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Effect of Hydrofluoric Acid Etching Time on Flexural Strength and Surface Roughness of CAD/CAM Ceramic Materials

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Abstract

Objective: This study emulated the influences of varied hydrofluoric acid etching durations on the flexural strength and surface roughness of three CAD/CAM dental glass ceramic materials: feldspathic—CEREC blocs CPC, leucite-reinforced—IPS Empress CAD, and lithium disilicate—IPS e.max CAD.

Methods: The samples were prepared and divided with respect to the type of material to be etched for 0, 20, 60, and 90 seconds. This was followed by ultrasonic cleaning and successive thermocycling. SR and FS were measured with the profilometer and by the 3-point bending test, respectively. Data were statistically analyzed using ANOVA.

Results: The results indicated that increasing HF etching time significantly reduced the FS of the lithium disilicate group only, thus being dependent on material composition, $p < 0.05$. In all materials, SR increased with longer etching time. This increase in SR with deeper etching therefore places a direct relationship between etching time and surface texture.

Conclusion: This paper points out that one of the most critical factors in regard to the optimization of mechanical properties in ceramic materials for dental restorations is HF etching time. The choice of appropriate etching times relative to what exists is essential for the ultimate clinical performance and lifetime of ceramic restorations, with chosen durations favoring specific materials over others. This information is very valuable for dental practitioners in making appropriate choices toward durability and reliability in ceramic dental restorations.

Keywords: Flexural, Strength, Surface Roughness, Ceramic Materials, Dental Restorations.

1. INTRODUCTION

Glass-ceramic materials are a huge adoption for clinical applications because of their excellent optical properties, resistance to wear and fracture, and true bonding to tooth surfaces [1, 2]. Several glass ceramics available in the market include feldspathic, lithium disilicate, zirconia-reinforced lithium silicate, leucite-reinforced, and polymer-infused ceramics. Whereas feldspathic and lithium disilicate ceramics have shown clinical durability, a fair number of failures mainly in the form of cavities at the adhesive interface, fractured restorations, loss of retention, or even dislodgement have been noticed and these failures prove the relevance of the cementation procedure [3, 4].

The nature of the ceramic material and the luting agent represent the principal factors that govern the success of the luting. These can be zinc phosphate, glass ionomer, or resin composite. In cementing a ceramic restoration, two interfaces need to be dealt with: the cement-dentine and the cement-ceramic interfaces. If the bonding at both interfaces is not adequate, then there is a risk of microleakage, resulting in reduced survival of the restorative work. In particular, at the resin-cement ceramic interface, problems may occur because paraffin-derived cement has poor bonding properties to the untreated ceramic.

Surface treatment has played a key role in attainment of maximum adhesion between resin composite and ceramic restoration right from when HF acid etching was first introduced as a ceramic surface preparation for resin bonding. It can also be demonstrated to affect the microstructural surfaces of materials. HF acid etching, silane application, abrasive blasting, laser irradiation, tribo-chemical, and pyro-chemical silica coating are the different formulations of chemical and mechanical conditioning processes that influence the surface structure of the material. This pre-treatment is very efficient for procedures that use abrasion to obtain micro-pits on the surface and promote adhesion. According to Puppin-Rontani, Sundfeld et al., the silane coupling agent adapted can improve the wettability of the surface and energy; therefore, the ceramic will be more resistant to delamination from the resin [5]. In this way, the effectiveness of HF acid etching will be influenced by several factors: acid concentration, etching time, temperature, and the nature of the restoration. The optimal strength and duration of HF acid etching for these materials are unknown, and different ceramics may act differently concerning this treatment.

The aim of this study was to determine the optimum HF etching time for feldspathic ceramics and leucite-bearing and lithium disilicate glass ceramics, which can produce strong bonding for resin cement without significantly reducing ceramic strength. In general, higher concentrations of HF acid are related to increased toxicity. Thus, a lower concentration is recommended to minimize the possible hazard [6].

