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Assessment of the Hardness of Disks Fabricated by Zirconia Reinforced Lithium Silicate Glass Ceramic; VITA Suprinity and IPS E-max CAD

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Abstract

Introduction: The introduction of ceramic restorative materials has drawn a lot of attention from dental technicians and dentists alike. More recently, dentists prefer using ceramic crowns in clinical restorations. Vita Suprinity and IPS E-max CAD are zirconia reinforced lithium silicate glass ceramics that are used for CAD/CAM applications. These ceramic materials are used in the fabrication of veneers, partial crowns, on-lays, in-lays, anterior and posterior single tooth restorations.

Objective: The study has aimed to assess the hardness of disks fabricated by Zirconia Reinforced Lithium Silicate Glass Ceramic, VITA Suprinity, and IPS E-max CAD.

Method: This quantitative study was conducted to assess and evaluate the surface hardness of disks in terms of fabrication. Two sorts of glass ceramics were included; first one being, VITA Suprinity; zirconia-reinforced lithium silicate and the other one was IPS e.max CAD (IC); lithium disilicate. A total of 16 disks were obtained, and 8 disks (13 x 15 mm) were obtained from each material. Vickers diamond indenter was utilized in accordance with micro-hardness tester.

Result: The correlation between E-max HV and Suprinity HV revealed that there was an insignificant but positive correlation between two tests at 5% level of significance. The findings further showed that there was no significant difference for evaluating the surface hardness of disks using both E-max HV and Suprinity HV tests ($p > 0.05$). The mean hardness value of IPS E-max was 606.9 while the mean hardness value of suprinity was 563.083.

Conclusion: The results concluded that IPS E-max CAD displays a higher surface hardness than the VITA Suprinity that would be favorable for clinical procedures.

Keywords: *CAD/CAM Applications; Ceramic Restorative Materials; Fixed Dental Prostheses; Partial Crowns; Zirconia Reinforced Lithium*

Introduction

Restorative dental glass ceramics are used for reconstruction and restoration of teeth. The demand for materials for the purpose of dental products is increasing immensely. These dental products include and comprise of dental bridges, veneers and crowns. Similarly, computer-controlled machines are used for this purpose. The two primary technologies that are used in modern restorative dentistry are the development of ceramic based dental materials and Computer-aided Design/ Computer-aided manufacturing materials. Tooth-colored restorative materials and adhesive bonding procedures are commonly used in restorative dentistry. Moreover, the adhesive bonding

veneers are made from different silicate ceramic restorative materials and it has been a huge milestone in prosthodontics. Veneers have a wide ranging applications, and they are used to mask discolored teeth. Besides this, they are also used to establish sufficient function and restore the biomechanics of teeth dentition [1].

Methods and procedures like CAD/CAM have demonstrated to be efficient when it comes to satisfying patients in terms of dental restoration [2]. Apart from this, ceramic restorative materials can be classified into three groups, namely; polycrystalline ceramics, glass-matrix ceramics and resin-matrix ceramics [3]. However, it is important that the materials being processed should have certain properties to bring a satisfactory outcome. Restoration of appealing properties gives an idea regarding the appearance of natural teeth. The restoration is supposed to be done in such a manner that it is esthetically pleasing in terms of its shape, size, surface texture, and translucency [4]. In some cases, light reflection from the opaque metal structure compromises the natural appearance and the outcome of restoration deteriorates [5]. Therefore, new ceramic systems have been developed to fulfill patient's need and to provide them with similar natural tooth translucency [5]. Among various ceramic systems, zirconia-based ceramics are considered to be more efficient and attractive in the eyes of dentists [6].

