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Review

# All-ceramic inlay-retained fixed dental prostheses for replacing posterior missing teeth: A systematic review

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ABSTRACT

*Purpose:* To evaluate the current status of all-ceramic inlay-retained fixed dental prostheses (CIR-FDPs) for the replacement of posterior teeth.

*Study selection:* Screening of titles and abstracts, full-text analysis for inclusion eligibility, quality assessment, data extraction and evaluation of the scientific evidence were performed independently by two reviewers. The electronic databases MEDLINE/PubMed, EMBASE, Cochrane Central Register of Controlled Trials, and Compludoc were searched with no restriction to publication date or language. The quality of the studies was evaluated through: the original 'QDP' ('Questionnaire for selecting articles on Dental Prostheses') (for research papers); the 'Guidelines for managing overviews' of the Evidence-Based Medicine Working Group (for reviews); the Cochrane risk of bias tool; and the GRADE scale for grading scientific evidence.

*Results:* This review started with 4942 articles, which were narrowed down to 23 according to the selection criteria. The data was not statistically treated because of the heterogeneity of the studies. Zirconia-based CIR-FDPs may be recommended for restoring posterior single missing teeth, although the prosthesis/tooth bonded interface has yet to be improved. The addition of lateral wings to the classical inlay preparation seems promising. The weakest parts of CIR-FDPs are the connectors and retainers, while caries and endodontic problems are the most common biological complications. The fabrication of CIR-FDPs with monolithic zirconia may eliminate chipping problems.

*Conclusions:* A three-unit CIR-FDP is a viable treatment option for replacing a posterior missing tooth. Appropriate case selection, abutment preparation and luting procedures may be decisive for clinical success.


**Contents**



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## 1. Introduction

The treatment of choice for replacing a missing posterior tooth with healthy adjacent teeth is usually a dental implant-supported restoration [1–5]. However, clinical contraindications (such as smoking patients, uncontrolled diabetes, or several cancer therapies) and other surrogate situations (such as economic problems or fears of surgery) may be encountered [4–7]. The first option in these cases has traditionally been crowning the adjacent teeth for a three-unit fixed dental prosthesis (FDP). Nevertheless, when preparing teeth for a full coverage, approximately 63–73% of the dental structure has to be removed [3,8]. Irreversible pulpitis and pulpal necrosis have been reported to occur in 15.6% of the teeth treated with single crowns and in 32.5% of the teeth restored with FDPs after 10 years of oral service [9–11].

In the last decades, the use of inlays for retaining a three-unit FDP has increasingly been considered [5,12]. This alternative has been defined as '*a minimally invasive treatment modality for replacing posterior single missing teeth, which uses box-shaped cavities as retainers and might include existing fillings made of gold, composite, ceramic, or other materials that are luted to the adjacent teeth*' [13]; *thus preserving the dental structure and the integrity of the periodontal tissues* [5,14–17].

Inlay-retained FDPs were introduced in 1960s and were originally made out of noble metals [2,3,18]. This allowed for a conservative preparation and facilitated a proper load and stress distribution [12,19,20]. Nonetheless, in addition to the aesthetic inconvenience [21], the detachment of the retainers was a common problem, and often led to the development of secondary caries [22,23]. Mean failure rates of 46.4% have been reported for this type of restorations after 2.5–9 years [3]. Although nearly parallel-sided box configurations with frictional retention seem to increase their clinical success until 96.1% at 5 years of follow-up [24] it still remains unknown whether such positive outcome is confirmed in the long-term [3].

In order to avoid these problems, glass fiber-reinforced composites (FRCs) and dental ceramics were proposed for the fabrication of inlay-retained FDPs [21,25]. These restorations, which are bonded to the abutment teeth and require simpler and minimally invasive preparations [26–28], may be used as definitive treatments instead of implants in the presence of scarce bone or other anatomical, medical, or economical constrains [29,30]; and also in juveniles as temporary solutions that can be readily replaced or modified [29–31]. Decementation has been rated as the most common failure type of resin-bonded FDPs [32]. Other typical events are secondary caries on the abutments [30], chipping of the veneering material [33], and/or fracture at the connectors and retainers [34]. The long-term success of these prostheses, which range from 59% to 100% at 5 years, mainly depends on the mechanical properties of the materials used, the preparation configuration [29,35], the occlusal loads, the presence of parafunctional habits [5,26,36], and the quality of the adhesion at the tooth/restoration interface [29,35]. The geometry of the inlay cavity must offer favourable conditions for adhesive cementation. The location of the margins should allow a rubber dam to be placed for ensuring a complete isolation [37] thus preventing contamination with saliva or sulcus fluid [38]. Moreover, the increased inclusion of enamel promotes the bond to dentin, which still needs to be enhanced [37,39].

Glass fiber-reinforced composites were presented as universal dental aesthetic restorative materials when they were introduced to Dentistry in the late 1990s [12,21,40]. FRCs are composed of a core material made of fiber composite and an external veneer surface of hybrid or microfilled particulate filler composites (PFC) [41,42]. The physiological stiffness of the structure, resilience, satisfactory immediate aesthetics, and proper adhesion of the composite luting agent to the framework are their main advantages [5,40,43,44]. Nevertheless, they are limited by their low fracture toughness, high wear of the veneering composite that may lead to fiber exposure, degradation of marginal integrity, and discoloration compared to other materials [3,4,28,45,46]. Their survival rates have been observed to drop considerably below 80% after 5 years [47], so that this material has mostly been relegated to temporary solutions [48,49]. However, the reinforcing effect of the fiber restorations depends, in turn, on the characteristics of the fibers, matrix, and polymer; the quantity of fibers and their location, direction, construction, and distribution; the impregnation of the fibers in the resin; the adhesion of the fibers to the matrix; the elastic modulus of the supporting substructure; the features of the luting agent; the thickness of the restoration; and the preparation design [5,21,43,44]. For instance, the shape of the framework (i.e., parallel *vs.* parallel and woven fibers) has been reported to affect the fracture resistance, being higher for parallel fibers [50]. Also, when the structure is fabricated without the recommended dimensions, the excessive frame flexibility may increase the microfractures of the aesthetic veneering [51].

Ceramics are the material of choice for guaranteeing durable aesthetic results [17,37,52]. Each situation must be particularly evaluated to determine whether the case complies with the ideal number of teeth lost and location; edentulous space (20 mm or less between the remaining teeth); integrity and periodontal health of the abutment teeth [3,4,17,21]; favourable occlusal loads, and absence of parafunctions [5,26,36].

Yttria partially stabilised CAD/CAM zirconium-oxide ceramic (YPSZ) has been proved to have excellent mechanical performance as core material for all-ceramic fixed dental prostheses. The zirconia surface is usually coated with glass-ceramic layers to optimise the aesthetic appearance [38,53]. However, these rehabilitations are prone to failure primarily by chipping of the veneering ceramic [33], which might be circumvented by the use of monolithic zirconia [3].

High-strength heat-pressed lithium-disilicate ceramics may be used as well for all-ceramic structures [53]. The outstanding aesthetic features of these tooth-coloured systems, which