

## Review

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# Clinical Attitude for Failed Fixed Restorations: An Overview

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## ABSTRACT

Fixed prosthodontic failures are varied and complex. Complications associated with conventional fixed prostheses are dental caries, need for endodontic treatment, periodontal disease. Poor esthetic is one of the most frequent reasons for replacing failed restorations. Knowledge regarding the clinical complications enhances clinicians to complete a thorough clinical examination and diagnosis, and to develop an esthetic-driven treatment plan including the selection of bleaching agent, the reconstruction type, and the ceramic material. This article illustrates several clinical complications of full coverage restorations, and discusses different therapeutic modalities which have to be combined and synchronized to enhance the esthetic outcome of the final fixed prostheses.

**KEYWORDS:** Failure; Whitening; Fiber reinforced composite post; Zirconia; Esthetic; Crowns.

**ABBREVIATIONS:** FPD: Fixed Partial Dentures; CAD/CAM: Computer-aided design/Computer-aided manufacturing; YTZP: Ytria Stabilized Zirconia.

## INTRODUCTION

A failure has been defined as the state or condition of not meeting a desirable or intended objective, and may be viewed as the opposite of success. Fixed prosthodontic failures can be complex in terms of both diagnosis and treatment.<sup>1</sup> Knowledge regarding the clinical complications that can occur in fixed prosthodontics enhances the clinician's ability to complete a thorough diagnosis, develop the most appropriate treatment plan, communicate realistic expectations to patients, and plan the time intervals needed for post treatment care.<sup>2</sup> When a crown or Fixed Partial Dentures (FPD) fails, the primary question is whether the problem can be easily resolved, or requires extensive rehabilitation and reconstruction. A mild failure may be considered one that is generally correctable without having to remake the restoration.<sup>1</sup> As a matter of fact, the objectives of fixed prosthodontic treatment include: the preservation or the improvement of tissue structure, oral functions, and esthetics, ensuring restoration retention, resistance, and stability, and improving patient comfort for maximum longevity.<sup>1</sup>

Fixed prosthodontic failures are varied and include secondary caries, endodontic complications, ditching of the cement margin, unacceptable esthetics, cracking, and chipping fracture.<sup>3</sup> Burke, et al. reported in a retrospective study that there were 36% of the re-intervention involving recementing, 17% replacement of crowns, 13% direct restorations, and 12% root treatment.<sup>4</sup>

Walton, et al.<sup>5</sup> studied in 1986 the causes of loss of serviceability of crowns and FPD, and concluded that secondary caries were the most frequent cause of failure accounting 24.3% of the units requiring replacement. The decay process may be responsible for the structural weakening of teeth.<sup>6</sup> This may explain what was cited by Burke, et al.<sup>4</sup> reporting a percent-

age of 12% of root treatment as a reason of re-intervention on crowns placed in the oral cavity for 18 years or more. The caries removal and teeth preparation for endodontic treatment may contribute to the increased fragility.

In case of large destruction of coronal tooth structure and after endodontic therapy, the reconstruction of structurally compromised non vital teeth seems to be necessary. In fact, selecting the appropriate reconstruction for each non vital tooth should be based on many factors such as the remaining hard tooth structure, the number and thickness of the residual cavity, the position of the tooth in the arch and the load implied.<sup>6</sup> The clinical choice may be an esthetic post and core restoration consisting of a composite resin core retained by a fiber post which has better stress distribution pattern and esthetic result.<sup>7</sup>

As reported, Walton, et al.<sup>5</sup> periodontal diseases or mobility were the next most frequent oral diseases causing failure of single crowns or PDF accounting 4.6% of all units requiring replacement. The second most frequent reason for replacement was poor esthetics as reported by patients themselves accounting for 6% units requiring replacement. Worn or loss of resin veneers led to failure in 10.8% of the units observed and the need of replacement in 7.2%.

The metallic component in some restorations can cause a discoloration of the abutment teeth and gingival collar, and aesthetic demands have an enormous impact of the treatment planning of single tooth crowns replacement, this leads to interdisciplinary treatments such as intracoronal bleaching to improve esthetic, and to the use of colored material like ceramic and glass fiber post with a reinforced composite to build up post cores.<sup>8</sup>

Following the introduction of the first feldspathic porcelain crown, the interest and demand for non-metallic and biocompatible restorative materials increased for clinicians and patients. Developments in ceramic core materials such as lithium disilicate, aluminium oxide, and zirconium oxide have allowed more widespread application of all-ceramic restorations over the past 10 years.<sup>9</sup>

In the past, the importance of esthetics was discounted in favor of terms such as function, structure, and biology. However, if a treatment plan does not begin with a clear view of its esthetic impact on the patient, then the outcome could be disastrous. In today's interdisciplinary dental world, treatment planning must begin with well-defined esthetic objectives. By beginning with esthetic considerations, and taking into consideration the impact on function, structure, and biology, the clinician can use the various disciplines in dentistry to deliver the highest level of dental care to each patient.<sup>10</sup>

The ultimate goal of single crown replacement is to treat at first crown complications and second to improve esthetic and to restore function. This article illustrates the clinical

techniques and esthetic-driven sequence for an outcome-based protocol that enhances therapeutic cohesiveness and ensures the sequential transfer of design objectives for the preservation of esthetics in multidisciplinary therapy.