Zirconia based ceramic systems tend to fulfill biomechanical requirements; but due to the enhancement in the crystalline content, the overall strength and opacity of all-ceramics increases [7]. Therefore, it could result in differences related to refractive indices and homogeneity of crystals [8]. In addition, Zirconia cores when compared to other, all-ceramic systems have poor translucency and are extremely white in appearance [9]. Lithium disilicate glass ceramic (IPS e.max CAD) uses CAD/CAM method, which is very common, when it comes to restoration. Similarly, it tends to showcase remarkable esthetic properties as well as high strength [10]. Zirconia reinforced lithium disilicates vita suprinity (VS) that ensures the strength of zirconia crystals by 10% [11]. These materials showed tremendous outcomes in terms of physical and optical properties, similar to lithium disilicates [12]. However, IPS e.max includes both press and CAD/CAM options because lithium disilicate can be pressed from ingot as well as, milled from a block form. In case CAD/CAM option is taken into account, the restoration will be done digitally rather than full wax-up or press.

Going about alternative solutions rather than typical traditional ones to satisfy the patient's needs is often a challenge for the dental restoration team. In comparison with glass ceramic materials, substructure materials are high in terms of value and opacity, but they are not esthetically pleasing. Restoration significantly depends on the ability to create a strong bond between the dissimilar materials like silica-based glass ceramic and oxide-ceramic. Though, it is not much difficult to bond them together, but the quality of the band interface bond may vary. The aim of this study was to analyze and evaluate the hardness of VS and zirconia reinforced lithium silicate. Moreover, it is further aimed to evaluate their physical and mechanical properties.

Literature Review

In a study conducted by Naumova., *et al.* [13], where they evaluated different CAD/CAM crowns for their wear behavior. Crowns were made through natural antagonists and other restorative materials. Lithium disilicate was enriched with zirconia (Vita Suprinity); Vita Enamic (VE) is a glass ceramic in a resin interpreting matrix; and a full Lava Ultimate (LU) CAD/CAM crown was fabricated with nanoceramic resin. These restorative materials were related to stimulated chewing. 3D data sets were created and matched before and after the chewing simulation. The vertical and volume loss, the occlusal surface roughness of natural antagonists, and other restorative materials were evaluated and analyzed. The crown vertical loss fluctuated in all the groups of antagonists and restorative materials. The antagonist, having lowest volume loss, was achieved by Lava Ultimate group. Apart from this, the antagonist, having highest volume, was Lava Ultimate (LU) CAD/CAM crown reached by the Vita Enamic group. Besides this, the highest crown volume loss was discovered in the Lava Ultimate (LU) CAD/CAM crown. Furthermore, the crown volume loss was revealed in the Vita Enamic group. They concluded that the roughness increased after the stimulation of chewing. The Lava Ultimate (LU) CAD/CAM crown were the most vulnerable to both vertical and volume loss. With regard to the occlusion, the Vita Enamic crowns were the most stable [13].

A study was conducted by Mota., *et al.* [14] to examine the milling and post-milling methods on the surface roughness of CAD/CAM materials. Five CAD/CAM ceramics and one CAD/CAM composite resin were used to evaluate their surface topography after milling at CEREC MCXL system. Blocks of different ceramics such as the IPS E-max CAD, Enamic, IPS Empress CAD, Mark 11 and Suprinity were milled. Additionally, blocks of the composite resin Lava Ultimate was also milled. Ten samples of all the materials was obtained. Scanning Electron Microscope (SEM) and Atomic Force Microscope (AFM) analysis were conducted. Apart from this, the surface roughness test was performed. Moreover, polishing, glazing, and crystallization was done when indicated and specified. The data was complied with Tukey test and one-way ANOVA test. The results showed that the milling procedure had significantly increased the surface roughness of all the materials. The significance levels were less than 0.05 in all the tested restorative materials. Scanning Electron Microscope (SEM) and AFM images showed that the glazed surfaces were smoother than the polished surfaces. Furthermore, except for the lithium-based ceramics, the polishing procedure in all the other materials reduced the surface roughness to baseline values. It was concluded that the glaze method can be ignored and it will result in saving time in the full procedure. It was further concluded that all hard-milling CAD/CAM restorative materials should only be hand polished. Consequently, it was discovered that lithium-based ceramics such as the IPS E-max CAD and the Suprinity were more suitable to surface roughness than all the other restorative materials.

