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Contemporary Alternatives to Zirconia-Based Crowns: An in Vitro Fracture Strength Study

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ABSTRACT

Objectives: Aim of the study is to compare the fracture strength of the crowns made by the newly introduced ceramic material to the conventionally used zirconia- based crowns and to assess the fracture behavior of the newly engineered ceramic material.

Materials and Methods: The study was used artificial replicas of human teeth. It was laboratory based study, no human subjects was included. The sixty samples will be randomly allocated to three groups, one control and two tests. An artificial plastic mandibular molar was prepared to the ideal specification required for an all-ceramic crown. 60 metal dye exact replicas were fabricated and randomly distributed among three groups, Zirconia (Zr), Suprinity (Sp) and Enamics (En).

Results: preliminary data proved that there were no statistically significant differences in static fracture strength among the groups.

Conclusion: Based on the preliminary data, it was concluded that the contemporary alternatives to zirconia crowns do indeed poses similar strength and, thus, can be used as alternatives to the zirconia crowns to overcome their drawbacks.

Key words: Zirconia, Crown, Aesthetic, Ceramic, Prosthesis

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INTRODUCTION

Crowning badly damaged teeth is among the most frequent treatment options undertaken by dentists. For a long period, the metal-based ceramic crowns were the standard therapy [1]. However, the popular for more aesthetic options lead to the arrival of all-ceramic crowns. Several types of all-ceramic crowns can be found in the market, negatives and each using its pros [2]. Despite the fact that the zirconium dioxide ceramic (zirconia) displays the maximum fracture strength [3] of most ceramic materials, its low translucency reduces its aesthetic prospective [4]. Veneering it with a more translucent ceramic can overcome this. However, the bond between your zirconia coping and the veneering ceramic isn't as strong as the metal-based alternative [5]. This escalates the chance of veneering ceramic fracture and restricts the usage of the zirconia-centered crowns [5]. The glass-ceramic crowns have higher translucency and aesthetic potential, which removes the require for veneering it and thus the risk for veneer fracture. However, their lower strength is really an important drawback. The material choice appropriate for particular clinical situation is really a challenge experienced with each patient, because there is no ideal materials that may be as natural because the tooth structure. All-ceramic crowns, however, are significantly popular because of their outstanding aesthetics and biocompatibility and suitable strength [6].

Recently, new generation of glass-ceramic has been launched to the marketplace with claimed higher strength. Reinforcing the glass-ceramic with zirconium dioxide, Vita™ Suprinity®, or inclusion of polymer, Vita™ Enamics ®, are two mainstream examples [7]. The clinical application of such recently engineered ceramic materials should be preceded with in vitro studies to anticipate their clinical behavior. Therefore, the aim of the research is to evaluate the fracture strength of crowns made out of those newly engineered glass-ceramics to the zirconia-based crowns.

MATERIALS AND METHODS

Comparative in vitro study was carried out in collaboration between Colleges of Dentistry at King Khalid and King Abdulaziz Universities, Saudi Arabia. The study was used artificial replicas of human teeth. It was laboratory based study, no human subjects was included. The sixty samples will be randomly allocated to three groups, one control and two tests. An artificial plastic mandibular molar was prepared to the ideal specification required for an all-ceramic crown. 60 metal dye exact replicas were fabricated and randomly distributed among three groups, Zirconia (Zr), Suprinity (Sp) and Enamics (En). All crowns were made with a 5-axis CAD/CAM machine (Ceramill Motion 2, Amann Girrbach North America, USA) with one design following the manufacturer recommendation. Subsequently, all crowns were cemented with resin cement (Multilink Speed®, multilink automix- ivoclar vivadent). All crowns were statically loaded to fracture in a static loading machine (Instron, Instron Co. Ltd., Norwood, MA, USA). The results were analyzed using one-way ANOVA followed by Tukey's Post Hoc Test using IBM SPSS Statistics for Macintosh, Version 22.0 (IBM Corp, Armonk, NY, USA).

RESULTS

Although the zirconium dioxide ceramic (zirconia) exhibits the highest fracture strength of the all-ceramic material, its low translucency lowers its aesthetic potential (Figure 1). Shade matching difficulty with natural teeth. Veneering it with a more translucent ceramic can overcome this (Figure 2). Zirconia coping with veneering layers. However, the bond between the zirconia coping and the veneering ceramic is not as strong as the metal-based alternative. This increases the risk of veneering ceramic fracture and limits the use of the zirconia-based crowns (Figure 3). Chipping of zirconia crown. However, preliminary data proved that there was no statistically significant differences in static fracture strength among the groups.

