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Clinical and Esthetical Evaluation of 79 Lithium Disilicate Multilayered Anterior Veneers with a Medium Follow-Up of 3 Years

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Abstract

Objectives Primary aim of this study was to evaluate survival rate of lithium disilicate veneers in upper and lower anterior teeth. Secondary aims were to evaluate changing in proportions of teeth before and after restorations and to assess mean thickness of the veneers.

Materials and Methods Seventy-nine upper and lower lithium disilicate veneers were made in 13 patients with worn teeth. Mean follow-up was 3 years. To perform anterior definitive rehabilitations, malocclusions and loss of vertical dimension were treated by full mouth rehabilitations to obtain proper occlusal conditions. Veneers were made of lithium disilicate core and fluorapatite-based ceramic stratification. Survival rate was calculated by Kaplan–Meier analysis. Changing in teeth proportion before and after restorations was analyzed by a paired *t*-test. Descriptive statistics of thickness values were also performed.

Results One case of detachment was observed with a 98.7% survival rate. Teeth's proportions were preserved although the first upper right incisor and canine changed in dimension.

Conclusions Lithium disilicate veneers in esthetical rehabilitations of worn teeth proved to be an effective way of treatment in a medium follow-up of 3 years. Proportions seemed to be maintained with a minimum dental removal.

Keywords
- lithium disilicate veneers
- esthetical proportions
- worn teeth

Introduction

Veneers can be made of different ceramic materials, especially of feldspathic ceramic and lithium disilicate.[1] Advantages of all-ceramic dental restorations are the high-performing esthetical results alongside recognized biocompatibility and integration in oral environment thanks to low solubility of material,[2] reduced plaque accumulation properties,[3] and satisfying marginal fitting.[4]

Lithium disilicate is a glass ceramic with a high concentration of ceramic crystals, approximately 70% of the substrate.[5] This structure allows to obtain a flexural strength similar to enamel (360–400 MPa)[5] and a biaxial flexural strength three times greater than feldspathic ceramic.[6] Translucency is made possible despite the high concentration of crystals thanks to their low refractive index.[5] The high translucency helps to achieve natural results also in cervical portion of restoration where, conventionally with metal-ceramic restorations, a dark shadow could be visible. Lithium disilicate has a distinctive property, called "Umbrella Effect" by Magne et al,[7] that allows light to cross the material and be adsorbed in part. This feature provides lithium disilicate high esthetical properties and makes possible facilitating adhesive procedures and a more conservative dental preparation.[8-10]

IPS e.max (Ivoclar Vivadent Manufacturing SRL) is a lithium disilicate material that could be machined with computer-aided design/computer-assisted manufacturing[11-15] or simply pressed. Dental practitioners and technicians can

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choose the most suitable and proper procedure without undermining biomechanical and esthetical properties.[16,17]

Considering the location of restorations, IPS e.max (Ivoclar Vivadent Manufacturing SRL) can be used as monolithic or multilayered. Restorations are usually monolithic in posterior rehabilitations because of the lower esthetical requirements, whereas for the anterior teeth, to reach esthetical goals,[18] the stratification technique is preferred.

Different kinds of IPS e.max core can be chosen to satisfy every single case giving a large spectrum of colors. With respect to the rehabilitation, tooth's color,[19] and preparation's thickness, the operator can choose many lithium disilicate cores.[20]

The primary aim of this study was to evaluate the survival rate of veneers made by lithium disilicate in anterior teeth with a mean follow-up of 3 years.

The secondary aims were:

- Assessment of change in proportions (mean percentage ratio) of covered teeth before and after the restoration's placement and comparison with the literature.
- Evaluation of thickness of material in different sites of restorations.

Materials and Methods

Seventy-nine lithium disilicate lower and upper veneers in the anterior area were performed in 13 patients (6 men and 7 women, aged between 30 and 70 years) from May 2013 to November 2018. Inclusion criteria to be enrolled in the observational study at baseline were: teeth abrasion and loss of dental tissue in the anterior area, dental misalignment, diastemata, and teeth discoloration. Provisional posterior rehabilitation was required before the anterior rehabilitation in all patients. The exclusion criteria were poor oral hygiene, restrictive dietary habits,[21] parafunctions, active periodontitis, and probing depths more than 4 mm.