2. MATERIALS AND METHODS

2.1 flexural strength and surface roughness tests

2.1.1 Sample Preparation

A total of one hundred twenty bar-shaped ceramic samples with dimensions of 14 mm × 4 mm × 1.2 mm were made from ceramic blocks and split into three groups (n=40) based on the kinds of materials used: feldspathic (CEREC blocs; CPC Sirona Dental Germany) (group FP), leucite reinforced (IPS Empress CAD; Ivoclar Vivadent Schaan Liechtenstein) (group LR), and lithium disilicate (IPS e.max CAD; Ivoclar Vivadent Schaan Liechtenstein) (group LD). The samples were prepared using a low-speed diamond disc under water-cooling in a sectioning machine [7, 8]. Surface irregularities were removed with 400, 600, and 1200 grit silicon carbide paper, followed by ultrasonic cleaning in deionized water for ten minutes. Samples of IPS e.max were crystallized using a VITA VACUMAT 4000 M furnace (VITA Zahnfabrik Germany) according to the manufacturer's instructions, as e.max blocks were supplied in a partially crystallized condition.

2.1.2 Surface treatment

Each group was further divided into four subgroups (n=10) based on the ceramic surface treatment: Group 1 (control) received no ceramic surface treatment, Group 2 underwent 20 seconds of HF etching (4.5% hydrofluoric acid gel; Ivoclar Vivadent), Group 3 underwent 60 seconds of HF etching, and Group 4 underwent 90 seconds of HF etching. Following etching, the gel was rinsed off with distilled water, and thorough air-drying for 1 minute ensued. Safety precautions were observed during the etching process, including the use of a face shield, coat cover, and acid-resistant gloves. The etching gel was neutralized with sodium and calcium carbonate for five minutes, followed by ultrasonic cleaning in a water bath for ten minutes. The samples were then subjected to the thermocycling process (10,000 cycles between 5/55°C) [9].

2.1.3 surface roughness measurement

Post-surface treatment, a profilometer equipped with a contact-type stylus (Mitutoyo SJ-410, Kanagawa, Japan) was employed to measure surface roughness for each group. The tracing diamond stylus (with a 5µm tip radius) moved across the surface at a speed of 0.5 mm/sec and a cut-off value of 0.8 mm, measuring the roughness profile (Ra) value in micrometers (µm). The Ra values, representing the average roughness of the surface, were obtained from three different points on each sample, as per ISO 4287:1997 standards. Subsequently, the average Ra value for each ceramic sample was calculated for statistical analysis [7, 10, 11].

2.1.4 Flexural strength measurement

To measure flexural strength, a three-point bending test was conducted using a computer-controlled universal testing machine (LARYEE, China), following ISO 6872:2008. The treated side of the ceramic sample was positioned downward and flat between rounded supporting rods placed 12 mm apart. The fracture occurred at the center of the specimens using a round chisel (radius 3 mm) at a crosshead speed of 0.5 mm/min. Flexural strength (σ) was calculated in MPa using the formula provided [12-14]

$$\sigma = \frac{3FL}{2bh^2} \quad (1)$$

$$Flexural\ strength = \frac{3xFxL}{2}$$

$$= \frac{36F}{11.5} \quad (2)$$

F is the fracture load (force) at the fracture point (in N), L is the length of the support span (12 mm), b is the width (4 mm), and d is the thickness (1.2 mm).

2.2 Resin bond strength test

2.2.1 Sample preparation

A total of ninety samples of the same three ceramic materials: feldspathic (CEREC blocs CPC; Sirona Dental Germany) (group FP), reinforced with leucite (IPS Empress CAD; Ivoclar Vivadent Schaan Liechtenstein) (group LR), and lithium disilicate (IPS e.max

CAD; Ivoclar Vivadent Schaan Liechtenstein) (group LD) with dimensions of (10 mm×8 mm×2 mm) were prepared for shear bond strength testing. The samples were made from ceramic blocks using a water-cooled, low-speed handpiece with a diamond disc bur (40 mm in diameter and 1 mm in thickness) in the sectioning machine and measured with a digital caliper [12, 15]. According to the manufacturer's instructions, IPS e.max samples were crystallized using a VITA VACUMAT 4000 M furnace (VITA Zahnfabrik Germany). The samples were embedded in self-polymerized acrylic resin (acryl Plus, SpofaDental, Czech Republic) using specially designed custom-made silicone mold with dimensions of (20×20×15 mm). After finishing acrylic polymerization, the surface of ceramic samples was wet polished with 400-,600-, and 1200-grit silicon carbide paper to remove the irregularity and then cleaned ultrasonically in a water bath for 10 min.