Figure 1: Zirconia based crown showing the shade matching difficulty with the natural teeth.

Figure 2: Zirconia crown shows 2 layers, zirconia coping and the veneering ceramic.

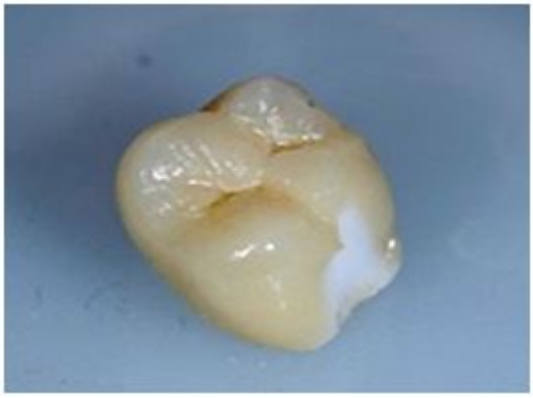

Figure 3: Chipping of the zirconia based crown with ceramic veneer.

DISCUSSION

Partial coverage restorations create it probable to maintain an additional 20%-30% more tooth structure than other even more invasive restoration methods, such as for example full coverage crowns [7]. The occurrence of complications, both pulp (1.3% after 12.6 years) and periodontal, is lower with inlay, onlay, and overlay incrustations than complete coverage crown teeth [8]. The existing survival rate of incrustations differs between 75 and 98% after 5 years, providing an efficient therapeutic option to standard techniques [9]. The progress of metal-free and hybrid materials merging 2 primary restoration components (resin and ceramic) has offered an array of components with functional indications and superior biomechanical properties. An

in-depth analysis of delicate components, such as for example ceramic, will obtain a distribute data set related to various stages and types of growth and various forms of surface fracture [10]. The Weibull distribution analyses the natural possibility of a structure's fracture mechanics, and so gives an indicator of the material's reliability that means it is achievable to standardize the outcomes of testing [11].

All ceramic restorations have turn into more broadly distributed because of their high aesthetic potential and their outstanding biocompatible properties.1-5 Currently, numerous framework structures for prosthetic restorations are fabricated using CAD/CAM system, meaning that a significant part in the workwithing sequence is completed through industrial machines [12]. Then frameworks could be created better. Also, it is possible to attain industrial quality standards, which are particularly crucial for ceramic materials. Each pore and imperfection is really a possible starting point for cracks and therefore for the clinical failure of ceramic restorations.

A probable cause for the occurrence of chippings could be discovered in the former limited CAD software possibilities by which crown and fixed partial denture (FPD) frameworks cannot be machined to an anatomically reduced form, which provides sufficient assist to the veneering material. On the other hand many techniques could offer only uni-thickness copings for crowns and also bar-shaped connectors for FPDs. Therefore with one of these techniques, veneering ceramic had to end up being applied in thick layers to accomplish functional and esthetic demands without the cusp support [13]. For metal-ceramic restorations, it acquired been documented that insufficient framework design presents one significant reason behind an unfavourable failure rate of the veneering material.

Over the last decades, a change towards metal-free restorations has been noticed in the field of dentistry. To meet the improved demands of patients and dental practitioners in terms of esthetics, biocompatibility, and long-term success of the restorations, various types of all-ceramic systems have already been produced, from glass ceramics to zirconia polycrystal materials [14]. The primary purpose of the industry would be to refine the composition and microstructure of the ceramic materials to generate a harder ceramic without having reducing aesthetics.3 The lithium disilicate IPS e.Max (Ivoclar Vivadent) falls i nto thwes category, having strong needle-like crystals embedded inside a cupy matrix4 that mimics the looks of enamel and functions well for crown applications [15]. On the list of newer ceramics, the materials based on lithium silicate reinforced by zirconium oxide (such as Suprinity, Vita Zahnfabrik, Bad Sackingen, Germany; Celtra Duo CAD, Degudent GmbH, Hanau; Wolfgang, Germany) and glass-ceramic infiltrated by polymer, also referred to as hybrid ceramic, ought to be described (such as Enamic, Vita Zahnfabrik). Although highly esthetic, these ceramic components are abundant with silica content material and are not as tough as materials predicated on dense zirconia polycrystals; hence, they're less appropriate when high stress concentrations should be endured [16].

CONCLUSION

Based on the preliminary data, it was concluded that the contemporary alternatives to zirconia crowns do indeed poses similar strength and, thus, can be used as alternatives to the zirconia crowns to overcome their drawbacks.

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Nil.

CONFLICTS OF INTEREST

There are no conflicts of interest.

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