

# Modern Adhesive Ceramic Onlay, A Predictable Replacement of Full Veneer Crowns: A report of three Cases

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## ABSTRACT

For many years the decision to crown a tooth was relatively easy. Traditionally crowns were indicated for the restoration of teeth that had lost a significant amount of tooth structure due to caries, toothwear or fracture. The conventional crown strengthened the remaining tooth structure, restored the occlusal and axial contours and as a result restored the tooth to function. However, in more recent years the dental profession is gradually accepting the destructive restorative procedures involved in the placement of conventional full coverage restorations having significant biological downsides. With the increasing emphasis of tooth conservation and the high demand of esthetically pleasing restorations, the focus is shifting towards adhesively bonded ceramic inlays and onlays for restoration of damaged posterior dentition. They combine the biologic benefits of tooth conservation and preservation of pulpal and periodontal tissues along with technical gain of prosthodontic ease. We present three clinical scenarios in which replacement of tooth structure with bonded ceramic onlays can be justified according to modern concepts.

**Key words:** Ceramics, onlay, full veneer crown, adhesive bonding.

*How to cite this article:* Vohra FA, Baloch HR, Ghani SM. Modern adhesive ceramic onlay, a predictable replacement of full veneer crowns: A report of three cases. J Dow Uni Health Sci 2014; 8(1): 35-40.

## INTRODUCTION

Loss of tooth structure is a common occurrence in any population and is frequently replaced by direct or indirect restorations. Restorations conventionally used are fixed partial dentures (FPD) and full veneer crowns,<sup>1</sup> fabricated in ceramo-metal, metal and ceramic materials. The use of full veneer crowns and FPD, requires extensive reduction of existing tooth structure to provide mechanical retention and resistance form, durability and esthetics to the restoration.<sup>2,3</sup> One of the important factors in the survival of natural teeth is the quantity and quality of the remaining tooth structure<sup>4</sup> which helps preserve tooth vitality and hence its survival. Cheung et al 2005 investigated the fate of vital pulps

beneath metal ceramic crown and bridge retainers.<sup>5</sup> They reported 81.2% survival rate of pulps beneath metal ceramic crowns. Saunders and Saunders<sup>6</sup> reported in a Scottish subpopulation, 19% of crowned teeth with presumably pre-operative vital status had radiographic signs of peri-radicular disease. Full coverage crowns or FPD retainers are in majority a detriment to healthy periodontal tissues.<sup>7,8</sup> They promote accumulation of plaque,<sup>9</sup> increase virulence effect of plaque microorganisms<sup>10</sup> and make the oral hygiene maintenance a challenge, even for the healthy patient. This follows soft and hard tissue inflammation of the periodontal apparatus and periodontal attachment loss.

With advances in adhesive dentistry more conservative techniques have evolved that reduce the need for extensive removal of tooth tissue. These include direct restorations like bonded amalgam and composites, resin bonded indirect restorations including metallic inlays and onlays (gold and nickel chrome), ceramic and composite inlays and onlays, resin bonded minimal preparation bridges and bonded ceramic bridge.<sup>11</sup>

Bonded restoration with cuspal coverage (onlays) having supragingival margins, allow for conservation of tooth structure. Furthermore, they offer prosthodontic ease (ease of tooth preparation, impression making, cementation, finishing and polishing). In modern

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dentistry ceramic onlays are the restoration of choice when an indirect restoration is required for tooth structure replacement. Dental ceramics are claimed to be the most bio-compatible materials used to date for dental restorations.<sup>12</sup> Their physical and mechanical properties – modulus of elasticity, hardness and coefficient of thermal expansion are closer to those of enamel and dentine as compared to resinous materials.<sup>13</sup> Ceramic onlays allow for the following benefits; better esthetic, form adhesive bond to enamel and dentine providing tooth conservation, low plaque accumulation and secondary caries, preservation of soft tissue, prosthodontics ease and provide good access for post-operative care.

