Bulk-Fill Resins versus Conventional Resins

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Contributor: Gonçalo Silva , Carlos Miguel Marto , Inês Amaro , Ana Coelho , José Sousa , Manuel Marques Ferreira , Inês Francisco , Francisco Vale , Bárbara Oliveiros , Eunice Carrilho , Anabela Baptista Paula

Composite resins have become the material of choice for the restoration of posterior teeth. Although bulk-fill resins represent a tempting alternative due to their lower complexity and faster use, some dentists are reluctant to use this material.

abrasion bulk-fill composite resin microleakage

1. Introduction

Caries lesions represent the pathology that dentists are most often faced with in oral cavities. These arise due to bacterial activity that promotes demineralisation on the tooth surface, through the production of acidic components that result from the metabolism of nutrients. The recommended treatment for this pathology consists of removing all the carious tissue and subsequently filling the cavity with a suitable restorative material [1][2].

Currently, due to increasing demands and the establishment of higher standards, often strictly related to aesthetic aspects, restorative materials have had to evolve to live up to these expectations. Thus, currently, composite resins have become the material of choice for the restoration of posterior teeth [2].

Although composite resins are a frequently used, promising material, with many advantages compared with their precursor (dental amalgam), they still present some problems [2]. The biggest fear that arises when using this type of material is mainly related to polymerisation shrinkage and the successive mechanical stress that is associated with direct composite resin restorations. Microleakage, loss of adhesion of the restoration to the tooth structure, and, more commonly, secondary caries is some of the examples of the consequences that can arise from the failure of this type of material [3].

Polymerisation shrinkage is the main disadvantage of composite resin restorations. To combat the weaknesses associated with this material, some techniques have been proposed to reduce the stress associated with the material shrinkage and ensure better results. These techniques include the adjustment and modelling of the light intensity in polymerisation, the use of indirect composite resin restorations (whose polymerisation takes place outside the cavity, with only the contraction of the resinous cementing material), the application of a liner of flowable composite resins (for adjustment to the irregularities of the cavity floor), and the use of the incremental technique, which is quite common in direct composite resin restorations [4][5][6]. This last technique is widely recommended, since when smaller amounts (around 2 mm) are placed, successively, oblique and with altered

geometry, it is expected that there will be a decrease in the stress related to the C-factor (ratio between the areas of adhered surfaces and the areas of free surfaces). In turn, this consequent decrease will lead to the possibility of decreasing the shrinkage stress on the material [6][7].

The modification of the composite resin insertion was one of the ways found to reduce the effects of polymerisation shrinkage. However, over time, changes in the composition of composite resins were used with the same objective, either in changing the percentage of filler versus resin or in the introduction of other resin monomers, namely ormocer and silorane [8][9][10][11].

Bulk-fill resins have emerged with the objective of simplifying the insertion technique with the placement of layers of greater thickness, keeping the polymerisation shrinkage low. They simplify the restorative procedure in posterior teeth, since they allow the use of a single composite resin increment of 4–5 mm, resulting in a less time-consuming procedure than the conventional method [12][13]. This is possible since these composite resins have several specificities that make them ideal for the treatment of posterior teeth. They present greater translucency and, consequently, better light dissipation in the composite resin, with photo initiators allowing a greater polymerisation depth and polymerisation modulators allowing for less polymerisation shrinkage [14].

Bulk-fill resins can be categorised into two groups, base with low viscosity and full-body with high viscosity, depending on the purpose for which they are used, namely the restoration type and its mechanical requirements [6][15].

The first group, having a low viscosity, is easy to sculpt and can be sonically activated to become more fluid and more easily adaptable to the cavity walls [6].

Normally, the application of flowable bulk-fill resins can be carried out using a syringe, since they are characterised by their high fluidity. Thus, the application is simpler, allowing use of the composite resin in cavities that are more difficult to access. However, this type of composite resin is often associated with low strength, and it is necessary to cover it using conventional composite resins, thus hiding the more transparent aspect of the restoration given by bulk-fill composite resins [14][15][16][17].

However, despite bulk-fill resins representing a tempting alternative, due to their lower complexity and faster use when compared with conventional resins, they are still not widely used by clinicians [1].

In the current literature, several studies address the different mechanical properties of bulk-fill composite resins and compare them with conventional resins. However, the results are inconsistent, and it becomes impossible to say with certainty that these composite resins are associated with greater clinical efficacy when compared with conventional resins. Therefore, it is extremely important to review the evidence available in the literature to allow reliable conclusions to be drawn [13][18][19].

2. Related Studies

Regarding the properties evaluated in the different studies, the total cumulative number of properties evaluated for all included studies was 39. The numbers of evaluated characteristics of the various studies were:

Arbildo-Vega et al. (2020)–11 characteristics [1]; Bellinaso, M. D. et al. (2019)–1 characteristic [20]; Cidreira Boaro et al. (2019)–9 characteristics [21]; Gerula-Szymańska et al. (2020)–1 characteristic [22]; Kruly et al. (2018)–5 characteristics [23]; Meereis et al. (2018)–1 characteristic [24]; Veloso et al. (2018)–8 characteristics [25]; and Zotti et al. (2021)–3 characteristics [26].

Among the various articles, there were common properties present. The evaluated properties that appeared most frequently in the included studies were the following: the appearance of secondary caries or caries recurrence appeared in four different studies [1][23][25][26]; marginal discoloration was appraised in four studies [1][23][25][26]; similarly, marginal adaptation was recorded in four different studies [1][23][25][26]; and postoperative sensitivity was measured in three different studies [1][23][25]. It should be noted that three of the studies only evaluated one single property [20][22][24].