A past study has assessed the mechanical properties of zirconia reinforced lithium silicate glass-ceramic [15]. Two glass-ceramics were used; namely, Vita Suprinity and IPS e.max CAD (IC). They were evaluated on the basis of toughness, flexural strength and hardness. Data for each glass-ceramic was analyzed separately. The end result illustrated that VS glass-ceramic showed lower probability of failure, but higher strength in comparison to IC glass-ceramic. Furthermore, VS zirconia-reinforced silicate showed higher mechanical properties as compared with glass-ceramic, IC lithium silicate [15].

By incorporating manual polishing and glazing, most of the silica-based glass ceramic restorative materials attain the standard enamel-like surface roughness and gloss. The most common procedure for monolithic chairside restorations is manual polishing and finishing. Furnace-based restorations are not popular and neither are they preferred as the right and satisfactory procedure. A study was conducted by Vichi and colleagues to examine the efficiency of gloss and the polishing and finishing systems on the surface roughness of VITA Suprinity and the IPS E-max CAD. By using the InLab MC-XL milling unit, 24 blocks each, of the IPS E-max CAD and VITA Suprinity were cut into wedge shapes. The Suprinity wedges were further divided into four sub groups. They were the VITA Akzent Plus Paste, the spray, the 60 second Suprinity polishing Set and the 30 seconds polishing sets group. In the same way, the 24 wedges of IPS E-max CAD were also separated into four groups. The different groups were the IPS E-max CAD crystal and glaze paste, and the spray group. Apart from these, there was the 60 and 30 seconds Optrafine Ceramic Polishing System group. The surface roughness of the IPS E-max CAD and VITA Suprinity was analyzed with a profilometer and the polishing and gloss was evaluated using the glossmeter. Furthermore, the evaluation and the analysis of the surface roughness and the variance for the gloss was done to determine and ascertain the results. One sample from each sub group was examined using the Scanning Electron Microscope. It was revealed that the IPS E-max CAD showed significantly higher surface roughness than the VITA Suprinity. Both surface treatment and material were significant factors for gloss. The IPS E-max CAD showed significantly lower gloss than the VITA Suprinity. It was concluded in the study that the most effective methods in lowering the surface roughness of CAD/CAM silica-based glass ceramics were the glazing paste and the manual polishing procedure for 60 seconds. In the same way, the CAD/CAM silica-based glass ceramics yield a higher gloss with the application of the manual polishing for 60 seconds procedure. On the contrary, VITA Suprinity demonstrated higher polish ability than the IPS E-max CAD [16].

Methodology

This study was conducted to assess and evaluate the surface hardness of disks in terms of fabrication. The evaluation and the analysis of the obtained data have been done quantitatively. Two sorts of glass ceramics were included; first one being, VITA Suprinity; zirconiareinforced lithium silicate and the other one was IPS e.max CAD (IC); lithium disilicate. A total of 16 disks were obtained; 8 disks (13 x 15)

mm) were obtained from each material. These disks were obtained to carry out Vickers Hardness test. The Vickers hardness test is also referred as microhardness test method, and it is used to test the surface hardness of various types of metals, composites, and ceramics. Furthermore, this method tends to test the softest and hardest of the materials.

Figure 1: *Vita Suprinity.*

Initially, each specimen was polished with silicon carbide sandpapers (400-600-1200 grit) and polisher. A Vickers diamond pyramid indenter test was used for determining the microhardness of discs. The procedure covered the requirements of the Standard Test Method for Microhardness of Materials. Hardness measurements were made with a Durimet microhardness tester (Leitz GmbH, Wetzlar, Germany). Three indentations were produced for each sample. With the help of Vickers diamond indenter that was utilized in accordance with micro-hardness tester, under 15 second dwell time and 9.8N load. A diamond indenter was used to make indentation, which resulted in providing the hardness value. Every type of material can be used as long as, the test samples surfaces are carefully formed. Once the indentations were performed, the values were obtained in Vickers Hardness Number. Furthermore, the data was evaluated and analyzed using independent t test. In a similar way, mean and standard deviation was determined with the help of statistical analysis through SPSS version 20. This evaluation was done to examine the surface hardness of the disks in comparison with both glass-ceramics. Moreover, it was easier to get to know more about the physical and mechanical properties of these materials and how they differ from each other with the help of this test.

