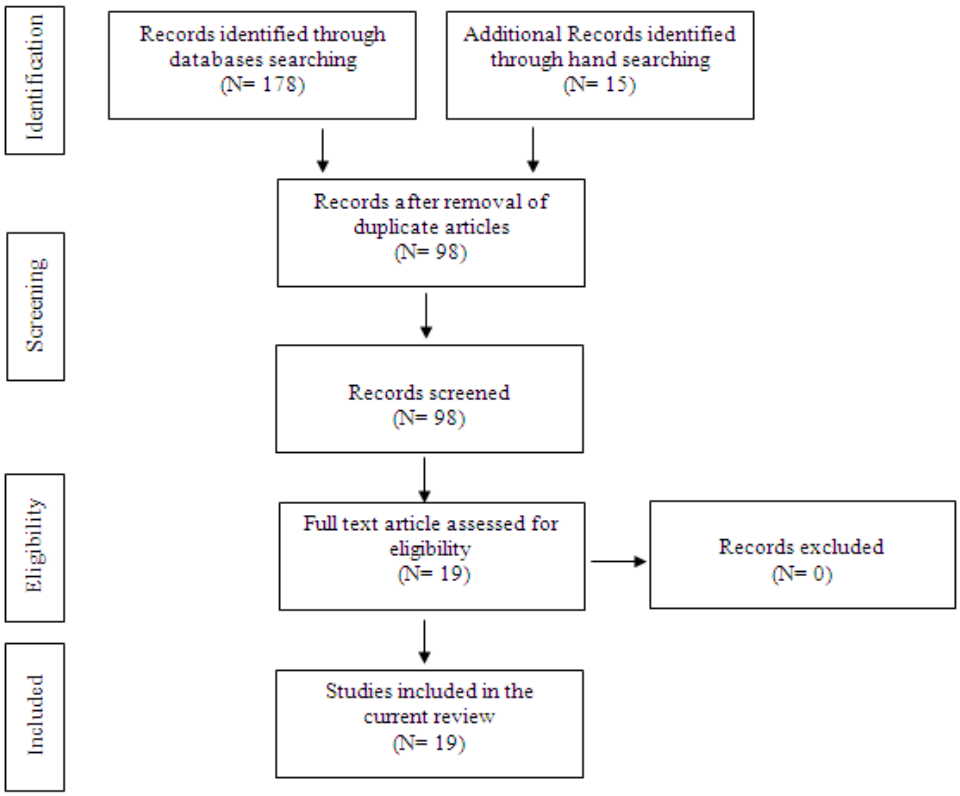

Fig. 1 Flow of records through the reviewing process.

2.1. Bonding of Orthodontic Brackets

Flowable composite resins as an alternative to orthodontic bracket adhesive bonding have lately gained popularity. Many in-vitro studies [5-9] have looked at the properties of flowable composite resins as a bonding agent for orthodontic brackets. There were found favorable shear bond strength, bond failure values, reduced adhesive left after bracket de-bonding, and less damage on microscopic analysis of enamel surfaces following bracket de-bonding. However, clinical investigations are needed to determine if flowable composites are suitable for bonding orthodontic brackets.

2.2. Bonding of Fixed Retainers

It has recently been suggested that flowable composites bond fixed lingual retainers. Flowable composite resins are considered excellent alternatives for composite resin bonding agents. Particularly for lingual retainers, because they can be placed simply with needle tips in difficult-to-reach areas, are non-sticky, flow toward the bulk of the material rather than away from it, and do not require trimming or polishing [10].

According to a study, flowable composite resins have the same shear bond and wire pull-out strengths as standard orthodontic resins; consequently, they could be utilized to lingual bond retainers instead of the traditional composite resins [11].

High microleakage values at the adhesive–wire interface, as well as a lack of wear resistance, have cast doubt on their use as a bonding agent for fixed retainers, encouraging more investigation [12].

2.3. Bite Raisers

It is sometimes necessary to temporarily open the patient's bite during orthodontic treatment. Namely to avoid traumatic occlusal contacts, eliminate posterior or anterior crossbite, eliminate bracket interferences, and facilitate different tooth movements in patients with deep interdigitation, such as deep bite patients,
To date, a variety of devices have been used for this purpose, including removable bite plates, adhesive agents, cement [13].

A simple and rapid strategy is to use flowable composite resin at occlusal contact locations after acid etching and irrigation, confined to one or multiple areas of occlusal contacts (Fig. 2). One of the advantages of this method is the ability to apply the material quickly and simply with needle tips, especially in hard-to-reach areas of the posterior, as well as the ability to remove the material swiftly and safely with instruments such as Weingart pliers [4].

Fig. 2 Flowable composite is used as a bite raiser

2.4. Constructing Attachments for Clear Aligners

Clear aligner-based orthodontic movement methods have shown limits in the configuration of complicated force systems, including the canine rotation and inclination, central incisor extrusion, and bodily tooth movement. Biomechanically "enhancing" composite attachments bonded to the dental surface have been developed to overcome these limitations. These applications extend the biomechanical capabilities of the aligners by permitting the production of more complex force systems, such as couples or pairs [14]. Certain clinicians favor flowable composite resins for this use since they may be injected into a plastic template, placed on the tooth's surface, and cured with light.

