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**Mohamed Mahmoud Shenawy Gad Ali**
Fixed prosthodontics, Faculty of Dentistry, Cairo University, Cairo, Egypt

**Omnia Mohamed Abd-Elhamed Al-Shehy**
Professor of Fixed Prosthodontics, Faculty of Dentistry, Cairo University, Cairo, Egypt

**Samaa Nagy Kotb**
Lecturer of Fixed Prosthodontics, Faculty of Dentistry, Cairo University, Cairo, Egypt

**Corresponding Author:**
**Samaa Nagy Kotb**
Lecturer of Fixed Prosthodontics, Faculty of Dentistry, Cairo University, Cairo, Egypt

# Effect of surface finish and acidic medium on hardness and fracture toughness of zirconia reinforced lithium silicate (An *In-vitro* study)

**Mohamed Mahmoud Shenawy Gad Ali, Omnia Mohamed Abd-Elhamed Al-Shehy and Samaa Nagy Kotb**

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**Abstract**
**Aim:** To assess the effect of surface finish and acidic beverage (cola beverage) on hardness and fracture toughness of zirconia lithium silicate (Celtra press)
**Methodology:** Total of n=36 samples of zirconia reinforced lithium silicate (Celtra press) plates were divided into two main groups (n=18 glazed samples and n=18 polished samples) and then each group was subdivided into two equal groups according to immersion solution (artificial saliva & cola beverage). Surface hardness and facture toughness measurements were obtained for each specimen, before and after storage in the solutions. Surface micro hardness was measured by Vicker Micro-hardness tester. The fracture toughness was measured by using the indentation method.
**Results:** For Vickers hardness results: For Glazed group, it was found that the values of Vickers hardness were recorded before immersion subgroup followed by artificial saliva immersed subgroup while the lowest values were recorded with Cola immersed subgroup. For Polished group, it was found that the highest values of Vickers hardness were recorded before immersion subgroup followed by artificial saliva immersed subgroup while the lowest values were recorded with Cola immersed subgroup. For fracture toughness results: For Glazed group, it was found that the highest values of fracture toughness were recorded before immersion subgroup followed by artificial saliva immersed subgroup while the lowest values were recorded in Cola immersed subgroup. For Polished group, it was found that the highest values of fracture toughness were recorded before immersion subgroup followed by artificial saliva immersed subgroup while the lowest values were recorded in Cola immersed subgroup.
**Conclusion:** Ageing in acidic medium negatively affected both the surface hardness and the fracture toughness for Celtra press and polished Celtra press had prominent hardness and fracture toughness compared to auto-glazed Celtra press.

**Keywords:** Celtra press, hardness, fracture toughness, hydrothermal aging, acidic medium and artificial saliva

## 1. Introduction
In recent years, all ceramics materials are showing high improvement in their mechanical, clinical and esthetic properties, making their utilization increase in dental restorations [19]. Ceramics are inert and biocompatible materials which can be used safely in the oral cavity, however they are brittle material and prone to fracture [34]. The science of fracture mechanics examines how cracks propagate and how materials respond to that process, making the strength is insufficient when there is likelihood of cracks especially in brittle materials. Dental ceramics have inherent flaws which randomly distributed in this brittle material, these defects act as stress concentrators. All ceramics materials can be classified according to fabrication technique into 1. Free hand layering technique, 2. Heat pressing of ingots into a mold and 3. Machining of blocks or disks [49]. According to Mously *et al*., 2014, heat pressing technique is showing the best internal crown adaptation and marginal fit than machining (CAD/CAM) technique, however some authors stated that the marginal gap difference between them is non-significant especially with the continuous improvement in the machining technology. Hardness is the resistance to surface indentation and scratching, which is a crucial clinical quality for

maintaining surface smoothness and avoiding plaque accumulation, soft tissue irritation, wear of the opposing dentition and resistance to discoloration. Fracture toughness is resistance to fracture or resistance to crack propagation. So hardness and fracture toughness are considered important factors for long term success of any restoration. But all dental ceramics have inherent imperfections that negatively affect mechanical properties including surface hardness and facture toughness, which make them highly susceptible to fracture and affect whether ceramic restorations are successful or unsuccessful clinically [13]. The oral cavity is a challenging environment for the ceramic restoration because of the regular fluctuation of potential hydrogen (PH) level and temperature changes. The compositions, PH of the environment, temperature, and length of exposure all have an impact on the stability of the various ceramic restorations in the oral cavity [50]. Celtra press is zirconia reinforced lithium silicate glass ceramic, the combination of lithium silicate and zirconia containing glass ceramic in the new material makes excellent material quality in optical and mechanical properties [20]. Many authors have researched the influence of polishing and glazing on the mechanical properties of ceramics; however, there is still disagreement over the best procedure for producing a smooth and strong surface [41].

## 2. Materials and Methods

### 2.1 Samples fabrication

Celtra press ingots were used for fabrication of plates through heat pressing, plates was with dimensions 3x12x14mm, thickness of the plates is 3mm which allow indentation test without fracture of the sample according to the 10% rules which include that samples thickness should be 10 times more than the indentation depth to allow accurate and correct testing procedure to ensure standardization of thickness of specimens, thickness and the width of the each specimen will be measured using a caliper. And to standardize the dimensions of the wax pattern using metal model with the dimensions 3x12x14mm (figure 1).