Rehabilitations were planned on a dental wax-up, and before teeth preparation, a temporary mock-up (Tetric Evo-Flow; Ivoclar Vivadent Manufacturing SRL) was placed in all patients to show patient the prospective final result and clinician volume and proportions of rehabilitation.

Slight chamfer, axial reduction from 0 to 0.8 mm, and incisal reduction from 0 to 1.5 mm were performed.[22] Interproximal contact points were modified during preparation only where Class III composite restorations, diastemata, or interproximal black triangles were present.[22] Palatal side was prepared in its coronal one-third with 90-degree butt-joint finishing.[23-25] The preparation margin was preferably located over the gum line to make easier taking the impression and the maintenance of periodontal tissue's health. Margins were placed at the gingival crest or slightly into the crevice when the outline preparations required.[22]

Impressions were taken with a simultaneous dual-mix one-step technique (3M Imprint II Garant Heavy Body and Light Body, 3M ESPE) and the interocclusal relationship was registered by a silicon index (Occlufast Rock, Zhermack SPA).

All restorations were made of IPS e.max Press (Ivoclar Vivadent Manufacturing SRL) with a core of lithium disilicate and a superficial stratification using fluorapatite-based ceramic.

Adhesive cementation was performed for all restorations after isolation of operative field by a rubber dam. The inner layer of restorations was etched by hydrofluoric acid 9.6% (ENA etch, Micerium SPA) for 30 seconds and then rinsed and dried. A silane coupling agent (ESPE Sil–3M ESPE) was applied for a minute onto the inner surfaces, and then air-dried. A bonding layer was applied on inner veneer surface (Adper Scotchbond 1 XT 3M ESPE). Dental enamel was conditioned with 37% orthophosphoric acid (Total etch; Ivoclar Vivadent Manufacturing SRL) for 30 seconds, then rinsed and air-dried. A bonding layer was placed on enamel (Adhese Universal VivaPen, Ivoclar Vivadent Manufacturing SRL) but not polymerized to avoid incongruous thicknesses on the tooth/restoration surface. Cementation was performed with Variolink Esthetic DC Refill (Ivoclar Vivadent Manufacturing SRL) placed on the inner surface of the veneers. The overburden was removed by a dental probe and floss before the polymerization (30 seconds per side) and occlusion relationships were carefully checked and stabilized.

►**Figs. 1–3** show a representative case of this study. Survival was defined as a restoration being free of all

Fig. 1 Patient's conditions at baseline.

Fig. 2 Mock-up placement.

Fig. 3 Final restorations cemented and finished.

complications over the entire observation period[26] and was calculated as the ratio between the number of veneers that did not present complications and the number of total veneers examined. Each complication was considered as a statistical event, cumulate survival was recorded using Kaplan–Meier analysis. All evaluations of potential failures were performed by the same operator at 3-month checks during the observation period, following advices from the literature to detect chipping, fractures, and other causes of failure.[27]

Proportions of teeth (width/length) were determined before and after restorations with a digital software elaboration (ImageJ, U.S. National Institutes of Health) of photographs.

For measurements, the major points of width and length were identified on pictures of tooth and the distances were measured. The evaluated teeth were upper and lower canines and incisors (►**Fig. 4**).

Analysis of percentage ratio was performed comparing the following ratio (width/length x 100):

- ratio of width/length of upper right incisors before and after restoration;
- ratio of width/length of upper left incisors before and after restoration;
- ratio of width/length of first upper right incisor and upper right canine before and after restoration;
- ratio of width/length of first upper left incisor and upper left canine before and after restoration;
- ratio of width/length of lower right incisors before and after restoration; and
- ratio of width/length of lower left incisors before and after restoration.

Measurements of linear distances on software were performed twice by the same operator. A single-measures interclass correlation coefficient (ICC) to evaluate the repeatability of these measurements was performed. ICC values change from 0 to 1. 0.01 indicate "poor" agreement; from 0.01 to 0.20 indicate "slight" agreement; from 0.21 to 0.40 indicate "fair" agreement; from 0.41 to 0.60 indicate "moderate" agreement; from 0.61 to 0.80 indicate "substantial" agreement; from 0.81 to 1.00 indicate "almost perfect" agreement; and 1 indicate perfect agreement.