2.2.2 Surface treatment

Depending on the ceramic surface treatment, the samples in every group were separated into three subgroups randomly (n=10): HF acid (4.5%) etched Groups 1, 2, and 3 for 20, 60, and 90 seconds, respectively. An adhesive tape with a 3 mm perforation delimited the area to receive the acid. The HF acid was applied to the surface using a micro-brush (Dentsply, New York, USA) and dried with a stream of air for 60 seconds after being washed off from the surface using an air/water jet [16]. After that, the samples received a 10-minute ultrasonic cleaning in a water bath. A thin layer of a saline agent, Monobond N (Ceramic N, Ivoclar Vivadent, Schaan/ Liechtenstein), was applied using a micro brush to the uncovered surface of the sample and permitted to react for 60 seconds and then dried using oil-free air following the manufacturer's recommendations. Subsequently, a thin coat of unfilled resin (Heliobond, Ivoclar Vivadent, Schaan/ Liechtenstein) was applied using a micro-brush and dried with compressed air [17, 18].

2.2.3 Cementation process

A cylinder of luting resin cement (Rely x adhesive resin cement, 3M Dental) was applied on the exposed ceramic surface according to the manufacturer’s instructions using a specially constructed Teflon mold with a central hole (2 mm in height and 3 mm in diameter). A Teflon mold was used to standardize the adhesive area. A celluloid strip was positioned beneath a glass slide and forced under a 200g load, light cured for 20 seconds (1,200 Mw/cm^2), then left for a 5-minute chemical curing [19, 20]. Before the shear bond test, each sample performed 10,000 sessions of thermocycling with remaining times of 30 seconds and transfer times of 5 seconds, at 5 °C and 55 °C [10, 21, 22].

2.2.4 Shear bond strength measurement

The SBS was measured using a computerized universal testing machine (Zwick Roell Germany). The shear force was exerted at a speed of 0.5 mm/min and load cell of 5 Kg until the sample fractured. The stainless-steel shearing blade had a knife-shaped edge and was positioned perpendicular to the bottom of the resin cylinder on the adhesive connection [11, 23].

The formula calculated the shear bond strength: SBS= Force (Newton)/surface area (mm^2). The ceramic samples' adhesive area was expressed by the area of circle $A = \pi r^2$, where $\pi = 3.14$ and r = the cylinder's radius.

3. RESULTS

3.1. Flexural Strength (FS)

3.1.1. Effect of Etching Time

Results also showed that there was a statistically significant difference in mean FS among various etching times for the LD group ($p < 0.05$). Analysis of the data related to the LD1 HF application revealed that it had a significantly higher FS compared with both LD3 and LD4, with $p < 0.05$. There was a remarkable difference between the FS values for LD2 and LD4, the former group demonstrating a significantly higher FS (Table 1).

3.1.2. Effect of Type of Ceramic

Table 3 described an important difference in the mean FS among groups at 0, 20, 60, and 90 seconds. The LD at zero and 20 seconds had an important increased mean FS when compared to the LR and FP groups, respectively, with $P < 0.05$. At 60 and 90 seconds, LD had a considerably higher FS compared to both LR and FP with $p<0.05$. Moreover, at 60 and 90 seconds, the FS for the LR group was significantly higher when compared to the FP group with $p<0.05$, as shown in Table 3.

3.2. Surface Roughness (SR)

3.2.1. Effect of Etching Timing

There was a significant difference among means of Ra values for different etching times in each group, except for LD1 and LR1 and also LD2 and LR2, which showed minor differences in SR ($p > 0.05$). Specifically, the LD4 and LR4 subgroups exhibited significantly higher SR compared to other etching times. LD3 and LR3 had significantly higher SR than LD1, LR1, and LD2, LR2. In the FP group, a significant difference in mean SR was observed among different etching times, with FP4 showing significantly higher SR than other times, as detailed in Table 2 and Figure 1, 2.

3.2.2. Effect of Ceramic Type

A significant difference in surface roughness (SR) was evident between different categories at each time point ($p < 0.05$). Specifically, LR1 exhibited significantly less SR than the other groups. Subgroups FP2 and FP3 demonstrated significantly higher SR than LD2, LR2, LD3, and LR3 respectively ($p < 0.05$). Notably, LD4 displayed significantly lower SR compared to the other groups, as detailed in Table 1.