Results and Discussion

The mean value of IPS E-max CAD number 7 was the highest at 790 (Table 1; Figure 2). Apart from this, the mean value of sample number 8 was the lowest at 537. Furthermore, the mean value of sample number 5 was averaged at 591.

Sample	Hardness Value				
	1	2	3	Mean	SD
1	575	583	572	576.6667	5.686241
2	587	583	574	581.3333	6.658328
3	580	578	574	577.3333	3.05505
4	578	588	580	582	5.291503
5	591	593	589	591	2
6	591	585	576	584	7.549834
7	797	783	790	790	7
8	558	587	574	573	14.52584
General Mean				**606.917**	

Table 1: *Vickers Hardness test for mean value of IPS E-max CAD.*

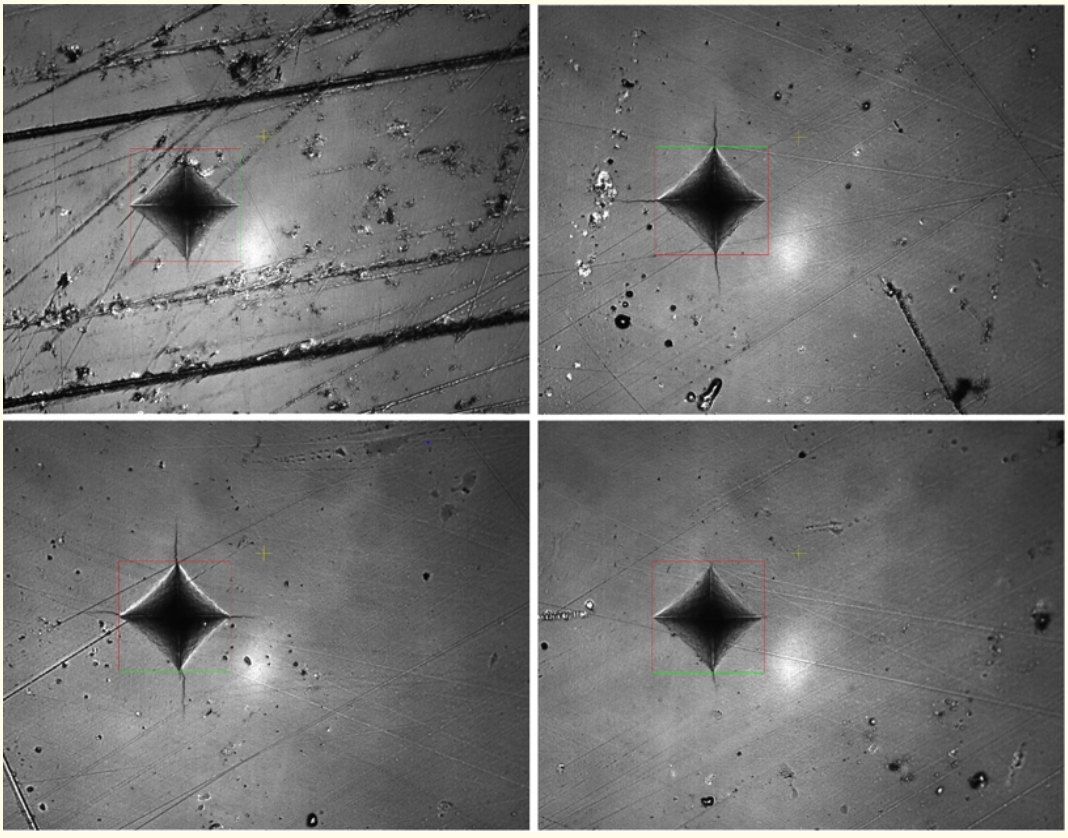

Figure 2: *SEM samples.*

The mean value of suprinity number 6 was the highest at 582.66 (Table 2). Apart from this, the mean value of sample number 5 was the lowest at 547.66. Furthermore, the mean value of sample number 1 was average at 565.33.

