THE JOURNAL OF PROSTHETIC DENTISTRY

CLINICAL SCIENCE

Survival rate of lithium disilicate restorations at 4 years: A retrospective study

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ABSTRACT

Statement of problem. Ceramic restorations are frequently being placed due to the esthetic demand and the cost of noble metals that has increased considerably. One major disadvantage of ceramic restoration is failure of the material due to fracture by crack propagation. In vitro studies are of little clinical significance and in vivo studies are too short to support clinical success.

Purpose. The purpose of this retrospective study was to evaluate the failure rate of lithium disilicate restorations (monolithic and layered) at 4 years.

Material and methods. Data were collected over 45 months from 2 commercial laboratories. Restorations were categorized into monolithic restorations and layered restorations. Each category was further classified into complete coverage single crowns, fixed dental prostheses, e.max veneers, and inlay/onlay restorations. Failure rates were compared and analyzed using Chi-square (α=.05).

Results. A total of 21 340 restorations were evaluated in this study and included 15 802 monolithic restorations and 5538 layered restorations. The failure rate for single crown monolithic restorations was 0.91% and was 1.83% for single crown layered restorations. For fixed dental prostheses, 4.55% of monolithic restorations failed. For e.max veneers, 1.3% of monolithic veneers fractured and 1.53% of layered veneers fractured. Of the inlay/onlay restorations group, 1.01% of monolithic restorations fractured.

Conclusion. In the short term (45 months), restorations fabricated with the lithium disilicate material (IPS e.max) had relatively low fracture rates. Layered single crowns fractured at approximately 2 times the rate of monolithic crowns. (J Prosthet Dent 2015;114:364-366)

Ceramic restorations are frequently placed in contemporary dental practices. Some of these restorations are primarily placed for esthetic reasons. Others are placed because the cost of noble metals has increased considerably and most ceramic alternatives are less expensive than metal ceramic restorations.[1]

Many of the new ceramic systems have impressive physical and mechanical properties.[2] However, clinical longevity cannot be accurately predicted based on these properties or from in vitro load-to-failure tests.[3-6] Most of these systems have been brought to market with almost no independent clinical testing. Ninety-five percent of metal ceramic restorations are intact and functioning at 11 years.[7] Dr Peter Scharer suggested that before a clinician uses a new ceramic system, the manufacturer should provide data from independent clinical trials that indicate 95% survival at 3 or preferably 5 years.[8]

The problem facing clinicians is that data from independent clinical trials are rarely available in the first 5 years after the introduction of a new ceramic system, and manufacturers are quite aggressive in their marketing strategies. The problem for the manufacturers is that clinical trials are both expensive and time-consuming and that competition in the marketplace is fierce.

This study was undertaken to provide useful data relative to the early survival rates of lithium disilicate materials, specifically one popular system, the IPS e.max restoration. (Ivoclar Vivadent). IPS e.max is a lithium disilicate glass-based material, in which small needle-shaped crystals compress the surrounding glass matrix during cooling. Therefore, IPS e.max has a high flexural strength (400 MPa)[9] and has become popular in recent years. It is provided in two different forms, the more popular being monolithic IPS e.max, which is milled or pressed and then stained. Monolithic crowns tend to be relatively strong, because only a single material is involved and there is no veneering layer.

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Clinical Implications

Restorations fabricated with the lithium disilicate material (IPS e.max) had relatively low fracture rates in the short term (45 months).

However, the esthetic result with monolithic crowns is not equivalent to that achieved with layered restorations, in that there is high surface reflectivity and no internal coloration. The other type of IPS e.max is the layered restoration with a milled or pressed lithium disilicate core and a thermal expansion/contraction coefficient matched veneering porcelain. The layered restoration has better esthetics but significantly reduced strength. Zhao et al[10] reported in a load-to-failure test of IPS e.max crowns that the monolithic anatomic design shows superior fracture resistance behavior compared with bilayered IPS e.max crowns. A sliding-contact fatigue test of IPS e.max conducted by the same group of researchers showed that cyclic loading is an accelerating factor contributing to fracture for monolithic IPS e.max crowns but not bilayered crowns.[4] Because ceramic failure is enhanced by mechanically driven tests in an aqueous environment, the mode of failure and impact of fatigue testing is still not fully justified; typical in vitro testing of ceramic material does not challenge the material as in a clinical situation.[11]

A retrospective study of 860 anterior and posterior lithium disilicate restorations demonstrated a 95% success rate in the medium term (3 to 5 years).[12] In a recent systematic review,[13] the short-term (1 to 5 years) and moderate-term (5 to 10 years) survival rates of lithium disilicate single crowns and fixed dental prostheses were analyzed. Only two studies were randomized controlled trials, and 5 were prospective studies in the included search criteria for articles between 1998 and 2013. The review revealed excellent short-term cumulative survival rates of 97.8% for single crowns, while the cumulative survival rates for fixed prostheses was 78.1%. Limited evidence of success was reported for the medium term. However, systematic reviews of short-term or underpowered studies can result in misleading conclusions.[14-16]

For this study, it was assumed that clinicians who experienced a premature failure with a recently introduced ceramic system that would require remaking the restoration would return it to the laboratory for warranty purposes. It was also assumed that patients experiencing an early restoration failure would return to the dentist who provided that restoration.

