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Review article

Direct versus indirect inlay/onlay composite restorations in posterior teeth. A systematic review and meta-analysis

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ABSTRACT

Objective: To evaluate the long-term clinical performance of direct versus indirect composite inlays/onlays in posterior teeth.
Data: Screening for inclusion eligibility, quality assessment of studies and data extraction was performed independently by two authors.
Sources: The electronic databases MEDLINE, EMBASE, Cochrane Oral Health Group's Trials Register and CENTRAL were searched (14.12.2015), with no restriction to publication date or language. We included only randomised controlled trials (RCTs) and evaluated them according to Cochrane risk of bias tool. The main outcome assessed was the restoration failure, determined by several clinical parameters.
Study selection: Two studies concerning direct and indirect inlays (82 patients with 248 restorations) and one study for onlays (157 patients with 176 restorations) satisfied the inclusion criteria. Two trials, one of unclear and one of high risk of bias, could be mathematically combined. The meta-analysis indicated no statistically significant difference in the risk failure between direct and indirect inlays, after 5 years (RR: 1.54; 95% CI: 0.42, 5.58; p = 0.52) or 11 years of function (RR: 0.95; 95% CI: 0.34, 2.63; p = 0.92). Only one parameter, the marginal discoloration, slightly favored direct inlays after 11 years (RR: 0.41; 95% CI: 0.17, 0.96; p = 0.04). Only one study dealt with onlays; an overall 5-year survival of 87% (95% CI: 81–93%) was reported.
Conclusion: The difference of the two techniques did not reach statistical significance in order to recommend one technique over the other. The scarcity of primary studies support the need for further well-designed long-term studies in order to reach firm conclusions about both techniques.
Clinical significance: Resin composite materials, placed directly or indirectly, exhibit a promising long-term clinical performance when rehabilitation of posterior teeth is needed. Although many years in clinical practice, the selection of the best treatment protocol still remains subjective. The available studies, and their synthesis, cannot provide reliable evidence in this field.

1. Introduction

Failure of dental restorations presents a major complication in everyday dental practice. It has been reported that about 60% of all operative dental workload refers to placement and replacement of restorations [1]. Correct material manipulation and proper technique selection may be regarded as the key factors that affect restoration success or failure [2].

Contemporary dentistry evolves along with patient's demand for high aesthetics. Even though amalgam and gold have been materials with a long history of clinical success and biocompatibility, patients often reject these treatment options, as the desire of a restoration that resembles natural tooth structure, even for posterior teeth, is high [3].

Conservative restorative dentistry is provided with a wide range of techniques and systems for the rehabilitation of posterior teeth in a minimal invasive way. Resin composite materials, placed directly or indirectly, are among the best alternative non-metallic, tooth-colored restorative treatments [4].

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Composite resin materials usually consist of a matrix (organic polymer) and fillers (combination of inorganic particles) of different types. Some of these resinous materials are based on Bisphenol-A (BPA), which is used as a precursor of BPA glycidyl dimetha-crylate (Bis-GMA) or BPA dimethacrylate (Bis-DMA). The BPA structure assembles a bulk, stiff chain that offers low susceptibility to biodegradation as well as great rigidity and strength [5]. Clinical, physical and mechanical properties of composite resins depend on the percentage of fillers in their volume, the particle size, and load and matrix bonding of the filler. In fact, the more the loading of the filler particle is, the less the wear resistance [6]. However, these resins are less polishable. Resin composites have gone through generations of traditional (macro-filled) composites, microfilled composites, hybrid composites, microhybrid composites and nano-composites. Newer resin formulations of smaller filler particles but higher filler loading percentage (approximately 66% inorganic fillers and 33% resin matrix) have been developed to enhance mechanical characteristics. The submicron-particle fillers provide abrasion resistance, more color stability and less polymerization shrinkage, while increasing flexural and tensile strength. Resins are converted from monomer to polymer by various methods of polymerization devices. The controlled degree of polymerization also enhances tensile strength, wear resistance, fracture toughness and color stability [7,8].