Kramer and Frankenberger<sup>14</sup> after a prospective controlled clinical study evaluating the clinical performance of IPS Empress inlays and onlays with cuspal replacements and proximal contacts have reported, 8% failure rate after eight years. In a recent report, survival rates for onlays after a mean follow up of 80 months was 92.4% at 10 years.<sup>15</sup> Two studies of all-ceramic partial-coverage crowns reported cumulative survival rates after 7 years of 81%<sup>16</sup> and 56%.<sup>17</sup>

The case reports present, restoration of teeth with adhesive ceramic onlays as a viable and predictable treatment option in comparison to full veneer crowns in patients treated in a hospital setting.

### Case Presentation

The following three reports present cases receiving indirect ceramic onlays for restoration of lost tooth structure due to reasons of failed restoration, esthetic improvement and cuspal coverage. The patients were treated at King Saud University, College of Dentistry teaching hospital.

#### Case 1

A 45-year-old male, presented to the department of prosthetic dentistry with a desire to replace old metal restorations with an esthetic option. He needed replacements of gold onlays present on maxillary posterior teeth (tooth no.14, 15,16 and 24), which he received 10 years ago (figure 1A & 1B). The teeth were found to be vital (Electric pulp tester, EPT) and had no history of pain or discomfort. Patient complained of sensitivity around the restorations and requested esthetic replacements. Radiograph did not show any signs of pulpal or peri-apical pathology and all teeth had good bone levels. The oral hygiene was excellent with no pathological periodontal probing depths. Dentition showed signs of mild tooth wear which were related to previous erosion due to frequent acidic drink consumption and had canine guided occlusion. The patient was also provided with a hard occlusal splint

that he was not wearing at the time. Gold onlays were removed and tooth structure assessment indicated absence of caries and presence of half of remaining tooth structure with flat occlusal surface. Options for replacement restorations were direct composite resin, composite onlay, metal ceramic crowns and ceramic onlays. Direct and indirect composites were rejected due to reasons of low wear resistance, as they were to cover the entire occlusal surface of four posterior teeth, other reasons included poor occlusal anatomy, low translucency, future microleakage and marginal staining and shade change. The other available option was full veneer crowns. Although having proven their longevity, it warranted extensive removal of tooth tissue, risking pulpal and periodontal health, along with opacity of metal substructure (metal ceramic crown). Adhesively bonded Lithium disilicate (IPS e.max Press, ivoclar vivadent) onlays were the opted choice of treatment. They not only provided an esthetic alternative but also preserved the tooth structure, ensured ease of prosthetic procedure and durability. Preparation of teeth involved a supra-gingival circumferential chamfer margin with no undercuts and smooth line angles (figure 1C). Impressions were recorded using polyvinylsiloxanes (PVS) (Express 3M ESPE) in a stock tray without the use of retraction cords. Provisional restoration were directly made using composite resin material with a matrix and luted using spot etching and light cured flowable composite resin (figure 1D). The onlays were fabricated using Hot pressing. Onlays were etched with 4% hydrofluoric acid for 90 seconds and treated with silane application (Monobond S) for 5 minutes prior to drying. The tooth surface was etched with 37% phosphoric acid, followed by the application of primer-bond (Prime & Bond NT). The luting agent used was dual cured resin cement (Calibra Esthetic Resin Cement, Dentsply, USA). Onlays were seated and excess cement removed using a fine microbrush. 60 second curing was done from buccal, lingual, mesial, distal and occlusal surfaces each (figure 1E). Occlusion was adjusted with finishing carbide burs and surface finishing at the margin and the occlusal surface was completed using fine diamond abrasive rubber burs and disks, along with diamond polishing paste on a slow speed motor. The patient was also provided with a hard maxillary splint and was advised to wear it. These restorations provided excellent esthetics with adequate function at a 6 months review appointment.