2.5. Reactivation of Open Coil Springs

In some circumstances, open coil springs are used on the base archwire to open spaces during fixed orthodontic treatment. In these cases, the clinician must either remove the archwire and replace it with a new, slightly longer segment of the open coil or crimp a C-Ring over the archwire at each visit [15, 16]. It lengthens the patient's chair time.

Alternatively, a small amount of flowable composite resin can be injected with a syringe on the archwire adjacent to the open coil. The open coil can then be compressed with finger pressure or an explorer or tucker until cured. It is unnecessary to remove the base archwire in subsequent visits, and by using a flowable composite resin, it is possible to reactivate the open coil in subsequent sessions. The degree of reactivation of the open coil can be fine-tuned using this way (Fig. 3).

This method has the advantage of changing the direction of force application; in other words, the composite is positioned on one of the sides and acts as a stopper, preventing movement in one direction while the tooth moves in the opposite direction [4].

Fig. 3 Flowable composite is used to reactivate open coil spring

2.6. Reactivation of Twin-Block Appliance

In modern orthodontic therapy, the twin-block appliance is one of the most extensively used functional appliances. It is most commonly used to treat adolescents with Class II malocclusion, characterized by mandibular deficiency and a lack of facial height [17].

When the construction site is prepared, the jaw is generally directed forwards up to the amount required to establish normal overjet when the discrepancy is not extreme [an overjet of about 6 mm]. Most clinicians prefer to advance the mandible relative to its original position in multiple phases treating patients with a more severe discrepancy (overjet greater than 6 mm). It helps keep the controlling muscles active, resulting in a reduction in mandibular incisor protrusion; also, the patient's compliance with such an approach is more likely [18].

The activation of twin block appliances is traditionally achieved in numerous sessions by

abrading occlusal ramps and applying a time-consuming fast-curing methacrylate acrylic resin. Furthermore, the methacrylate monomer left in the newly set acrylic rein is cytotoxic and may irritate the patient's mucosa. As an alternative, a flowable composite resin can be added and light-cured after abrasion, acid etching, and irrigation of the contact region of the appliance's occlusal ramps. As a result, the appliance can be reactivated in less time since the flowable composite resin cures faster than methacrylate acrylic resin and does not irritate the patient's mucosa because it is monomer-free [4].

2.7. Protection of the Patient's Mucosa Against Irritation Resulting from Orthodontic Appliance Components

Brackets, archwires, tongue cribs, TADs, closing loops, auxiliary arch [such as Ballista and biggy-back springs], and other orthodontic appliance components may irritate the oral mucosa in orthodontic patients in a variety of ways. As a result of these irritations, ulcers and mucosal hyperplasia might develop. When the archwire irritates the mucosa, elastic tubes known as shrink tubing are usually wrapped around the portion of the archwire, irritating, especially if the free part of the archwire is long.

Alternatively, a small amount of flowable composite resin can be applied to the protruding wire and light-cured to prevent direct contact between the mucosa and the archwire or any other appliance component (Fig. 4). If the patient's mucosa has been injured by TADs, tongue cribs, bracket hooks, or closure loops, a small amount of flowable composite resin can be applied in the area and light-cured [4].

Fig. 4 Flowable composite is used to prevent tissue irritation (a and b)

2.8. Increasing the Retention of Removable Orthodontic Appliances

A small amount of flowable composite resin can be placed on the facial surface of the mandibular deciduous or permanent tooth to improve retention and compliance with removable appliances like the labial bow and even a C-clasp. In addition, similar attachments are used during clear aligner therapy to prevent aligner displacement [4].

2.9. Enhancing Tooth Movement Achieved with Orthodontic Appliances

Flowable composite resins can extrude or intrude the anterior teeth when using a removable orthodontic appliance to fix misalignment teeth; flowable composite resins can extrude or intrude the anterior teeth. A little amount of flowable composite is injected on the tooth surface, allowing the Hawley arch to be positioned above or below this projection, allowing the teeth to extrude or intrude. Suppose the labial movement of a lower incisor is required. In that case, a small amount of flowable composite can be cured on the lingual arch against the incisor that needs to be pushed labially.

2.10. Managing Some Cases of Crossbite

Reverse stainless steel crowns, fixed acrylic planes, tongue blades, removable plates with Z- spring may all be utilized to address anterior crossbite [19]. For dealing with such a situation, alternatively, flowable composite slopes with an inclined plane [20-23] made of bonded resin can be used (Fig. 5).

Fig. 5 Flowable composite is used to correct an anterior crossbite

2.11. Acting as Molar Stops

A molar stop (small U-loop) was anterior, frequently introduced to the molar tube by Begg to prevent the lower molars from moving forward [24]. Instead of wire bending, this can be done chairside or within the patient's mouth with flowable composite by making two composite beads anterior to the molar tube.