In direct restorations, light-cured resin composite material is placed directly into the prepared cavity. The greatest advantage presented by this procedure, is that it permits the maximum preservation of tooth structure, which collaborates with the modern concept of a minimal-invasion conservative restorative dentistry. In addition, they are usually performed in one treatment appointment, at relatively low costs. However, direct restorations are associated with polymerization shrinkage and low wear resistance [9,10].

Indirect technique involves fabricating the restoration outside the oral cavity, using an impression of the prepared tooth. This technique overcomes some of the disadvantages of direct resin composites, such as polymerization shrinkage to the width of the luting gap [11]. Furthermore, it provides better physical and mechanical properties by post-curing the inlay/onlay with light or heat, ideal occlusal morphology, proximal contouring and wear compatibility with opposing natural dentition [12,13]. However, this technique is more time consuming and requires extra cost and appointments that may, in turn, be out of patient wishes and budget.

As evident in the literature, many *in-vitro* studies have examined the behavior and durability of direct composite restorations and indirect composite inlays [14,15]. Although, several studies have verified the long-term *in-vivo* performance of those materials separately [16,17], only few have compared these techniques [18,19]. In a recent systematic review, Grivas et al. concluded that there was insufficient evidence to make recommendations for the use of indirect composite inlays over direct. In this review, the variety of methodology, the heterogeneity of the trials – 3 randomized controlled trials (RCTs) and 4 controlled clinical trials CCT until 2013 were considered eligible- as long as the unlimited observation time could not permit a valid assessment on the basis of a meta-analysis regarding the longevity of the composite inlays [20]. Even though there is a systematic review that compares clinical effectiveness of composite versus ceramic inlays/onlays [21], there is no systematic review apparent in the literature that has evaluated effectiveness of direct versus indirect composite inlays/onlays.

The aim, therefore, of this systematic review was to provide updated evidence stemming from randomized controlled trials comparing direct and indirect composite restorations in posterior teeth, with at least 3 years of follow-up after initial restoration. Comparison results relied on the clinical parameters of longevity, secondary caries, post-operative sensitivity, marginal discoloration and color match between intervention modalities.

2. Materials and methods

This systematic review was based on the guidelines of the PRISMA Statement for reporting Systematic Reviews and Meta Analyses of studies evaluating health-care interventions [22].

2.1. Protocol and registration

Not available.

2.2. Selection criteria applied for the review

- Study design: Only randomized clinical trials were eligible for inclusion in this review. Non-randomized or quasi-randomized controlled trials were not eligible for inclusion
- Types of participants: Patients of any age who received direct or indirect composite inlays/onlays
- Type of intervention: All direct/indirect composite inlays/onlays irrespectively of the resin and bonding material and the type of tooth (molar, premolar)
- Outcome: Failure rate of direct and indirect composite inlays/onlays, (restorations which need replacement or repair) and risk ratio of (1) secondary caries, (2) postoperative sensitivity, and (3) marginal discoloration, color match between the two groups
- Follow-up: At least three years of observation
- Exclusion criteria: Animal and *in-vitro* studies.

2.3. Search strategy for identification of studies

Detailed search strategies were developed and appropriately revised for each database, considering the differences in controlled vocabulary and syntax rules. The following elec-tronic databases were searched: MEDLINE (via Ovid and Pubmed, Appendix A, from 1946 to December 14th, 2015), EMBASE (via Ovid), the Cochrane Oral Health Group's Trials Register and CENTRAL.

Unpublished literature was searched on ClinicalTrials.gov, the National Research Register, and Pro-Quest Dissertation Abstracts and Thesis database. The search attempted to identify all relevant studies irrespective of language. The reference lists of all eligible studies were hand-searched for additional studies.

2.4. Selection of studies

Two authors (F.A. and A.G.) of the review independently and in duplicate performed the study selection. The procedure composed of three stages: title-reading, abstract reading and full-text reading in order to identify studies that potentially met the eligibility criteria. After exclusion of not eligible studies, the full report of publication was obtained and assessed independently. Any disagreements were discussed and resolved by discussion and consultation with the other two authors. Reasons of exclusion and all decisions on study identification were recorded.

2.5. Data extraction and management

Data extraction was performed independently and in duplicate by the first two authors. In order to record the desired information, the following customized data collection forms were used.

- Author/title/year of study