Table 1: Mean Flexural Strength at Different Etching Times

Group	Time	Mean Flexural Strength	Std. Deviation	p-value*
IPS e.max (LD)	0 sec	$338.44^{a, b}$	22.77	0.000
	20 sec	313.86^{c}	31.58	
	60 sec	278.55^{a}	26.41	
	90 sec	$254.52^{b, c}$	35.60	
IPS Empress (LR)	0 sec	128.86	16.67	0.346
	20 sec	119.00	15.53	
	60 sec	120.83	17.71	
	90 sec	116.31	13.79	
CEREC blocs (FP)	0 sec	105.01	8.35	0.142
	20 sec	101.58	13.67	
	60 sec	96.35	15.16	
	90 sec	92.95	10.49	

*The superscript letters represent important differences between relevant etching times in each ceramic type.

Table 2: Mean Surface Roughness in Different Etching Times

Group	Time	Mean Surface Roughness	Std. Deviation	p-value*
IPS e.max (LD)	0 sec	0.0885[a]	0.0113	0.000
	20 sec	0.1057[a]	0.0311	
	60 sec	0.1597	0.0279	
	90 sec	0.2153	0.0103	
IPS Empress (LR)	0 sec	0.06830[a]	0.0131	0.000
	20 sec	0.0880[a]	0.0368	
	60 sec	0.1842	0.0579	
	90 sec	0.3327	0.0147	
CEREC blocs (FP)	0 sec	0.0945	0.0329	0.000
	20 sec	0.2115	0.0543	
	60 sec	0.2971	0.0604	
	90 sec	0.3600	0.0228	

*The superscript letters represent non-significant variations between relevant etching times in each ceramic type.

Table 3: Mean and SD of Flexural Strength and Surface Roughness of Different Groups

Time	Group	Mean Flexural Strength	Std. Deviation	p-value*	Mean Surface Roughness	Std. Deviation	p-value*
0	IPS e.max	338.44[a, b]	35.60	0.000	0.0885[a]	0.0103	0.004
	IPS Empress	128.86[a]	13.79		0.06830[a, b]	0.0147	
	CEREC blocs	105.01[b]	10.49		0.0945[b]	0.0228	
20	IPS e.max	313.86[a, b]	22.77	0.000	0.1057[a]	0.0113	0.000
	IPS Empress	119.00[a]	16.67		0.0880[b]	0.0131	
	CEREC blocs	101.58[b]	8.35		0.2115[a, b]	0.0329	
60	IPS e.max	278.55[a, b]	31.58	0.000	0.1597[a]	0.0311	0.000
	IPS Empress	120.83[a, c]	15.53		0.1842[b]	0.0368	
	CEREC blocs	96.35[b, c]	13.67		0.2971[a, b]	0.0543	
90	IPS e.max	254.52[a, b]	26.41	0.000	0.2153[a, b]	0.0279	0.000
	IPS Empress	116.31[a, c]	17.71		0.3327[a]	0.0579	
	CEREC blocs	92.95[b, c]	15.16		0.3600[b]	0.0604	

*The superscript letters represent significant differences between relevant groups in each etching time.