Sample	Vita Suprinity Hardness Value				
	1	2	3	Mean	SD
1	564	556	576	565.3333	10.06645
2	572	562	578	570.6667	8.082904
3	546	567	560	557.6667	10.69268
4	561	549	550	553.3333	6.658328
5	556	547	540	547.6667	8.020806
6	589	587	572	582.6667	9.291573
7	589	572	569	576.6667	10.78579
8	553	557	542	550.6667	7.767453
General Mean Value				563.083	

Table 2: *Vickers Hardness test for mean value of vita sup.*

The results revealed that IPS E-max CAD displays a significantly higher surface roughness and hardness than the VITA Suprinity. The results are consistent with a study conducted by Vichi., *et al* [16].

Table 3 has presented correlation between E-max hardness value and Suprinity hardness value and revealed that there is an insignificant but positive correlation between the two tests at 5% level of significance. This shows a lower chance of association between these two tests when used for evaluating the surface hardness of disks.

Paired Samples Correlations				
		N	Correlation	Sig.
Pair 1	E-max HV and Suprinity HV	8	.626	.097

Table 3: *Correlation between E-max hardness value & Suprinity hardness value (Sample 1).*

The mean difference between E-max hardness value and Suprinity hardness value is presented in table 4. The findings have indicated that there is an insignificant mean difference for evaluating the surface hardness of disks using both E-max hardness value and Suprinity hardness value tests (p = 0.136).

Paired Samples Test									
Mean		Paired Differences					t	df	Sig. (2-tailed)
		Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference					
				Lower	Upper				
Pair 1	E-max HV - Suprinity HV 1	40.87500	68.60120	24.25419	-16.47704	98.22704	1.685	7	.136

Table 4: *Paired Sample Test between E-max hardness value & Suprinity hardness value.*

The correlation between E-max hardness value and Suprinity hardness value for evaluating surface hardness of disks is presented in table 5. The findings have indicated that there is an insignificant but positive correlation between both tests for evaluating surface hardness of disks.

Paired Samples Correlations				
		N	Correlation	Sig.
Pair 1	Suprinity HV and E max HV 2	8	.274	.511
Pair 2	Suprinity HV and E max HV 3	8	.170	.687

Table 5: *Correlation between E-max HV and Suprinity HV (Sample 2 and 3).*

In table 6, the paired sample test has been presented for the mean difference of E-max hardness value and Suprinity hardness value. The findings have indicated that there is an insignificant mean difference between E-max hardness value and Suprinity hardness value for evaluating the surface hardness of disks.

Paired Samples Test									
Values		Paired Differences					t	df	Sig. (2-tailed)
Mean		Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference					
				Lower	Upper				
Pair 1	Suprinity HV – E- max HV	-47.87500	67.63017	23.91087	-104.41523	8.66523	-2.002	7	.085
Pair 2	Suprinity HV 3 – E max HV 3	-42.75000	74.44029	26.31862	-104.98364	19.48364	-1.624	7	.148

Table 6: *Paired Sample Test between E-max hardness value and Suprinity hardness value (Sample 2 and 3).*

Though the VITA Suprinity has established higher polish-ability than IPS E-max CAD; thus, it exhibited a significantly higher surface hardness and roughness than VITA Suprinity [16]. Similarly, in a study conducted by Mota., et al. [14], different ceramics; such as, the IPS E-max CAD, Enamic, IPS Empress CAD, Mark 11 and Suprinity were milled. The results revealed that the polishing technique in all materials reduced the surface roughness to baseline values, except in the lithium-based restorative materials. Conclusively, it was found that lithium-based ceramics; such as, the VITA Suprinity and the IPS E-max CAD were more appropriate to surface roughness and hardness than all the other restorative materials [14]. In a similar way, there are some studies that have revealed confirmatory results. The Vickers hardness values of lithium disilicate based pressed ceramic IPS E-max press and three other CAD/CAM restorative materials; such as, the Lava Ultimate, Vita Suprinity and IPS e-max CAD were recorded after polymerization. It was revealed that the cements that were under the Lava Ultimate samples had higher surface hardness than the other ceramic restorative materials [17]. Also it showed exceptional durability, high strength, biocompatibility, and translucency [18]. The results revealed and concluded that IPS E-max CAD displays a significantly higher surface roughness and hardness than the VITA Suprinity. Similarly, past studies have also supported the outcomes of current study [19].