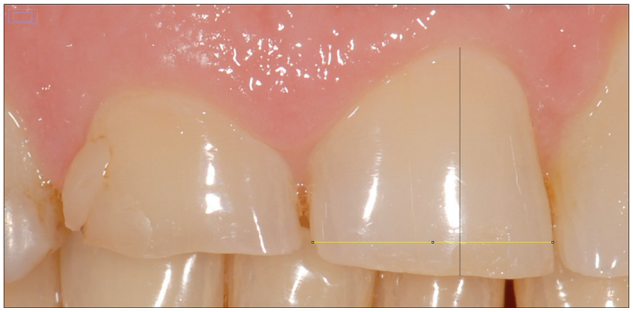

Fig. 4 Measurement of distances and calculation of proportions on software.

The collected data were also compared with those present in the literature. Comparisons of upper teeth was based on golden proportion proposed by Lombardi[28] and on Recurring Esthetic Dental (RED) introduced by Raj.[29] We stuck with Reynolds[30] for evaluation of lower arch teeth.

A single sample *t*-test analysis was then performed to clarify differences between data. All tests were considered significant at $p \leq 0.05$.

Thickness of veneers was first-hand measured by a caliber before placing them. Measurements of thickness were performed at different landmarks: incisal edge, middle of crown, and cervical area.

All values are expressed in mm as mean ± standard deviation.

All statistical analyses were performed using Statistical Package for Social Sciences Version 22.0 (SPSS Inc.)

Ethical Consideration: The procedures followed were in accordance with the ethical standards and with the Helsinki Declaration of 1975.

Results

In this study, 79 veneers were observed in 13 patients, 45 veneers in the upper arch and 34 in the lower arch (►**Table 1**). Sixty-six veneers were made with an IPS e.max Press LT core and 13 veneers with MO 0 core (Ivoclar Vivadent Manufacturing SRL).

Survival Rate

Anterior layered veneers showed cumulative survival rate of 98.7% with a medium follow-up of 3 years (from 14 to 66 months).

Only one complication occurred, which was a detachment in the lower arch. The restoration was immediately bonded and it was still in situ at the end of observation period.

Esthetical Analysis and Proportions

The ICC value obtained in this experiment was 0.931, with confidence interval included between 0.791 and 0.977, indicating almost perfect repeatability of measurements.

►**Tables 2–7** show percentage ratios of teeth examined before and after restorations and their comparison with the literature.

There were no statistical differences between measurements taken before and after restorations in the upper

Table 1 Patients' distribution (n = 13) according to the location of restorations (n = 79)

		Veneers
Gender		
Male	6	40
Female	7	39
Age (y)		
30–50	6	11
51–70	7	68
Restoration site		
Upper arch	45	
Central incisors	13	
Lateral incisors	30	
Canines	8	
Lower arch	34	
Central incisors	12	
Lateral incisors	12	
Canines	10	

right incisors as well as in the lower right incisors, neither when compared with results reported in the literature (►**Tables 2** and **6**).

Proportions of upper left incisors before and after restorations were not significantly modified. Comparison with the golden proportions showed no statistically significant differences in the *u*pper left incisors; however, proportions obtained compared with those of RED were statistically different (►**Table 3**).

Differences in percentage ratio of the first upper right incisor and upper right canine before and after restorations were statistically significant in our results, and also when compared with golden and RED proportions (►**Table 4**).

Differences in percentage ratio of the first upper left incisor and upper left canine before and after restorations were not statistically significant both in our results and also when compared with RED proportions, but were statistically different from golden proportion (►**Table 5**).

In lower left incisors were detected differences in percentage ratio before and after restorations; however, proportions were found to be not statistically different compared with proportions in the literature (►**Table 7**).

Table 2 Percentage ratio (±SD) of upper right incisors before and after restorations

Tooth 1.2/Tooth 1.1				
		Before	After	p-Value
Ratio (width/length)		0.61 ± 0.06	0.65 ± 0.05	0.26[b]
Golden proportion	0.62	p = 0.71[b]	p = 0.31[b]	
Red proportion	0.70	p = 0.02[a]	p = 0.10[b]	

Abbreviation: SD, standard deviation.
Note: Comparison with literature data and p-value results.
[a]Statistically significant.
[b]Not statistically significant.