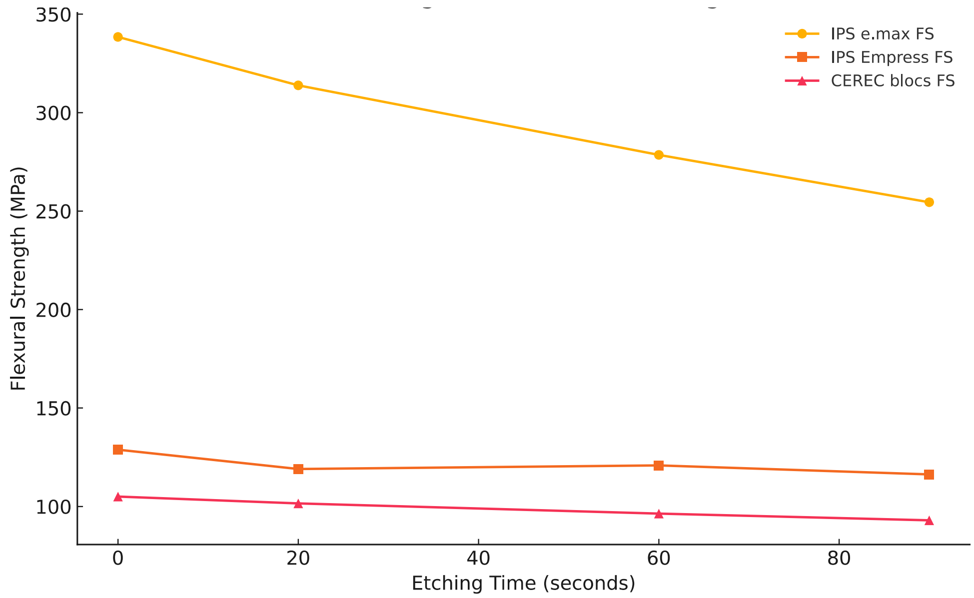

Figure 1: Flexural Strength at Different Etching Times

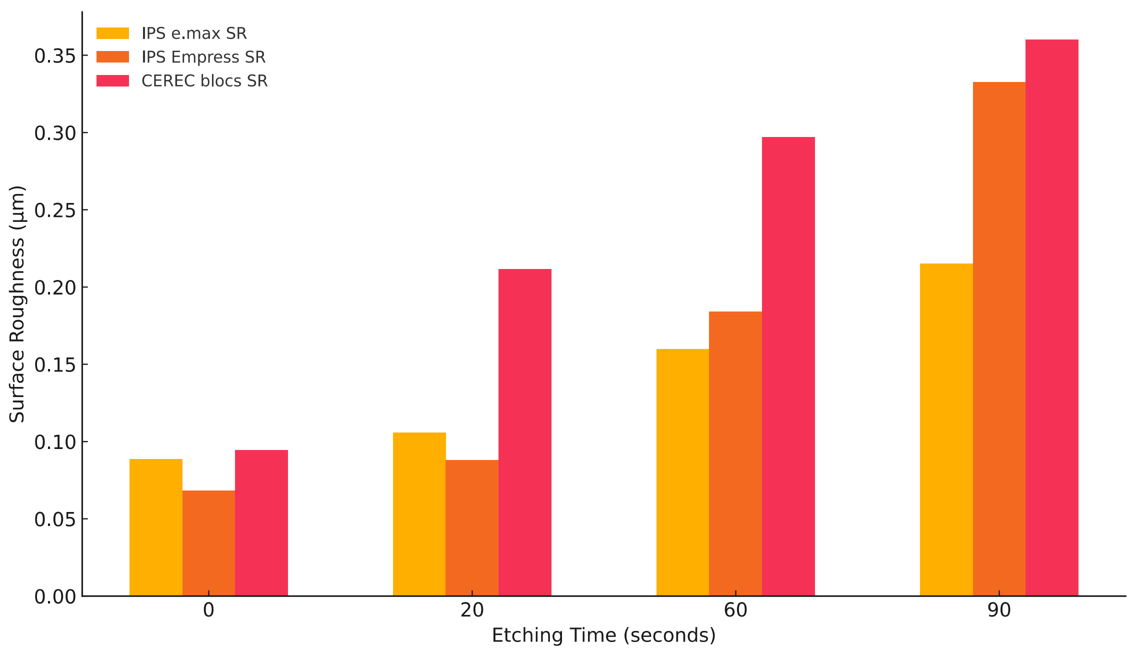

Figure 2: Surface Roughness at Different Etching Times

3.3. Shear bond strength (SBS)

3.3.1. Effect of etching time

There was a significant difference in mean shear bond strength (SBS) between different etching times in each group of material ($p<0.05$) (Table 5). In the LD1 group, SBS was significantly lower than in LD2 and LD3. ($p<0.05$). The LR2 showed significantly greater SBS than LR3 ($p<0.05$). The FP3 group showed significantly higher

SBS than FP1 and FP2, respectively ($p<0.05$), as shown in Figure 3.

