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# EFFECT OF THICKNESS OF BONDING AGENT ON BOND STRENGTHS OF LITHIUM DISILICATE DENTAL RESTORATIONS: A REVIEW OF THE LITERATURE

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## ABSTRACT

Dental ceramics are known for their natural appearance and their durable chemical and optical properties. However, dentists have remained suspicious of the structural longevity, potential abrasively and fit of ceramic restorations. It was predictable that recent dental research in ceramics addressed issues of clinical survival, response during wear, and fit. These concerns have directly influenced the development of recently introduced ceramic materials and laboratory processing systems. Afterward, clinical failure and damage mechanisms are crucial, so appropriate use of dental ceramics depends on strength of dental ceramics. Recently, there is frequent application for all-ceramic restorations than metal-ceramic because of their natural color, appearance and safety. However, fracture is one of the effective factors on acceptance of all-ceramic restorations. It is reported thickness of bonding agent has effect on strength of dental ceramics. So, in this literature review we discussed effect of different thickness of bonding agent on bond strengths of all-ceramic dental restorations. It is assumed this paper provide useful information on application of all-ceramic for Prosthodontics.

**Keywords: Bonding agent, Thickness, Strengths, Ceramic dental restorations**

## INTRODUCTION

The increasing demand for esthetics, combined with health and environmental concerns about some metallic restorations, has stimulated research in metal-free, tooth-colored restorations. On the other hand, new materials wedded to precise techniques have emerged to blur the interface between biologic and artificial structures **(1)**. New all-ceramic systems are continually introduced because they are metal free restorations of a high aesthetic quality. However, the strength of the ceramic remains a problem for a restoration's longevity. To overcome this problem, most of these systems require the combination of two layers of ceramic material, such as a strong ceramic core and weak veneering porcelain with better optical properties **(2)**.

### Ceramic Systems

Driven by a debatable need for metal-free restorations, the evolution of all-ceramic systems for dental restorations has been remarkable in last three decades. Processing techniques novel to dentistry have been developed, such as heat-pressing, slip-casting, and Computer Aided Design-Computer- Aided Machining (CAD-CAM). Concurrently, all-ceramic materials have been developed to match dental requirements, offering increasingly greater performance from a mechanical standpoint. As opposed to metal-ceramics, all-ceramics contain a significantly greater amount of crystalline phase, from about 35 to about 99 vol %. This higher level of crystallinity is responsible for an improvement in mechanical properties through various mechanisms, such as crystalline reinforcement or stress induced transformation **(3)**. All-ceramic restorations have several advantages, including life-like appearance, biocompatibility, wear resistance, and color stability. Disadvantages include less-than-ideal marginal adaptation, excessive wear of the opposing dentition, aggressive preparation design, technique sensitivity and susceptibility to fracture **(4)**.

### Lithium silicate based restorations

At a time when dentists and patients alike are seeking both esthetic and conservative smile makeover options, lithium disilicate glass ceramic is a unique material. Lithium disilicate glass-ceramics have been extensively studied. All studies seem to agree that the mechanisms leading to the crystallization of lithium disilicate in these systems are somewhat complex, due to the presence of nanosized crystal phases **(5)**. High temperature X-ray diffraction studies revealed that lithium metasilicate ($Li_2SiO_3$) and cristobalite ($SiO_2$) form during the crystallization process, prior to the growth of lithium disilicate ($Li_2Si_2O_5$) crystals **(3)**.

With high strength, natural optical properties, and the ability to be pressed thin, lithium disilicate has the potential to provide new options for minimal-preparation veneers. Lithium disilicate is an esthetic, high-strength material that can be conventionally cemented or adhesively bonded. It also can offer a full-contour restoration fabricated from one high-strength ceramic, as well as be used in all areas of the mouth when specific criteria are met. Laboratory ceramists find that the versatility and performance of lithium disilicate enable the optimization of their productivity when fabricating restorations using this material, since lost-wax pressing or CAD/CAM milling fabrication techniques can be used. Lithium disilicate is among the best known glass ceramics. Glass ceramics are categorized based on their chemical composition or application. IPS e.max lithium disilicate is composed of quartz, lithium dioxide, phosphor oxide, alumina, potassium oxide, and other components. This composition produces a highly thermal, shock-resistant glass ceramic as a result of the low thermal expansion that occurs when it is processed. This type of resistant glass ceramic can be processed with either lost-wax hot pressing techniques or modern CAD/CAD milling procedures **(6)**.

**Fracture resistance**

Several studies have investigated in vitro fracture resistance and origin of failure of simulated posterior teeth for all-ceramic crowns **(7)**. The fracture of veneering porcelain and/or is the most commonly reported major complication, often requiring restoration remakes **(8-10)** The strength of all-ceramic restorations is dependent on the ceramic material(s) used, core/veneer bond strength, crown thickness, and restoration design **(11)**. Currently, no clear evidence suggests the appropriate amount of tooth reduction for all-ceramic restorations. The guidelines for metal-ceramic restorations recommend a minimum of 2.0 mm reduction of tooth structure on functional cusps to accommodate such crown design. With significant tooth reduction of this sort, there is an increased risk of tooth sensitivity, dentin exposure, and risk for postoperative sensitivity or pulpal inflammation **(12)**.

