

## Minimally Invasive Posterior Full Crown Competitors: Onlays, Occlusal Veneers, Vonlays and Endocrowns: A Review and Proposed Classification

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### Abstract

The main disadvantage of the posterior full crown (PFC) is excessive loss of sound tooth structure. A new group of posterior minimally invasive (PMI) restorations have evolved that can be used for the same indications of PFC with the added advantage of tooth structure preservation, so they can compete PFC.

The purpose of this article is to a) summarize and suggest a classification of this new group of restorations b) compile different names for the same PMI restoration described in the literature. MEDLINE search was conducted using the following key words: "endocrowns", "occlusal veneers", "indirect onlays", "bonded onlays", "occlusal onlays", "ceramic overlays", "partial ceramic crowns", "tabletop restorations", "full crown alternatives", and "indirect minimally invasive restorations". English language articles were included within the last 10 years. 179 articles were finally selected after evaluation of the identified articles for eligibility.

The conclusion is "When a posterior tooth is planned for full cuspal coverage, the clinician mind should not go directly to conventional full coverage crowns, PMI restorations should be considered first".

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### Introduction

Preserving tooth structure is critical for the longevity of teeth and restorations.<sup>1</sup> It is obviously advantageous to save the pulp vitality and delay the need for endodontic treatment, dowels, and cores, because these are more invasive treatments that adversely affect the performance of restored teeth over time.<sup>2</sup>

The protocol for placing restorations have

changed due to greater advancements in optical and mechanical properties of dental ceramics<sup>3</sup>, restorations fabrication techniques<sup>4</sup> and adhesive systems<sup>5</sup>. So, removing only the pathology from a tooth and replacing the missing parts with an adhesive restoration should be a consideration.

Traditionally, posterior full crowns have been considered as the classic example of cuspal coverage restorations that provide the best retention and longevity, but they may be associated with periodontal disease especially in case of subgingival margins and unnecessary removal of tooth structure.<sup>6</sup>

Cuspal coverage can be provided without complete reduction of axial tooth surfaces or subgingival margins through restorations like onlays, partial coverage crowns and endocrowns. there is no clear classification for these restorations in the literature and controversies

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are also present regarding their definitions. So, the purpose of this article is to a) summarize these restorations that may compete the full crowns so that they are kept into the minds of dentists when a tooth is planned to receive cuspal coverage. b) suggest a classification of these new group of restorations for educational purposes c) compile different names for the same restoration described in the literature.

## Materials and methods

### Search strategy

An electronic search of the literature was performed to identify all article types with titles including one of the following keywords: "endocrowns", "occlusal veneers", "indirect onlays", "bonded onlays", "occlusal onlays", "ceramic overlays", "partial ceramic crowns", "tabletop restorations", "full crown alternatives", and "indirect minimally invasive restorations".

The search was conducted in MEDLINE database and limited to the last 10 years. A further google search was performed using the following 2 terms: "vonlays", and "veneerlays".

### Inclusion criteria

This review requested well-designed articles including in their titles one of the keywords used for electronic search. Articles describing history, definitions, preparations, indications, contraindications, advantages, disadvantages and fabrication techniques of these restorations were included.

### Exclusion criteria

Case reports, case series, opinions, and studies on direct adhesive restorations were not included in this review. Articles with similar results or repetitive information and published in non-specialized journals were excluded. Articles in any language other than English were excluded too.

## Results

A total of 1430 studies were identified in the literature, of which 299 were selected for full-text screening. 120 studies were excluded and a total of 179 articles were finally selected.

### Onlays

In the literature they may be described as bonded partial ceramic crowns<sup>7</sup>, occlusal onlays<sup>8</sup>, bonded onlays<sup>9</sup> and overlays<sup>10</sup>. They have been documented as durable minimally invasive restorations to restore posterior teeth with large

defects.<sup>11</sup>

Bonded onlays are mainly indicated when there is a prerequisite for protective coverage of the tooth cusps without doing conventional crown to preserve the amount of remaining tooth structure.<sup>12</sup> Also, they can be used for treatment of advanced occlusal wear<sup>13</sup> and reinforcement of teeth with cracked tooth syndrome.<sup>14</sup>

Unlike the conventional MOD onlays, the preparation for bonded onlays is defect specific, non-retentive with no sharp corners or acute angles and ensuring sufficient thickness of ceramic materials.<sup>15</sup>

When occlusal onlays are used for treatment of occlusal wear the preparation consists of occlusal reduction and circumferential finish line. Specific preparation kits, 4665 or 4665 ST occlusal onlay set from Komet Dental, have been recommended to perform this reduction. This kit includes mainly three instruments, first is the occlushaper instrument which design allows the dentist to perform the occlusal reduction in one step, second is a diamond instrument with non-cutting guide pin used for reduction of peripheral finish line on buccal and lingual surfaces. The third is a special sonic instrument with diamond particles only one side to avoid cutting of adjacent teeth while preparing the peripheral finish line in the proximal surfaces.