#### Case 2

A 40 year old male, presented with a failing composite restoration on tooth number 16. Patient had developed sensitivity and staining with no pain. Examination revealed a composite MOD restoration with stained margins and worn occlusal surface (figure 2A). The

mesial and distal boxes were at gingival margin. The tooth gave a positive response to electric pulp tester. Removal of restoration revealed stained but non-carious sclerotic dentine with a 3mm isthmus and boxes extending to the buccal and lingual line angles, weakening the cusps. For reasons of esthetics, durability and tooth preservation, the tooth was prepared for an e-max ceramic onlay. The buccal and palatal cusps were reduced a minimum of 2 mm, isthmus and all angles were rounded and supra-gingival margins were prepared for a sloping butt joint on enamel surface (figure 2B). Cementation was done under rubber dam with Calibra esthetic resin cement. Excess cement was removed, curing from five directions for 60 seconds each and finishing carried out by diamond burs and polishing using wheels and discs on slow speed motor (Brassler ceramic polish kit, USA) (figure 2C, 2D). Occlusal point contact was kept on palatal cusp. On a 3-month review, patient was comfortably functioning, had no sensitivity and was esthetically pleased.

### Case 3

A 50 year old female presented with a heavily restored tooth 27 with complaint of discoloration and rough restoration surface. The restoration was 15 years old and was placed for lost carious tooth structure. The restoration was an MOD amalgam with undermined buccal and lingual cusps. Tooth had a greyish hue due to amalgam products incorporated into dentine. The disto-palatal cusp was 2/3<sup>rd</sup> replaced with amalgam and the restoration was replacing half of the remaining tooth structure (figure 3A). Tooth tested vital using electric pulp tester, had no peri-apical pathology and had 50% bone loss with no active periodontal disease.

Preparing the tooth for full veneer crown would have resulted in loss of remaining tooth walls. An Emax ceramic onlay was chosen as the treatment option of choice. Remaining dentine was hard, stained and sclerotic. Due to undermined cusps all cusps were provided coverage and hence reduced 2 mm minimum for adequate strength of occlusal ceramic. Boxes with rounded line and point angles with smooth and wide isthmus were prepared. The buccal cusps had lingual sloping marginal preparation to provide a butt joint and the lingual surface had a continuous chamfer continuing into a rounded mesial and an outward sloping distal box. All margins were kept in enamel (figure 3B). A layer of adhesive bond was placed over the remaining dentine to act as both, a bonding and pulp capping agent. The restoration was cemented using Calibra esthetic resin cement. Finishing and polishing was performed as detailed in first two cases (figure 3C). Patient was reviewed after 4 months and tooth was performing as a functional restoration with excellent esthetics.