Table 3 Percentage ratio (± SD) of upper left Incisors before and after restorations

Tooth 2.2/Tooth 2.1				
		Before	After	p-Value
Ratio (width/length)		0.63 ± 0.06	0.64 ± 0.03	0.72[b]
Golden proportion	0.62	p = 0.71[b]	p = 0.21[b]	
Red proportion	0.70	p = 0.05[a]	p = 0.01[a]	

Abbreviation: SD, standard deviation.
Note: Comparison with literature data and p-value results.
[a]Statistically significant.
[b]Not statistically significant.

Table 4 Percentage ratio (±SD) of first upper right incisor and upper right canine before and after restorations

Tooth 1.1/Tooth 1.3				
		Before	After	p-Value
Ratio (width/length)		0.48 ± 0.04	0.56 ± 0.05	0.02[a]
Golden proportion	0.38	p = 0.003[a]	p = 0.002[a]	
Red proportion	0.49	p = 0.79[b]	p = 0.05[a]	

Abbreviation: SD, standard deviation.
Note: Comparison with literature data and p-value results.
[a]Statistically significant.
[b]Not statistically significant.

Table 5 Percentage ratio (±SD) of first upper left incisor and upper left canine before and after restorations

Tooth 2.1/Tooth 2.3				
		Before	After	*p*-Value
Ratio (width/length)		0.54 ± 0.05	0.54 ± 0.05	0.88[b]
Golden proportion	0.38	$p = 0.002$[a]	$p = 0.002$[a]	
Red proportion	0.49	$p = 0.10$[b]	$p = 0.09$[b]	

Abbreviation: SD, standard deviation.
Note: Comparison with literature data and *p*-value results.
[a]Statistically significant.
[b]Not statistically significant.

Table 6 Percentage ratio (±SD) of lower right incisors before and after restorations

Tooth 4.1/Tooth 4.2				
		Before	After	*p*-Value
Ratio (width/length)		1.00 ± 0.14	1.04 ± 0.08	$p = 0.42$[a]
Reynolds	1.10	$p = 0.16$[a]	$p = 0.14$[a]	

Abbreviation: SD, standard deviation.
Note: Comparison with literature data and *p*-value results.
[a]Not statistically significant.

Table 7 Percentage ratio (±SD) of lower left incisors before and after restorations

Tooth 3.1/Tooth 3.2				
		Before	After	*p*-Value
Ratio (width/length)		0.94 ± 0.08	1.05 ± 0.06	$p = 0.001$[a]
Reynolds	1.10	$p = 0.001$[a]	$p = 0.13$[b]	

Abbreviation: SD, standard deviation.
Note: Comparison with literature data and *p*-value results.
[a]Statistically significant.
[b]Not statistically significant.

Table 8 Thickness (mm ± SD and mm) of veneers at different landmarks

	Cervical	Incisal	Middle
Mean thickness	0.77 ± 0.40	1.66 ± 1.00	1.16 ± 0.32
Maximum thickness of upper restorations	2.0	4.4	2.1
Maximum thickness of lower restorations	2.0	3.0	1.5
Minimum thickness of upper restorations	0.4	1	1
Minimum thickness of lower restorations	0.3	0.8	1

Abbreviation: SD, standard deviation.

Thickness of Restorations Material

The mean thickness at incisal point was 1.66 mm ± 1.00; at middle point was 1.16 mm ± 0.32; at cervical point was 0.77 mm ± 0.40. All values are reported in ►**Table 8**.

Discussion

The primary aim of this study was to evaluate the survival rate of veneers made of lithium disilicate in the upper and lower anterior area with a mean follow-up of 3 years. With regards to this aspect, results were encouraging and only one episode of detachment in the lower arch occurred during the observation period. In detail, this detachment could be due to a slight miscalculation of functional guides and of Spee curve in the planning phase. As expected, survival rates in our study were in agreement with current data from the literature, taking into account the shorter follow-up of our study.[31,32]