When they are used to restore large occlusal defects or replace failed restorations, the preparation should follow some guidelines which have been suggested by Ed'Incau and Zunzarren.<sup>16</sup>

1. The main isthmus width should be more than or equal to 2mm.
2. Butt joint cavo-surface margin with no bevel.
3. The cavity walls occlusal divergence should not be too restricted more than or equal to 10°.
4. Occlusal contacts should be away from the tooth restoration junction.
5. Rounded axiopulpal line angles.
- 6 The mesiodistal width of the proximal box should be at least 1mm.
7. At the level of the covered cusps the ceramic or indirect composite thickness should be at least 1.5 to 2mm.
8. The remaining cavity walls thickness should be at least 2mm at the gingival level and 1 mm at the occlusal level.
9. At the level of the covered cusps a rounded shoulder is suggested.

### Occlusal veneers

These are extra coronal restorations demanding an easy preparation determined by occlusal anatomy and provision of adequate interocclusal clearance, they were first described by Pascal Magne<sup>17</sup>. They may be also called tabletop restorations.<sup>18</sup>

Ultrathin CAD-CAM occlusal veneers which are about 1 - 1.3 mm at the cusp tip and 0.4 - 0.6 mm thick at the central grooves; had been recognized as a better substitute to full crowns.<sup>19</sup> One study<sup>20</sup> used occlusal veneers as re enameling process for replacement of missed enamel in cases with sever erosion.

Two preparation designs of occlusal veneers have been described in the literature, the standard full coverage non retentive preparation which is driven by anatomy of occlusal surface and provision of adequate interocclusal clearance according to the restorative material used<sup>21</sup> and the no-preparation or minimally invasive design which have been advocated for teeth with a significant loss of dental tissue due to occlusal wear.<sup>22</sup>

#### Vonlays or veneerlays

Vonlays are a combination of onlay and buccal veneer, the term vonlay veneer + onlay was first used by Edward McLaren et al<sup>23</sup> who used a monolithic structure fabricated from lithium disilicate in maxillary bicuspid region, They are mainly used for posterior teeth with caries involving occlusal and buccal surfaces, also for patients presenting with occlusal wear in posterior teeth, according to McLaren et al.<sup>23</sup> the advantages of these restorations were less technique sensitivity, less invasiveness and more repairability than full crowns.

#### Endocrowns

These are monolithic one-piece core and crown restorations, their retention depends on friction with the pulp chamber walls and adhesion with the available tooth structure<sup>24</sup>, the term endocrown was used by Bindl and Mormann in 1999.<sup>25</sup>

Indications of endocrowns includes interocclusal space not enough for post core and crown<sup>26</sup>, to avoid surgical crown lengthening where ferrule cannot be established as the endocrown margins are mainly equigingival<sup>27</sup>, calcified, curved or short root canals where post application is difficult,<sup>28</sup> and for young permanent endodontically treated molars.<sup>29</sup>

When compared with conventional crowns, endocrowns have many advantages which are;

short clinical time and low cost<sup>30</sup>, preservation of sound enamel and dentin that is removed during conventional axial surface and ferrule preparation as endocrowns are usually prepared without ferrule<sup>31</sup>, higher fracture resistance due to thicker occlusal portion and better stress distribution.<sup>32</sup>

Two preparation designs of endocrowns described in the literature, a standard one non-ferrule containing, flat or classic consists of a circumferential wide shoulder margin and a centralized retention cavity inside the pulp chamber. Another design with 90-degree shoulder ferrule containing was also described.<sup>33</sup>

The endocrown material have an influence on its performance. It should be made from a material that have enough bond strength to the underlying tooth structure<sup>34</sup> and with a modulus of elasticity close to that of the tooth structure so that occlusal forces are distributed along the bonded interface.<sup>35</sup> Resin ceramics and lithium disilicate are the most used.<sup>36</sup>

Many studies have concluded that endocrowns are a hopeful and conservative substitute to full crowns as a post endodontic restoration for posterior teeth.<sup>37</sup>

Even in the presence of unfavorable occlusal relations as bruxism, they constituted a reliable approach for restoration of severely damaged premolars and molars provided that the adhesive technique is properly applied.<sup>31</sup>

## Discussion

There are two broad categories of fixed dental prothesis; old category known as conventional restorations that depend on frictional or mechanical retention and recent category known as minimally invasive MI or adhesive restorations that depend on adhesives. Conventional restorations can be fabricated from esthetic or non-esthetic materials whoever MI restorations are fabricated from esthetic materials only. Nowadays, selecting the best restorative option for posterior teeth is a challenge because of many minimally invasive restorations available.