To obtain information regarding the early clinical performance of both types of IPS e.max, two major dental laboratories were approached for data related to remakes. Both the laboratories had database systems that permitted the identification of remakes related specifically to the fracture of IPS e.max restorations.

The null hypothesis was that no difference would be found in the failure rate by fracture of porcelain between monolithic and layered lithium disilicate restorations.

Table 1. Failure rate of monolithic restoration and layered restorations by type of restoration

Type of Restoration	Monolithic Restoration			Layered Restoration		
	Units	Failure	Failure Rate (%)	Units	Failure	Failure Rate (%)
SC	11 603	106	.91	4162	76	1.83
FDP	1494	68	4.55	0	0	0
EV	1612	21	1.3	1376	21	1.53
IO	1093	11	1.01	0	0	0

SC, single crowns; FDP, fixed dental prostheses; EV, e.max veneer; IO, inlay/onlay.

MATERIAL AND METHODS

The data for this study were obtained from two commercial dental laboratories in the U.S. The data were collected from the laboratory database systems, which were designed to track the number of returned restorations. Failures included fracture of the restorative material that required a remake of the restoration. Data regarding the restorations included in this study were collected continuously for 45 months (June 2009 to February 2014).

A printed assessment sheet was used to record the type of restoration and the percentage of failures for each type. The restorations were categorized into monolithic restorations and layered restorations. Each category was further classified into complete coverage single crowns, fixed dental prostheses, e.max veneers, and inlay/onlay restorations. Restorations that were returned to the laboratory for poor marginal fit, shade match, or contour were excluded from the study.

The failure rates of monolithic and layered lithium disilicate restorations were compared and analyzed with Chi-square (α=.05).

RESULTS

A total of 21 340 restorations were evaluated in this study and included 15 802 monolithic restorations and 5538 layered restorations. Thus, approximately 3 times as many monolithic restorations were evaluated as layered prostheses. The complete data for the failure rate of the monolithic IPS e.max restorations and the results of the layered IPS e.max restorations are reported in Table 1.

Only 0.91% of single unit monolithic IPS e.max crowns and 1.83% of layered IPS e.max single crowns failed over the time period. The failure rate of the two types of single crowns (monolithic vs layered) showed a significant difference (P<.001) (Table 2). The combined failure rate of these two restorations was 1.15%.

For fixed dental prostheses, 4.55% of monolithic restorations failed. No layered fixed dental prostheses were

Table 2. Comparison of failure rates between monolithic single crowns and layered single crowns (IPS e.max)

Type of Restoration	Total	Failure	%
LR	4162	76*	1.83
MR	11 603	106	0.91
LR and MR	15 765	182	1.15

LR, layered restoration; MR, monolithic restoration.
*Statistically significant difference: $P<.001$.

placed. For inlays and onlays, 1.01% of monolithic restorations fractured. No layered inlays or onlays were placed. For the e.max veneers, the monolithic form showed a lower failure rate (1.3%) than the layered form (1.53%).

DISCUSSION

This study was designed to discover data that might help clinicians choose ceramic materials by providing information on the number of early or premature failures that occur with a popular ceramic system. The IPS e.max system was chosen for this study because it is a commonly used system with promising physical properties and optical characteristics that mimic the natural tooth.[1,17]

This study does not replace the need for properly designed, randomized, controlled clinical trials, but does provide data that show that, in the short term, restorations fabricated with IPS e.max do not experience a high rate of catastrophic failure.

The cause of failure in this study cannot be attributed solely to the material, because the fabrication process and clinical tooth preparation can play a major role in failure. A recent review of clinical tooth preparation[18] reported that the most important parameters for tooth preparation have changed and concluded that these parameters are rarely met. Clinical studies critically examining the causes of restoration failure are lacking, which can limit the prediction of outcomes.[19,20] Methods of analyzing the failure for ceramic restoration material, thickness, and load positions have been proposed so as to predict the success and longevity of ceramic restorations.[11,21]

An advantage of the method used in this study was that a large sample size was scrutinized in a short time. Data on more than 21 000 lithium disilicate restorations were analyzed. This method is practitioner-based and provides information on what happens with a new system when used by a large cross-section of dental practitioners in contrast to outcomes achieved in a controlled university-based study.

The data clearly show that the majority of restorations being placed are monolithic IPS e.max restorations. Monolithic single crowns had a lower failure rate than layered single crowns, although the failure rates of both are well below the 5% stipulated by Scharer. The failure rate for fixed dental prostheses was higher, but again was slightly below the 5% failure rate.

CONCLUSION

Within the limitations of this retrospective study, it is concluded that, in the short term (45 months), single tooth restorations fabricated with a lithium disilicate material (IPS e.max) had relatively low fracture rates. Layered single crowns fractured at approximately twice the rate of monolithic crowns, but the fracture rate was still low.

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