In this study, the survival rate of lithium disilicate restorations was 98.7% with a mean follow-up period of 3 years. The result can be overlapped to other published scientific works; however, comparison with the literature is difficult

because only few research discuss lithium disilicate veneers, meanwhile most of them focus on single crown or lithium disilicate unspecific rehabilitations.[33-36] Furthermore, our restorations were all performed in damaged or eroded anterior teeth, this means not having standard conditions and subsequently making it difficult to compare our results of survival with other results provided in the literature where initial conditions are not specified. Two retrospective studies evaluated multilayered lithium disilicate veneers: Fabbri et al report 97.5% of survival rate in a maximum period of 6 years of follow-up,[37]and Sulaiman et al observe a survival rate of 98.47% for multilayered veneers with a mean follow-up of 4 years.[38] In our opinion, stability of our anterior restorations was, in addition, closely related to a good posterior rehabilitation that allowed achieving occlusion stability and proper posterior contacts, especially in patients with compromised occlusal conditions.[39-41]

Clinical evaluation of potential failures was performed by the same operator in this study, and no questionnaires were administered to patients. This is a critical point to highlight; however, the choice was due to reduce chairside and checks time and to keep the patients' cooperation during the entire observation period, considering the mean age of patients and the reluctance to fill out forms or answer questionnaires.[42] We are well aware that the literature encourages to administer questionnaire to deeply evaluate failures and their reasons, as well as satisfaction of patients[43,44] however, the primary aim of this work was limited to investigate clinical complications of veneers.[45] In this regard, we assumed Anusavice criteria to detect chipping, fractures, and other causes of failure even if his method was proposed for posterior prosthetic restorations.[27]

The decision to deeply focus our attention on proportions of teeth was due to the main importance of this aspect in esthetical rehabilitations in dentistry[46]; our data were found to be generally in accordance with those in the literature.[47] However, some clarifications are needed. Change in percentage ratio was calculated between first and second incisor and between first incisor and canine in both arches as advised in the literature; this allowed comparing results of our restorations with golden and RED proportions in the upper arch and benchmarks proposed by Reynolds for the lower arch.[28-30] Variations from proportions provided by the literature were highlighted in some groups of teeth (first upper left incisor and canine, upper left incisors). Lower left incisors were found to be changed in proportion before and after our restorations and the percentage ratio of the first upper right incisor and upper right canine was significantly different both before and after veneers placement if compared with two literature parameters. These findings are most likely related to initial worn status of these teeth; lower incisors, upper canines, and incisors are actually more involved in abrasion processes than upper lateral ones.[48] The most remarkable differences between before and after status and from data in the literature were detected in upper incisor/canine comparisons. In our opinion, it might be taken into account that restored canines in the upper arch were only eight, and therefore also this aspect should be responsible for differences highlighted and it could affect the power and effectiveness of our analysis, providing not so strong results.

However, even though statistical differences were found, clinical results and esthetical patterns were not affected by these findings. In our opinion, statistical results are strongly related to measurements collected in every single tooth; nevertheless, the esthetical feature is absolutely related to overall view of smile,[49-51] and therefore in our opinion minimal changes in proportions did not affect esthetical performances of rehabilitation.

Another limitation in comparing data with the literature is the initial conditions of rehabilitated teeth, considering that among the inclusion criteria of this study were teeth abrasion and loss of dental tissue in the anterior area; therefore, results in proportions before and after restorations were determined also by need to recover these clinical statuses.

One of the secondary aims of this work was to evaluate thickness of veneers at different landmarks. As literature suggests, dental preparations were performed following the criteria of dental and periodontal tissues preservation, to guarantee space of manufacture.[52] The major thickness of restoration material was measured in incisal portion of veneers, according to the need of restore abrasions and loss of dental substance. Literature reports thickness of just under 1.26 mm for incisal portion of porcelain veneers; however, difference in our findings might be due to initial conditions of abrasion of teeth restored.[53]

Furthermore, it may be appropriate to administer questionnaire of satisfaction and comfort to patients to obtain more specific information about esthetical perception of restored smile and to deeply investigate realistic awareness of change in proportions of rehabilitated teeth.

Use of lithium disilicate in esthetical rehabilitations of eroded teeth proved to be effective in a medium follow-up of 3 years and survival rate was found to be according to the literature.

Proportions of restored teeth seemed to be maintained and esthetical and functional aspects improved with a minimum amount of dental tissue removed.

Note

The authors do not have any financial interest in the companies whose materials are included in this article.

Conflict of Interest

None declared.

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