Conclusion

New dental restorative ceramic materials have been developed and introduced in prosthodontics. Moreover, they are getting increasingly common amongst dentists. Additionally, amongst many of these dental materials, glass ceramics, polymer-infiltrated and glass

ceramics and zirconia are quite popular and widely used. They also have exceptional aesthetics, good durability and high strength. Within the limitation of this research, results revealed and concluded that IPS E-max CAD displays higher hardness than the VITA Suprinity. These two types of material perfectly complement each other and offer a versatile range of treatment options in fixed prosthodontic restorations.

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Conflict of Interest

The research has no conflict of interest and is not funded through any source.

Bibliography

1. Edelhoff D., *et al*. "Anterior restorations: The performance of ceramic veneers". *Quintessence International* 49.2 (2018): 89-101.
2. Apel E., *et al*. "U.S. Patent No. 7,871,948". Washington, DC: U.S. Patent and Trademark Office (2011).
3. Gracis S., *et al*. "A new classification system for all-ceramic and ceramic-like restorative materials". *International Journal of Prosthodontics* 28.3 (2015): 227-235.
4. Rosenstiel SF., *et al*. "Contemporary Fixed Prosthodontics-E-Book". Elsevier Health Sciences (2015).
5. Raptis NV., *et al*. "Optical behavior of current ceramic systems". *International Journal of Periodontics and Restorative Dentistry* 26.1 (2006): 31-41.
6. Denry I and Kelly JR. "State of the art of zirconia for dental applications". *Dental Materials* 24.3 (2008): 299-307.
7. Holloway JA and Miller RB. "The effect of core translucency on the aesthetics of all-ceramic restorations". *Practical Periodontics and Aesthetic Dentistry: PPAD* 9.5 (1997): 567-574.
8. Jiang L., *et al*. "Effects of sintering temperature and particle size on the translucency of zirconium dioxide dental ceramic". *Journal of Materials Science: Materials in Medicine* 22.11 (2011): 2429-2435.
9. Baldissara P., *et al*. "Translucency of zirconia copings made with different CAD/CAM systems". *Journal of Prosthetic Dentistry* 104.1 (2010): 6-12.
10. Chen YM., *et al*. "Translucency and biaxial flexural strength of four ceramic core materials". *Dental Materials* 24.11 (2008): 1506-1511.
11. Sannino G., *et al*. "Cerec CAD/CAM chairside system". *Oral and Implantology* 7.3 (2014): 57-70.
12. McLaren EA and Figueira J. "Updating classifications of ceramic dental materials: a guide to material selection". *Compendium of Continuing Education in Dentistry* 36.6 (2015): 400-405.
13. Naumova EA., *et al*. "Wear Behavior of Ceramic CAD/CAM Crowns and Natural Antagonists". *Materials* 10.3 (2017): E244.
14. Mota EG., *et al*. "The effect of milling and postmilling procedures on the surface roughness of CAD/CAM materials". *Journal of Esthetic and Restorative Dentistry* 29.6 (2017): 450-458.
15. Elsaka SE and Elnaghy AM. "Mechanical properties of zirconia reinforced lithium silicate glass-ceramic". *Dental Materials* 32.7 (2016): 908-914.

16. Vichi A., *et al*. "Effect of Finishing and Polishing on Roughness and Gloss of Lithium Disilicate and Lithium Silicate Zirconia Reinforced Glass Ceramic for CAD/CAM Systems". *Operative Dentistry* 43.1 (2018): 90-100.

17. Atay A., *et al*. "The effect of different distance of curing light and ceramic materials on microhardness of the resin cement". 7tepe klinik 14.1 (2018): 43-50.

18. Montazerian M and Zanotto ED. "Bioactive and inert dental glass-ceramics". *Journal of Biomedical Materials Research Part A* 105.2 (2017): 619-639.

19. Rekow D and Thompson VP. "Near-surface damage-a persistent problem in crowns obtained by computer-aided design and manufacturing". *Proceedings of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine* 219.4 (2005): 233-243.

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