Figure 1 A: Pre-operative image of gold onlays on tooth 14,15 & 16



Figure 1 B: Pre-operative image of gold onlay on tooth 24



Figure 1 C: Tooth preparations for emax onlays



Figure 1 D: Temporary onlays on teeth 14,15 & 16



Figure 1 E: Post-cementation image of emax onlays



Figure 2 A: Pre-operative MOD composite on tooth 16



Figure 2 B: Preparation and assessment of tooth structure under rubber dam



Figure 2 C: Post-cementation, buccal view of emax onlay



Figure 2 D: Post-cementation, occlusal view of emax onlay



Figure 3 A: Pre-operative image of MOD amalgam restoration on tooth 17



Figure 3 B: Onlay preparation of tooth 17



Figure 3 C: Post-cementation image of emax onlay restoration on tooth 17



## DISCUSSION

IPS e.max Press (Ivoclar Vivadent) was introduced in 2005 as an improved press-ceramic material compared to IPS Empress 2. It consists of lithium-disilicate glass ceramic, and its physical properties and translucency are improved through a different firing process.<sup>18</sup> The main crystal phases are needle shaped and deflect cracks; thus arresting the crack propagation through it, and hence increasing the flexural strength. The mechanical properties are far improved to that of the leucite glass ceramic, with a flexural strength and toughness approximately three times.<sup>19</sup> Due to their improved translucency and better flexural strengths e max press is advocated to be used for inlays, onlays, crowns and three unit anterior bridges.<sup>20</sup> The superior mechanical properties also render the material highly suitable for adhesive bonding.<sup>21</sup> E max restorations have reported evidence to support their clinical success however vital performance factors need to be strictly followed. One of the common reasons for fracture is inadequate tooth reduction. Recommendations include 2mm isthmus width, 1.5-2mm isthmus height, 2mm occlusal height, 1.5mm facial reduction, rounded angles, butt joint at box floors, rounded smooth margins of 1mm and smooth polished surface. These ceramics gain strength through bonding to substrate. Adhesive bonding should be used to improve the fracture toughness.<sup>22</sup> The accepted standards for bonding involve surface treatment of ceramic as well as tooth substrate. The regime for ceramic includes application of hydrofluoric acid producing micro-mechanical retentive surface,<sup>23</sup> followed by silane application, (coupling agent) providing a chemical bond between silica and resin polymer.<sup>24</sup> Emax restorations require luting with resin cements under rubber dam<sup>25</sup> for predictable outcomes and the gold standards include 3 step etch and rinse (ref) bonding agents. An effective bond can only be formed in the presence of adequate remaining dentine and enamel. Having margins in enamel is indispensable due to increased bond strengths. Stress production during cementation and onlay adjustments (occlusal and contacts) are also reasons for fracture. An adequate layer of die spacer and dynamic seating is required to minimize stress during cementation. Furthermore, try-in should be done under finger pressure (fit checker or cement try-in paste) and contacts lightly adjusted. Occlusal adjustments must be done post-cementation and followed by finishing and polishing to minimize crack initiation and propagation. The type of indirect restoration used, influences the prognosis of treatment.<sup>26</sup> In all three cases ceramic onlays were used, however each clinical situation also had other available options. Case 1 required an esthetic

replacement, of gold metal onlays. Composite restorations with time and research have improved immensely. Their mechanical properties are comparable to amalgam<sup>27</sup> and are available in multiple tooth colored shades. The use of altered light curing cycles, incremental curing, use of intermediate bonding agents and stress breaking liners have made leaps towards controlling polymerization shrinkage.<sup>28-30</sup> However the priority was esthetics, conservation of tooth structure and wear resistance, as the restoration required complete occlusal coverage. E max ceramic offered superior translucency,<sup>31</sup> adhesive bonding and increased surface hardness,<sup>32</sup> hence was the preferred option. Parafunction is one of the relative contraindications for bonded glass ceramics due to lateral shearing forces resulting in potential bulk fractures of bonded onlays,<sup>14</sup> however, in case 1 patient was informed about these effects and an occlusal hard splint was prescribed in order to prevent future failure. In cases 2 and 3, onlay with cuspal coverage was provided due to undermined cusps and excess width of the isthmus, as it provided strength and durability to the tooth by coverage and bonding. Adhesive bonding to sclerotic dentine is compromised.<sup>33</sup> A three step etch and rinse bonding agent with Calibra esthetic resin cement was used to optimize adhesive bond strength and hence the overall strength of the onlay.<sup>34</sup> In case 1, there was complaint of post cementation sensitivity, which is a reported effect of etch and rinse bonding agents,<sup>35</sup> however this subsided in a week's time. Luting options included warmed restorative composite, self-etch dual cure resin cements and dual cure resin cements (Calibra). Calibra is known for its excellent translucency along with the high bond strength, high rate of polymerization conversion and optimum abrasion resistance at the margin.<sup>36-38</sup>

The clinical cases presented, required cuspal coverage restorations, for need of esthetics, function and comfort. The objective of treatment was to preserve the vitality of teeth and strengthen the remaining tooth structure by conservative, minimally invasive preparation and adhesive bonding. A full coverage crown is the most common restorative option for such cases, however it would require extensive remaining tooth reduction rendering endodontic treatment and post/core as a likely adjunct for their predictable retention. Emax onlays are the treatment option of choice in such cases, as they combine, excellent esthetic, adequate strength, predictable bond, accuracy of fit, sufficient abrasion resistance, biocompatibility, along with conservative tooth preparation, tooth re-enforcement, low plaque accumulation, preservation of soft tissue, and prosthodontic and maintenance ease.

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