3.3.2. Effect of type of ceramic

There was a significant variation in the average SBS between the various groups. at all etching times ($p<0.05$), as shown in Table 6. The LD1 and LR1 show considerably greater SBS than FP1 ($p<0.05$). Also, LD2 and LR2 show significantly higher SBS than FP2 ($p<0.05$), and LD2 shows significantly more SBS than LR2 ($p<0.05$). The LD3 shows significantly greater SBS than LR3 and FP3, respectively ($p<0.05$), as shown in Figure 3

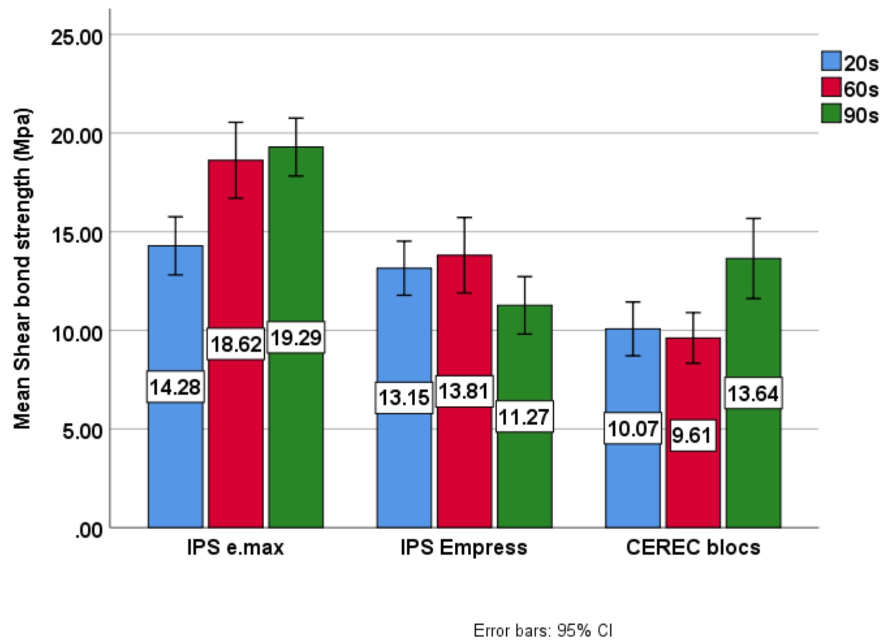

Figure 3: Bar chart of SBS in different groups and time

Table 5: Mean and SD of SBS after different etching times

group	Time	N	Mean	Std. Deviation	p-value*
IPS e.max (LD)	20 sec	10	14.28[a,b]	2.06	**0.000**
	60 sec	10	18.62[a]	2.69	
	90 sec	10	19.29[b]	2.05	
IPS Empress (LR)	20 sec	10	13.15	1.91	**0.045**
	60 sec	10	13.81[a]	2.67	
	90 sec	10	11.27[a]	2.03	
CEREC blocs (FP)	20 sec	10	10.07[a]	1.91	**0.001**
	60 sec	10	9.61[b]	1.80	
	90 sec	10	13.64[a,b]	2.84	

*One-way ANOVA. Identical superscript small letters represent significant differences between relevant etching times in each group.

Table 6: Mean and SD of SBS of different ceramic groups.

Time	group	N	Mean	Std. Deviation	p-value*
20 second	LD	10	14.28^{a}	2.06	**0.000**
	LR	10	13.15^{b}	1.91	
	FP	10	$10.07^{a,b}$	1.91	
60 second	LD	10	$18.62^{a,b}$	2.69	**0.000**
	LR	10	$13.81^{a,c}$	2.67	
	FP	10	$9.61^{b,c}$	1.80	
90 second	LD	10	$19.29^{a,b}$	2.05	**0.000**
	LR	10	11.27^{a}	2.03	
	FP	10	13.64^{b}	2.84	

*One-way ANOVA. Identical superscript small letters represent significant differences between relevant groups at each time.

4. DISCUSSION

The mechanical strength of brittle materials, such as ceramics, is a critical factor influencing their performance. Various factors, including HF acid etching, can significantly affect the durability of ceramics [24]. HF etching action has been proven to increase mechanical interlocking between resin cements and ceramics due to surface microporosity, allowing cement penetration and thus promoting restoration retention. This difference may be attributed to various test settings, polishing techniques, specimen size, or testing protocols, considering the speed applied to measure ceramic strength. Etching of ceramic surfaces takes place dynamically with respect to etching time, surface topography, and acid concentration, among other factors, as cited by Bona et al. in 2002 and Addison et al. in 2007 [25, 26].