#### MANAGEMENT PROTOCOL

Complex perio-prosthetic cases that require multidisciplinary therapy often result in compromised esthetics.<sup>11</sup> Once, of the most common, yet difficult clinical determination is the prognosis of teeth that may serve again as prosthetic abutments. The crown-to-root ratio is one of the primary variables in the evaluation of the suitability of the tooth as an abutment for a fixed partial denture. Radiographic evaluation has been the most widely used technique in clinical practice for assessing bone level around teeth.<sup>12</sup> If the abutment can be conserved and the crown removal is recommended, it should be atraumatic to allow the protection of residual tissues, and then to inspect the prepared abutments.

#### Why Treating Abutments Endodontically?

Usually, when abutments are misaligned, orthodontic treatment is often an integral component of multidisciplinary therapy, frequently enhancing the esthetics of the final restorations.<sup>11</sup> However, sometimes this treatment option cannot be accepted by the patient who refuses any long-lasting treatment. In same situations in order to realign the teeth in occlusal plan, the axes of the abutments need to be significantly shifted. This rectification can require in some situations an endodontic treatment of the vital abutment. As it was reported by Goodcare, et al.<sup>2</sup> in 2003 that two of three needing endodontic treatment occurred in conjunction with tooth preparation and one subsequent to restoration. Stavropoulou, et al.<sup>13</sup> showed in 2007 that root canal treated teeth restored with crowns show an acceptable long-term survival of 10 years. The quality of root canal preparation and filling and coronal sealing are essential factors to achieve high rates of success.<sup>14</sup> In fact, the root canal treatment excellency is associated with the disinfection process, which involves removing microorganisms from the root canal system by emptying, cleaning, and enlarging/shaping, combined with the use of antibacterial therapies.<sup>14</sup> Estrela, et al.<sup>14</sup> reported that higher success rates are achieved when root canal filling is short 1 to 2 mm of the apex, and the filling material should remain confined to the root canal.

#### Bleaching Agent Selection

On the other hand and after removing metal restorations, the abutments can be discolored. This leads to intracoronal whitening as a step to lighten the abutment, especially when translucent ceramics are recommended. Intracoronal bleaching is a conservative alternative to the more invasive esthetic treatment of non-vital discolored teeth. For that a careful examination is necessary, since the method requires healthy periodontal tissues and a root canal that is properly filled to prevent the bleach-

ing agent from reaching the periapical tissues.<sup>15</sup> Maleknejad, et al.<sup>16</sup> demonstrated in 2012 that all bleaching agents increased dentinal tubule diameter and promote alterations in mineral content of dentin with the exception of sodium perborate mixed with water. Chemical analysis revealed a significant reduction in sulfur weight percent in sodium perborate mixed with water and no significant reduction in phosphorus and calcium weight percent. These findings were proved by Rotstein, et al.<sup>17</sup> Moreover, Dahl, et al.<sup>15</sup> proved that no evidence of root canal resorption was found when sodium perborate mixed with water was used as a bleaching agent. More than 90% immediate success has been reported with the conventional bleaching process using sodium perborate mixed with water.<sup>18</sup> Dahl, et al.<sup>15</sup> reported that at present no study has provided a good predictor for the long-term outcome of internal bleaching. Sometimes, the attempt of whitening cannot be contributing and a slight discoloration persists. This can lead to contra-indicate vitro-ceramic in favor of opaque ceramic which can hide the coloration of the abutment tooth.

#### Why Fiber Reinforced Composite Posts Are Recommended?

In another point of view, and after failed restoration removal, abutments can be decayed. This can indicate its reconstruction. For that, many clinical factors can be implicated when selecting the appropriate reconstruction for non-vital tooth, such as: the number, the thickness and the length of residual dental tissues, the remaining hard tooth structure, the position of the tooth into the arch and the load implied, and the type of the restoration.<sup>6</sup> Recently, fiber reinforced composite post and core systems have become widely used in the restoration of endodontically treated teeth. Fiber reinforced resin posts offer a number of advantages over metal posts thanks to their modulus of elasticity being closer to that of dentin and superior esthetic quality.<sup>19</sup> For esthetic consideration, dentin color post core materials are normally used for all-ceramic crown restorations regarding its esthetic performance.<sup>8</sup> Teeth restored with fiber reinforced resin posts show better resistance to fracture propagation than teeth restored with prefabricated or cast metal posts.<sup>19</sup> Different factors are important in longevity of the post and composite core restorations, such as: the core material, post type, and the bonding strength between the fiber post and the composite cement, and between post and the composite core restoration. But the failure of these restorations mostly occurs at the junction between the composite resin core and fiber post. However, Chemical treatments can also roughen the post surface and consequently increase its mechanical interlock with composite resin core. Mosharraf, et al.<sup>7</sup> proved in 2012 that the tensile bond strength of core resin to fiber posts was affected by the surface treatments applied to the post surface. Sandblasting and silanization of the post surface could result in a slight improvement of the bonding strength of core resin to fiber posts. Hattori, et al.<sup>19</sup> reported in 2010 that the use of a prefabricated fiber post in a post-and-core complex improved the flexural properties of the core composite, regardless of fiber direction. Roberto, et al.<sup>20</sup> studied the influence of different restorative procedures on the fracture resistance of endodontically treated teeth submitted to