As for the main results obtained in each of the studies, they demonstrated a trend of similarity between conventional resins and bulk-fill resins in terms of clinical performance.

Arbildo-Vega et al. (2020) [1] did not find significant differences between the two types of composite resin after evaluating the different characteristics related to clinical performance, regardless of the type of restoration (class I/II and non-carious cervical lesions), the type of dentition (primary or permanent) and the technique used (incremental, bulk or two-step bulk).

For Bellinaso et al. (2019) [20], when comparing the time required to perform a restoration between the two types of composite resin, demonstrated that the full-body bulk-fill composite resins required a shorter chair time to perform restorations in posterior teeth than conventional resins applied incrementally, thus confirming one of the main characteristics that make this type of composite resin desirable. However, flowable bulk-fill composites do not show the same evidence.

Cidreira Boaro et al. (2019) [21] concluded that bulk-fill resins perform similarly or better than conventional resins. However, although no differences were found between the two materials in terms of flexural strength and fracture strength, in terms of polymerisation stress and cusp deflection, they were lower when referring to bulk-fill resins. It should also be noted that, the volumetric shrinkage, degree of conversion and microhardness varied in their results according to the thickness and/or viscosity of the materials.

Gerula-Szymańska et al. (2020) [22] presented as the main result a similarity in marginal integrity between different types of bulk-fill resins (flowable and packable). It should be considered that the marginal integrity was analysed based on the restoration margin of two types of tissue: enamel and dentin.

Meereis et al. (2018) [24] compared the polymerisation shrinkage stress in different materials, including bulk-fill resins. This showed that bulk-fill resins demonstrate better potential for reduced shrinkage stress, especially if

materials with a low modulus of elasticity are used, hence favouring the use of fluid materials instead of materials with higher viscosities. However, the authors also list other studies that contradict this statement. Thus, they conclude that bulk-fill resins showed only a moderate potential in reducing mechanical stress.

Veloso et al. (2018) [25] divided bulk-fill resins into two groups (base/flowable and full-body/sculptable), and these were independently evaluated against conventional composite resins. The parameters evaluated were anatomic form, marginal discoloration, secondary caries, composite resin fracture, tooth fracture and postoperative sensitivity. The results showed no significant differences, either with the base/flowable bulk-fill or with the full-body/sculptable bulk-fill. This way, the clinical performance of bulk-fill composite resins is comparable to conventional resins in direct posterior restorations.

Finally, in Zotti et al. (2021) [26], bulk-fill resin restorations showed a 5.1% reduction in the risk of marginal discoloration and 1.4% of secondary caries while demonstrating a 6.5% increase in the risk of marginal misfit when compared with conventional composite resins. However, the author notes the possible low evidence of the meta-analysis performed and mentions that a possible risk of associated bias is present.

3. Meta-Analysis

The exclusions in three studies were due to the lack of quantitative data comparing bulk-fill resins and conventional resins, namely in Gerula-Szymańska et al. (2020) [22], Meereis et al. (2018) [24] and Veloso et al. (2018) [25]. In the study by Zotti et al. (2021) [26], there was no report of the number of events in each group, only the total number of teeth included.

In the evaluation of discoloration or marginal staining, the type of composite resin used seems to be negligible.

Regarding the marginal adaptation, the type of composite resin used seems to be irrelevant. However, both previous meta-analyses report a trend towards better results with conventional resin, although none of the results are statistically significant. The overall result is also not statistically significant, but it appears to be about four times more likely to obtain a favourable result with a conventional resin than with a bulk-fill resin.

Concerning the appearance of secondary caries, the results with conventional resin or bulk-fill resin are similar.

In assessing the restoration integrity, the type of composite resin used also appears to be irrelevant, with similar clinical results for both types of composite resin.

4. Quality of the Included Reviews

All studies presented information related to the PICO question applied inclusion criteria and used comprehensive research. The study selection was performed in duplicate in all studies; however, data extraction was not performed in duplicate in two of the studies [21][24]. The list of excluded studies was not presented in five reviews [1]

[20][21][22][26]. The description of included studies was performed in all studies. All articles presented the assessment of the risk of bias of the included studies, as well as the results of the statistical combination, while none of the articles referred to the funding of the included studies. The effect of ROB on the statistical combination was not shown in two of the included articles [1][20] and ROB was not mentioned in the discussion of three of the articles [1][21][22]. Heterogeneity was discussed in all articles. Only one review did not present a publication bias analysis [20]. Finally, two of the studies did not mention any type of publication funding [20][24].

Therefore, with the application of the criteria of the AMSTAR 2 tool, one review was considered of very low quality [21], four reviews qualified as low quality [1][20][22][26] and three were considered of moderate quality [23][24][25][26].

5. Degree of Umbrella Review' Overlap

In eight systematic reviews selected for this umbrella, a total of 236 primary studies were included. According to the table in the supplementary information, in columns, eight systematic reviews were from recent to past years, and, in rows, 236 primary studies were ranked in the same way. According to the formulas, the CA and CCA were calculated as follows (Equations (1)–(3)) [27][28][29][30]:

$$\mathbf{N = 278; r = 236; c = 8} \quad (1)$$

$$\mathbf{CA\ (covered\ area)} = N/rc = 278/236 \times 8 = 278/1888 = \mathbf{0.147} \quad (2)$$

$$\mathbf{CCA\ (corrected\ covered\ area)} = N - r/rc - r = 278 - 236/(236 \times 8) - 236 = 42/\ 1652 = \mathbf{0.025} \quad (3)$$

The results of CA and CCA were in the range between 0 and 5, which is considered a mild overlap. Thus, the low overlap of this umbrella review also confirms the need for conducting an overview such as this.

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