According the glossary of prosthodontic terms<sup>38</sup>, a fixed dental prothesis is the general term for any prosthesis that is securely fixed to a natural tooth or teeth, or to one or more dental implants/implant abutments<sup>39</sup>, it cannot be removed by the patient, a partial-coverage crown is an artificial replacement that restores missing

tooth structure by surrounding part of the remaining structure and is retained by mechanical or adhesive means; and an onlay is a partial-coverage restoration that restores one or more cusps and adjoining occlusal surfaces or the entire occlusal surface and is retained by mechanical or adhesive means.

Simply, an onlay restoration covers the occlusal surface while a partial coverage crown covers the occlusal surface and surrounds parts of the remaining tooth structure.

Unfortunately, there is no clear classification for MI restorations in the literature. Also, controversies are present regarding the MI restoration that is used to cover all the occlusal surface; it may be called overlay, tabletop, occlusal veneer, full coverage occlusal veneer, ultrathin occlusal veneer, ceramic onlay<sup>40</sup>, occlusal onlay, bonded onlay, bonded ceramic partial crown or ceramic fragments.<sup>41</sup>

A new suggested restoration that covers occlusal and buccal surfaces is called vonlay or veneerlay<sup>42</sup>, we cannot classify it as onlay or crown.

Another unpublished type of restoration called crownlay; also, there is sharonlay<sup>43</sup> which is used as post endodontic restoration for premolars; actually, this restoration is an updated idea of what had been called Richmond crown.<sup>44</sup>

These controversies may complicate teaching these new group of restorations to dental students, also it makes communications among dentists and dental technicians confusing.

Based on this discussion, posterior minimally invasive fixed dental prosthesis PMI FDP restoring one tooth can be classified into four main restoration types: -

- a. Onlay (tabletop or occlusal veneer): - A restoration that covers all the occlusal surface without covering axial surfaces of the clinical crown.

The term onlay is used when replacing old restorations or restoring large occlusal defects without need to cover axial surfaces while the term occlusal veneer or tabletop is used when restoring occlusal surfaces lost mainly because of occlusal wear. Occlusal veneer may be of different thicknesses according to the lost tooth structure.

- b. Partial coverage crown: - A restoration that covers all the occlusal surface and less than 100% of the axial surfaces of the clinical crown.

- c. Endocrown: - An endocrown that covers 100% of the axial surfaces of the clinical crown is called full coverage endocrown, while a partial coverage endocrown covers less than 100% of the axial surfaces of the clinical crown.

- d. Minimally invasive posterior indirect restoration (MIPIR): this is a restoration that does not have a specific shape or preparation and it is not an onlay, partial coverage crown or endocrown.

The terms described in the literature as overlays, occlusal onlays and bonded onlays are not justified because we cannot differentiate them from the well-known restorations which are partial coverage crowns. A full coverage endocrown is minimally invasive restoration in relation to post and core supported complete coverage crown; also, an adhesive restoration that covers 100% of the clinical crowns' axial surfaces of a vital tooth cannot be categorized with these restorations because it is a complete coverage crown.

Following the same rule used for Vonlays or veneerlays veneer on buccal surface + onlay, a restoration covering the occlusal and palatal surfaces may be called reversed vonlay and so on. This will open the door to many new names of restorations and more controversy and confusion.

Although there is a good evidence that endocrowns and MI onlays can be used as a reliable alternate to full crowns; the competition is still running because the full crown will be used after failure of these MI restorations.

The main benefit of this competition is increasing the serviceability of natural teeth by limiting the primary indications of full coverage crowns to main three areas which are, the replacement of old full crowns, implant supported crowns and post – core supported crown.

Finally, for these restorations to compete the full crowns the following factors should be considered during their planning.

- a. The adhesive potential<sup>45</sup> which means how is the existing caries extension size and how much healthy enamel remaining for adhesive retention.
- b. Parafunctional activity must be examined and evaluated.<sup>46</sup>
- c. The tooth type as bite forces increases the further posterior the tooth.<sup>47</sup>

- d. Opposing teeth wear must be considered. In these cases, the restorative material selection is very important; indirect composite may be more effective in the long term.<sup>48</sup>
- e. Applicability of adequate isolation, which is critical to the success of adhesive bonding.<sup>49</sup>
- f. The bonding protocols.<sup>50</sup>

## Conclusions

When a posterior tooth is planned for full cuspal coverage, the clinician mind should not go directly to conventional full coverage crowns. PMI FDP should be considered first.

Provided that a good case, restorative material, processing, and adhesive techniques are selected together with good clinical experience, posterior full crown indications may be limited to, replacement of old crowns, over implant abutments and over post and core restorations.

For these competitors to succeed, it is necessary to follow their preparation guidelines, to recognize their indications, to select the adequate material and to respect the procedure of bonding.

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## Declaration of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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