Moreover, the same stopper with a slightly larger size can increase the dental arch perimeter by advancing anterior teeth forward then activated by a slight opening. Like above, they can be replaced with flowable composite beads anterior to the first molars applied directly on the NiTi archwire positioned anterior to the incisors' brackets (Fig. 4a).

2.12. Engaging Archwire into the Bracket Slot

In the absence of a ligature tie or elastic module, a flowable composite can be used to engage wire into a bracket slot. In tandem mechanics, a flowable composite could be used to support a thin, flexible wire that must be positioned over a heavier stabilizing wire [1].

2.13. Tooth Movement

A wire or periodontal splint material may be bonded to the neighboring teeth with a flowable composite to produce tooth movements, such as extruding a damaged tooth for restoration. Extrusive force can be delivered via an elastomeric chain attached to this splint [1].

2.14. Constructing a button-like shape for attachment

An elastic separator can be used as a mold after etching, rinsing, drying, and applying primer to the tooth surface. A suitable amount of flowable composite can be injected and cured to be used as an elastic attachment in cases where there is no button or where the button is frequently de-bonded (Fig. 6).

Fig. 6 Flowable composite is used for construction button-like shape for attachment of elastics

2.15. Bonding a Crimpable Stopper for Rotated Teeth

In the case of a rotated canine, a metal stopper (Fig. 7) might be bonded to the tooth surface with a flowable composite rather than a bracket as it would be easier to place a smaller attachment at the center of the crown [25].

Fig. 7 Flowable composite is used to bond the crimpable stopper on the rotated canine [25]

2.16. Esthetic Replacement of the Missing Teeth in Essix Retainer

In case of space opening for the replacement of congenitally missing lateral incisors and during the delivery of the clear retainer, the created spaces are either replaced with artificial teeth within the Hawley retainer. An alternative may be making a wax impression of the missing tooth on the dental model of the patient during the fabrication of the clear retainer and later filling the void with flowable composite.

2.17. Aids in Fixing some Orthodontic Auxiliaries

A fiber post can be employed as a space maintainer on the proximal surfaces of adjacent teeth using flowable composite in certain circumstances where permanent teeth have not yet emerged.

Additionally, on some occasions, the NiTi retraction spring might be dislodged from the canine bracket hook or soldered on the wire, so a tiny amount of flowable composite could be added and cured over the hook to secure the spring.

Flowable composite can also be added to the inner surface of the crimpable hook before crimping on the archwire, then cured after crimping to prevent sliding or movement of the hook after placement of adjustable chain or retraction spring.

2.18. Acting as a Stopper to Prevent Further Activation of Hyrax

For avoiding a relapse, the Hyrax appliance must remain in place for a minimum of 3 months following the maxillary expansion is completed. For hiding the screw holes and preventing over-activation of the hyrax, flowable composite might be applied rather than acrylic.

2.19. Fabricating Immediate Pontic

Kravitz [26] described a flowable composite method for immediate pontic for the cosmetic restoration of extracted lateral incisors during fixed orthodontic treatment. The technique entailed using flowable resin, a mixing pad, and a light cure unit: flowable resin outlines the tooth's contour on a mixing pad. The tooth's body is constructed with flowable resin, which is spot-cured to maintain its shape. More resin is applied on top to add thickness. The ability to swiftly adjust the pontic's height, form, and contour and orthodontic brackets that can be glued on such a pontic with the same material are all advantages of such a treatment.

2.20. Used as a Wire Stopper

One method of preventing wire movement and travel through brackets/tubes, particularly in self-ligation brackets, is to utilize a metal stopper. Some manufacturers add a dimple or curve to the midline region for the same reason. If neither of these options is available, a flowable composite can be put directly to the wire and cured to obtain the same outcome (Fig. 8).

Fig. 8 Flowable composite is used as an archwire stopper

3. Conclusions

In the last year, much advancement in materials science and applications made different materials easy

and effective. The main findings from the current review article present the different uses of flowable composite in daily orthodontic work. They summarize different modifications that can be done using this material, like a bite raiser instead of an acrylic bite plane, which seems bulky and might affect speech.

Compared with different review articles on the same subject, the present article involved about twenty uses for flowable composite in orthodontics. Other articles explained not more than five to ten uses, so this comprehensive review also contains new uses explained by the authors, giving strength to it. This study had a limitation of lacking the evidence regarding the success of using flowable composite in bonding orthodontic brackets after testing the acid challenges of different food and beverages. Microleakage under orthodontic brackets and lingual retainers needs further studies to assess its damaging effect.

It is recommended to test the efficacy of bulk-fill flowable composite during bonding or improve the properties of the conventional flowable composite to increase its strength resisting the masticatory force and decrease the bond failure. Moreover, incorporating fluoride into the compositions of this material might have an extra- effect in reducing the white spot lesion.

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