Fracture Resistance and Fit of Hybrid Implant Abutment Crowns Using Two Different CAD/CAM Systems

A Research protocol submitted
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Dedication

This work is dedicated to

My Dear parents

Beloved wife and son

&

My siblings

Acknowledgment

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Introduction

The successful use of implants in the treatment of edentulous arches has been confirmed in various clinical studies.[1] In esthetically demanding anterior regions, restoring a single-tooth space with an implant-supported crown can be a challenge for a clinician.[2]

One of the main problems facing dentists after implant placement is management of esthetics specially when using titanium abutments with their gray shadow on peri-implant soft tissue.

Many studies were performed to solve this esthetic problem. Ready-made Zirconia abutments were introduced as one of the promising solutions to overcome the esthetic limitation of metal abutments, but mechanical problems regarding the implant abutment connection evolved.

Recent materials and techniques along with continuous development of CAD/CAM systems facilitated fabrication of customized ceramic implant abutments that improved implant esthetics of implant supra structures.

One of the new techniques is using CAD/CAM systems to produce hybrid abutment crowns either two pieces or one piece.

It’s worth mentioning that diversity of materials is now available for different CAD CAM systems either four axis or five axis. Implant solution blocks evolved mainly to overcome the misfit problems of hybrid abutments fabricated by normal blocks using four axis milling machines. Researchers claim that the misfit problem will be solved while using five axis milling machines with normal blocks.

Also, new materials other than zirconia like hybrid ceramic evolved to enhance better stress distribution and esthetics, yet the list of information and data about these new materials along with the accuracy of new milling machines is not enough, so many tests should be done to ensure a durable esthetic implant restoration before launching for clinical use.

That’s why this in vitro study was introduced to assess the effect of different CAD/CAM systems and materials on fracture resistance, marginal adaptation and internal fit of one-piece hybrid abutment crowns.

Review of Literature

Implant replacement may be the ideal choice to replace a single missing tooth, however, the restoration may present challenges in the surgical and prosthetic stages. Most dental implants are constructed entirely of commercially Pure Titanium. In patients with a wide smile line, implant-supported reconstructions demand a superior esthetic outcome because the exposed position enables a direct visual comparison of the restored gap with adjacent natural teeth.[3] Therefore, in this part of the jaw success is not only defined by established Osseo integration, but also by the presence of natural soft tissue and crown contours. Optimal implant positioning and superstructure design are essential to mimic the appearance of a natural tooth and achieve optimal aesthetics. [1]

Several factors determine the long-term success of implant-supported superstructures: a restorative design that matches the clinical requirements, the choice of a material that is appropriate to the indication while taking account of functional loads and biological reactions and the esthetic outcome of an implant-supported restoration. [4]

1-Implant abutments:

1.1 Prefabricated Abutments

Commercially pure titanium has been widely used as a material for prefabricated abutments in implant therapy because of its well-documented biocompatibility[5,6] and mechanical properties.[7] Even though these materials have demonstrated predictable outcomes in long-term clinical studies,[8,9] titanium abutments may cause an unnatural bluish appearance at the soft tissue junction in patients with relatively thin tissues that can result in a compromised esthetic outcome[10,11] however, numerous materials can be used to overcome this shortcoming, including cast gold alloys and gold colored titanium abutments. These materials may improve the gingival hue,[12]but the overall translucency of the restoration may remain limited because of the opaque nature of metal. Hence, for achieving optimal mucogingival esthetics, there is a need for a tooth-colored customized abutment. All ceramic abutments can give a more favorable esthetic outcome than titanium or metal abutments. [2]

Ceramic materials such as alumina have been used as implant abutment materials to assist in achieving optimal esthetics, [13,14]but studies have shown the relatively low fracture resistance of the material.[15,16]As a result, zirconia implant abutments have gained popularity because of their improved fracture resistance over alumina and superior optical properties over titanium.

Y-TZP abutments showed outcomes similar to titanium abutments in posterior regions as both exhibited 100% survival rates in two clinical studies.[17,18]. A prospective clinical study on Y-TZP abutments supporting single-tooth crowns exhibited excellent long-term outcomes with a cumulative success rate of 96.3% after 11 years of use.[19] However, clinical reports of catastrophic failures do exist and, thus, such predictions must be moderated by the relatively short-term evaluation in most prospective studies. Indeed, the mentioned clinical studies did not fully explain the reasons why restoration fracture occurs.[20,21]

Emergence profile is also another important factor that affects the success of implant suprastrucures. Since the cross-sections of implant platform and natural tooth at the gingival level differ, most of the prefabricated abutments fail to ensure a hygenic and esthetic emergence profile. Consequently deep subgingival crown margin will be established, leading to challenges during the removal of excess cement which is one of the main causes of periimplantitis.[17]