Various studies indicated that the strength of veneer ceramic dictates the strength of layered core veneered restorations. The strength of these restorations may be further compromised by complex distribution of tensile stresses. If these tensile stresses are not seriously considered in the design of the structure, failure can occur at unexpected low stresses **(11, 12)**. The location of interface as failure origin has been reported in retrieved failed clinical restorations as well as in laboratory testing procedures **(13–15)**. In a laboratory study zirconia layered crowns failed basically by delamination of the veneer from intact core structure, while crowns made of layered lithium disilicate core material failed by fracture of both the core and veneer ceramic **(16)**.

Failure of brittle ceramics is also related to structural flaws, which tend to concentrate stresses and can act as fracture initiation sites **(17)**. There are various causes and types of structural flaws which could be located at the surface, in the bulk of the material, or at core–veneer interface **(18)**. As dental ceramics are brittle they have limited ability to absorb elastic energy; thus tensile stresses and structural flaws can result in premature failure under low functional stresses **(19)**.

**Role of thickness of bonding agent on bond strengths of ceramics**

The ability of all-ceramic restorations to withstand occlusal forces is compromised by the presence of two types of inherent flaws, fabrication defects (internal voids, porosities, or microstructural features that arise during processing) and surface cracks (defects on the surface as a result of machining and grinding process) **(20)**. Failure begins with microscopic damage resulting from the interaction of preexisting defects with applied loads.5 Failure can also occur because of impact forces or subcritical crack growth, which is enhanced in an aqueous environment **(21)**.

Different factors may cause inferior core–veneer bond strength. Since lithium disilicate is readily produced, it is especially applicable for restoration of posterior teeth where sufficient reduction can be achieved. As with other bonded ceramic restorations, it is of interest to investigate the minimum thickness required for resistance to fracture. It was determined that four thicknesses of anatomically standardized full contour restorations for a mandibular molar be evaluated with sample sizes as established from the statistical analysis of the preliminary phase **(9)**.

Many attempts have been made to increase the fracture strength of all-ceramic restorations. N a study Dhima et al., **(22)** investigated effect of difference in failure mode of different thicknesses (2.0, 1.5, 1.0, and 0.5 mm) of anatomically standardized full contour monolithic lithium disilicate restorations for posterior teeth. Based on the findings of this study, it may be reasonable to consider a crown thickness of

1.5 mm or greater for clinical applications of milled monolithic lithium disilicate crowns for posterior single teeth.

In a similar study Anusavice et al., **(23)** investigated whether an increase in core ceramic/veneer ceramic thickness ratio for a crown thickness of 1.6 mm reduces the time dependent fracture probability of bilayer crowns with a lithium-disilicate-based glass-ceramic core. Based on their results, Predicted fracture probabilities (Pf) for centrally-loaded 1,6-mm-thick bilayer crowns over periods of 1, 5, and 10 years are 1.2%, 2.7%, and 3.5%, respectively, for a core/veneer thickness ratio of 1.0 (0.8 mm/0.8 mm), and 2.5%, 5.1%, and 7.0%, respectively, for a core/veneer thickness ratio of 0.33 (0.4 mm/1.2 mm).

Randomized, controlled clinical studies are regarded as the optimal approach to evaluate the performance of biomaterials and design aspects of dental fixed prostheses. However, these studies are extremely costly and the variables that control overall performance under the vast variety of conditions that are encountered in clinical practices must be limited. Biomechanics tests and analyses can greatly reduce the number of clinical studies that must be performed to characterize fully the performance of a given prosthetic system **(24)**.

## CONCLUSION

Although several contributing factors, such as residual tensile stress from thermal contraction effects, framework design, veneer thickness, load orientation, grinding damage, aging effects of zirconia, elastic modulus of support structures, and Para function have been proposed as causes of these structural failures, no single factor has been proven to be the dominant cause for the majority of these fractures. The reported reasons for ceramic-ceramic restoration fractures include veneer chipping, core fracture, and greater loading locations in the mouth, e.g., posterior tooth versus anterior tooth sites **(23)**.

In this regard it is reported that veneer application resulted in significant lower fracture load values compared to full anatomic crowns. Also, fracture initiated from occlusal fissures near the load application site. A combination of cohesive veneer and ceramic interface failure represents the main failure mode of lithium-disilicate-based bi-layered crowns, whereas full anatomic crowns failed mainly from ceramic bulk fracture at the occlusal fissures **(25)**. The continuing search for ultimate strength, esthetics, and biocompatibility has always encouraged the development of new improved restorative materials, especially in the field of dental ceramics **(26)**. However, understanding of the difference in strength and fracture process observed for monolithic versus veneered lithium disilicate ceramic crowns is the main objective of dentistry.

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