Since HF acid etching was introduced as a ceramic surface pretreatment for resin bonding, many researchers have investigated the relationship between the etching times and bond strength. A long etching time usually is associated with both higher bond strength and higher ceramic surface roughness. However, different studies reported conflicting results. Some studies have reported that HF acid etching does not significantly reduce the flexural strength in ceramics, while others indicate that different times and concentrations of acid etching can reduce the flexural strength in several types of ceramics. According to Addison et al., changes in the glass matrix with etching time can cause the creation of defects that result in changes in the dynamics of crack propagation, leading to fracture under smaller loads. However, Chapman and Fuller Jr. state that the etching processes can often strengthen ceramics because surface cracks that exist have been blunted during etching, thereby eliminating or deactivating the defects while lowering stress concentrations.

In this study, IPS e.max ceramic exhibited significantly higher flexural strength compared to IPS Empress or CEREC blocs across all groups. This difference may be related to the quantity, size, nature, crystalline phase distribution, and shape in the ceramics. The elongated lithium disilicate crystals in IPS e.max likely act as an interlocking structure, enhancing flexural strength. The study also found significant variation in flexural strength among different etching times for IPS e.max, with 20 seconds showing higher strength than 90 seconds, and 0 seconds showing higher strength than 60 and 90 seconds.

Surface roughness measurements revealed noticeable variations among the different groups at each time point, except at 0 seconds. CEREC blocs exhibited higher surface roughness than e.max and Empress at certain etching times. This aligns with previous research suggesting that increasing etching time leads to higher surface roughness for certain ceramics, particularly feldspathic and leucite-reinforced ceramics. The dissolution of glassy crystals in these ceramics through HF acid etching may contribute to this phenomenon.

This investigation partially accepted the third hypothesis, which suggested that the SBS between ceramic and resin cement would change depending on the time that HF etching and differing ceramic materials. When compared to the values associated with more extended etching periods the mean results demonstrated that lower values for SBS were obtained for smaller etching times for LD and FP groups, with a statistically significant difference. In contrast to more extended etching periods, lower HF acid etching periods showed minor vitreous phase dissolution. As the roughness of the ceramic surface directly impacts the shear bond strength, this is probably explained by the existence of diminished microporosities, which promote the lower level of contact between the resin cement and ceramic surface, leading to less mechanical interlocking and smaller bond strengths [27]. However, the LR group demonstrated that etching times greater than sixty seconds resulted in a significant reduction in SBS. Barghi and colleagues (2006) found that samples etched with HF gel for 90–180 seconds as opposed to 60 seconds resulted in lower bond strengths for a leucite-reinforced ceramic [28]. Longer etching durations may result in stronger bonds, but only to a certain extent; beyond that, longer etching times may weaken bonds. This could be explained by crystalline residue accumulating on the ceramic surfaces [29] and the deeper dissolving depth brought about by longer etching times is linked to inadequate resin cement penetration because of its high viscosity, resulting in an uneven cement-ceramic interface. Due to their fragile nature, ceramics may lose some of their mechanical strength if certain regions are left unfilled [30] using main approaches: Two potential areas of stress concentration are (i) the pronounced geometry of the empty channels and (ii) the delicate void area beneath the cement-ceramic entanglement, which could concentrate stress under mechanical loading [28, 31, 32]. Other studies showed contrasting results. This research revealed that increased HF concentrations strengthened the link between resin cement and disilicate ceramic, but no significantly differentiable results were obtained for leucite-reinforced ceramics [33].

When using the same etching time. LD had the highest bond strength values than other materials. The LR had higher SBS than the FP at 20 and 60 conditioning times. Similar results were found by Kansu and others and Verissimo and others [9, 34], who found that SEM scans revealed distinct ceramic surface topographies, with the treated groups having much more irregularities than the group that was not treated.

Regardless of the surface conditioning period, the LD exhibits significantly greater bond strengths and superior mechanical qualities due to its increased crystalline phase

(70% ± 5%) compared to the LR and FP. This finding appears to support the theory that the ceramic microstructure has an essential influence on the resin-ceramic adhesion zone's fracture resistance [34].

4.1 Clinical Significance and Relevance

The results of this study have significant clinical implications. Understanding the optimal HF etching time for different ceramic materials can help dental practitioners enhance the longevity and performance of ceramic restorations. The findings indicate that a one-size-fits-all approach to HF etching is not suitable; instead, specific etching times should be selected based on the type of ceramic material used. For instance, a 20-second etching time for IPS e.max yields better flexural strength compared to longer etching times, which is crucial for ensuring the durability of restorations.