intracoronary bleaching, and found a decrease in the fracture resistance of teeth submitted to dental bleaching, and restored only with composite resin or with fiberglass post, with no statistically significant difference observed when these teeth were compared to healthy teeth.

#### Recommendations for Preparation

After abutment teeth reconstruction, preparations should be rectified following traditional preparation guidelines not only to enhance retention of all-ceramic crowns, but also for stress distribution during dynamic loading of the restoration. Tooth preparations are made in a standardized manner: the incisal edge reduction is 1.5 to 2 millimeters, 10 degrees taper is made following the scalloping of the free gingiva margins. For esthetic reasons and for a sound tooth structure, the facial side taper is generally located 0.5 millimeter deep subgingivally with a supragingival lingual side.<sup>21</sup> Orkin, et al.<sup>22</sup> proved since 1987 that the mean duration of subgingival crowns is significantly longer than the supragingival crowns. Feather-edge finish lines, deep retentive grooves, and complex occlusal morphology are not recommended, not only for scanning and milling prerequisites, but also to decrease stress that would develop in a restoration with inadequate preparation and margin geometry.<sup>9</sup>

#### Interim Restoration Roles

A completed laboratory wax up reflecting final restorations should be utilized as a basis for the fabrication of a provisional prosthesis. Since the aesthetic outcome is pre-established in the waxup and subsequently programmed into the design of the provisional prosthesis, the latter may be utilized as a guide during adjunctive treatment procedures.<sup>11</sup> This provisional helps also to periodontal healing and serve to control the reduction measurements of prepared teeth. Once space requirements are satisfied, the procurement of accurate definitive impressions is quintessential to the fabrication of indirect restorations. Adequate periodontal health is a prerequisite to maintain predictable post-impression gingival margins. Atraumatic cord placement is mandatory if soft tissue marginal integrity is to be maintained. Proper technique will limit cord placement to the gingival sulcus and the junctional epithelium.<sup>11</sup> Then, the master impression is made reproducing the finish line, the prepared teeth, and the root emergent area.

#### Ceramic Selection

As it is known that the poly crystal ceramics are more opaque than vitro-ceramic. So when abutment discoloration persists, the opaque ceramics are recommended. With the development of crystalline ceramics, alumina and zirconia came into use for prosthetic reconstruction.<sup>23</sup> Zirconia based prostheses are commonly used for esthetic crowns and fixed restorations.<sup>21</sup> It can be indicated for posterior teeth, and for opaque or discolored anterior teeth. The overall esthetic and biological clinical scores for the analyzed zirconia prostheses are universally acceptable.

Tartaglia, et al.<sup>21</sup> reported that the patient satisfaction with the zirconia crown was also generally high. A shaded zirconia core, which has a more natural appearance with an opaque, yellow dentin overlaid by translucent enamel, provides greater esthetic results.<sup>24</sup> These findings were also confirmed by Schmitter, et al.<sup>25</sup> Yttrium-oxide partially stabilized zirconia (Y-TZP) has mechanical properties that are attractive for restorative dentistry; namely, its chemical and dimensional stability, high mechanical strength, and fracture-toughness.<sup>9</sup> Its mechanical properties, which are similar to those of stainless steel, allow for a substantial reduction in core thickness. Cyclical stresses are also well tolerated by this extremely biocompatible material.<sup>21</sup> So, zirconia has an acceptable clinical longevity that accompanies their long-lasting esthetic advantages.<sup>26</sup> Örtrop, et al.<sup>27</sup> evaluated in 2012 the 5-year clinical performance and survival of zirconia single crowns and found that out of the 143 crowns followed for 5 years, 126 (88%) did not have any complications. However, 9% of the restorations were judged as failures. Nevertheless, chipping of the veneering ceramic on zirconia restorations continues to be a problem.<sup>26</sup> Y-TZP can be manufactured through Computer-aided design/Computer-aided manufacturing (CAD/CAM) technology.

## CONCLUSION

Clinical complications in fixed prosthodontics require specific knowledge by the clinician to enhance a thorough diagnosis. Compromised abutments may need an endodontic treatment and reconstruction that should be selected appropriately regarding esthetics and fracture resistance of abutments. Esthetic reasons confirm the need of bleaching and opaque ceramic to hide abutment coloration. Zirconia prostheses may be a suitable treatment as they proved an overall esthetic and biological clinical scores.

## CONFLICTS OF INTEREST

The authors declare no conflicts of interest for the manuscript.

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