4.2 Study Limitations

Although the study provides valuable insights, it is crucial to recognize its limitations. The experimental assessment utilizing the 3-point bending test may not completely simulate real-life scenarios encountered by medical professionals. Also, other factors that may affect the strength of the sample are the luting resin cement used. One more limitation is that only one concentration of HF acid was used; therefore, further studies will be useful to determine the effect of cyclic loading on ceramics.

5. CONCLUSION

This was an in vitro study on the surface roughness and flexural strength evaluation of feldspathic, leucite-reinforced, and lithium disilicate ceramics at different etching times with hydrofluoric acid. The results showed that IPS e.max ceramics are of higher flexural strength compared to IPS Empress and CEREC blocks. It emerged that 20 seconds was the duration considered for HF etching. Its surface roughness increased with increasing time for all tested materials, and CEREC blocks were the roughest.

The results have direct implications for clinical practice. That is, individualization of HF etching protocols, based on the ceramic material being used, may lead to more appropriate conditions to increase durability and performance of restorations. For instance, it recommended 20-second etching time for IPS e.max to ensure flexural strength. Etching time should be monitored with caution to prevent excessive roughening or reduced strength.

Future studies on different etching protocols, ceramic compositions, and acid viscosities will have to be conducted to understand the complete interaction of these variables with flexural strength and surface roughness. Also, it would be advisable to investigate the effects of cyclic loading on these materials. This study gives further evidence on the appropriateness of HF etching protocols for different ceramic materials and thus should help dental practitioners optimize clinical procedures for ceramic restorations and their long-term durability and performance.

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تأثير زمن النقش بحمض الهيدروفلوريك على القوة الانحنائية وخشونة السطح لمواد السيراميك المختلفة المستخدمة في الترميمات السنية

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الملخص

الخلفية والأهداف: تبحث هذه الدراسة في تأثير أوقات الحفر المختلفة بحمض الهيدروفلوريك (HF) على القوة الانحنائية (FS)، وخشونة السطح (SR)، وقوة الربط بالراتنج (SBS) لثلاثة مواد خزفية مختلفة مصنعة بتقنية CAD/CAM: الفلدسباثيك (CEREC blocs CPC)، المعزز بالليوسيت (IPS Empress CAD)، ودي سيليكات الليثيوم (IPS e.max CAD).

منهجية الدراسة: تم إعداد العينات وتقسيمها إلى مجموعات بناءً على نوع المادة وخضعت لأوقات حفر مختلفة (20، 60، و 90 ثانية) تلاها تنظيف بالموجات فوق الصوتية، ودورات حرارية، وتطبيق مادة السيليان واللاصق حيثما ينطبق. تم قياس FS و SR باستخدام اختبار الانحناء ثلاثي النقاط وجهاز قياس الخشونة على التوالي. تم تقييم SBS بعد بناء أسطوانة من أسمنت الراتنج اللوتينج على السطح الخزفي المحفور والمسيلين، تلاها دورات حرارية.

النتائج: كشفت النتائج أن تمديد وقت الحفر بحمض الهيدروفلوريك يقلل بشكل كبير من FS لمجموعة دي سيليكات الليثيوم فقط، مما يشير إلى تأثير يعتمد على المادة. زادت SR مع زيادة أوقات الحفر عبر جميع المواد، مما يشير إلى أن وقت الحفر يؤثر بشكل مباشر على نسيج السطح. تفاوتت SBS بشكل كبير مع مدة الحفر؛ لا سيما، تحسنت SBS للمواد الفلدسباثية ودي سيليكات الليثيوم مع أوقات الحفر التي تزيد عن 60 ثانية، بينما انخفضت SBS للمواد المعززة بالليوسيت.

الاستنتاج: تؤكد الدراسة على الدور الحاسم لمدة الحفر بحمض الهيدروفلوريك في تحسين الخصائص الميكانيكية وقوة الربط للمواد الخزفية المستخدمة في الترميمات السنية. وتبرز ضرورة اختيار أوقات الحفر المناسبة لتعزيز الأداء السريري للترميمات الخزفية، مع تفضيل مدد محددة لمواد مختلفة. توفر هذه الدراسة رؤى قيمة لممارسي طب الأسنان الذين يسعون لتحسين طول عمر ومصداقية الترميمات السنية الخزفية.

الكلمات الدالة: القوة الانحنائية، خشونة السطح، المواد الخزفية، الترميمات السنية.