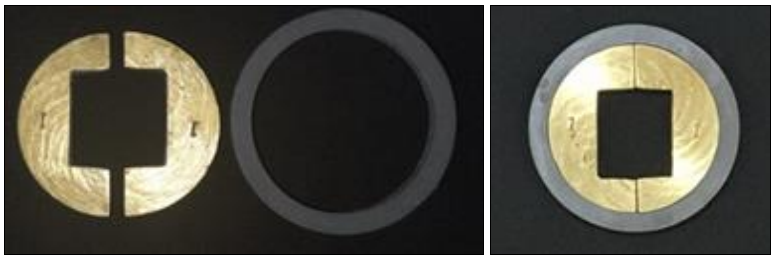

**Fig 1:** Metallic model to standardize the dimensions of the ceramic samples

### 2.2 Pressing procedure

After fabrication the wax pattern with the dimensions 3x12x14 mm by using metallic model for standardize the dimensions, and then spring the wax pattern. Then, fixing the wax pattern inside the investment ring, for investing using Celtra press investment (Phosphate bonded investment consist of silica, magnesium oxide and ammonium phosphate) which is finely structured and homogenous surface and prevent the formation of reaction layer this eliminates the additional acid washing and sandblasting step then pouring the investment material into the muffle using gentle vibration. After a setting time of 20 minutes from the start of mixing we remove the ring gauge, muffle base and the investment ring, placing the muffle in the furnace at 850 degrees Celsius for 45 minutes, placing the Celtra press ingots (shade LT A2) in the muffle and placing the alox pluger. The pressing furnace should already be preheated to the corresponding base temperature (700 degree Celsius) and adjust the appropriate pressing program (starting temperature was 700 degree Celsius with heating rate 40 °C per min and the final temperature was 860 °C, holding time was 30 min and pressing time was 3min) which recommended by manufacture for best result, once the furnace reach to the starting temperature of 700 degree Celsius we Placing the entire assembly in the Ceramic pressing Furnace and start the program in which the final temperature is 850 degree Celsius according to the manufacture, after completion of the pressing procedure the muffle is removed and placed on heat proof surface and allow to cool to room temperature.

### 2.3 Samples grouping

Allocation concealment mechanism: All the specimens were numbered from (1-36) and placed in envelopes which were properly sealed, opaque and numbered. Implementation: All the steps were done by the investigator under supervision and for ageing procedures the specimens were placed in testing tubes and stored in an incubator. Randomization: After the samples were numbered they were randomly divided into 4 equal groups by the website (http//www.random.org). Allocation of samples: Samples were divided into 2 equal main groups (18 samples for auto glazed and 18 samples for polished), each group subdivided into 2 equal subgroups (9 samples for immersion in acidic beverage and 9 samples for immersion in artificial saliva).

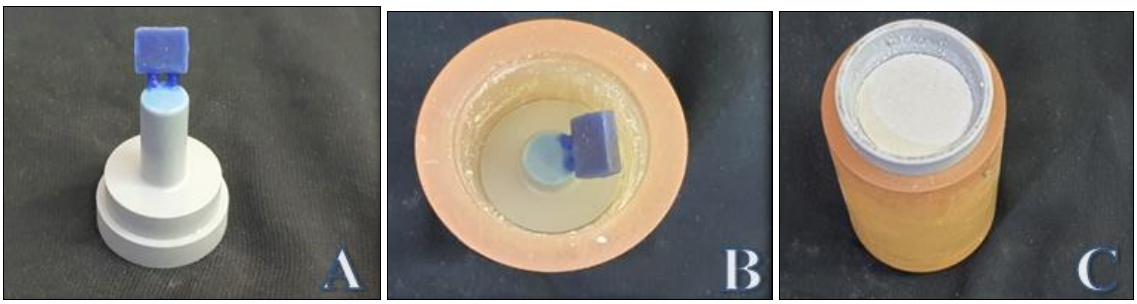


**Fig 2:** A: Wax pattern with the sprue (frontal view), B: Wax pattern after fixing inside the investment ring, C: After pouring the Celtra press investment material


**Fig 3: A:** Placing the muffle in the furnace at 850 degree Celsius for 45 minute, B: Placing the entire assembly in Ceramic pressing Furnace, C: Adjusting the mode of furnace for Celtra press program

**3-Samples preparation**

**3.1 Polishing procedure**

Half of the specimens (polished group) (18 plates) were finished using a coarse grit diamond stone and then polished using polishing technique with 2 steps by single operator. Using a low-speed handpiece without water cooling based on the guidelines that the manufacturer has provided at 10,000 rpm and 6,000 rpm for each step for 60 seconds for each plate. The samples then cleaned with distilled water by using ultrasonic cleaner.

**3.2 Auto glazing procedure**

Other specimens (Glazed group) (18 plates) were auto glazed. The pressing furnace should be preheated for 400 degree Celsius, then placing the ceramic plate on honeycomb tray in the furnace at final temperature 750 degree Celsius for 2 minutes

**4-PH measurement**

PH of the artificial saliva and cola beverage will be measured using PH Meter, all the PH measurements will be performed three times to avoid any error.


**Fig 4:** PH meter measure the PH of artificial saliva is 7.2, PH of cola beverage is 3

**5-Ageing procedure**

Half of polished and glazed samples were stored in cola beverage (acidic medium) for 8 hours at 37 degrees Celsius in the incubator which simulate 2 years *In vivo* (Demierl *et al*., 2005). The other half of polished and glazed samples were stored in artificial saliva in properly sealed testing tubes for 14 days at 37°C in an incubator which also simulate 2 years *In vivo* (Hwang *et al* 2001); the artificial saliva was changed twice daily. Prior to measuring surface micro-hardness and fracture toughness, samples were cleaned for five minutes with distilled water, then were wiped dry with tissue paper.

**5-Measurement of surface hardness and Fracture toughness**

Surface microhardness and facture toughness measurements had been assessed for each specimen, before and after storage in the solutions. Micro hardness of the specimens was assessed using a Vickers Microhardness Tester with a Vickers diamond indenter and a 25X objective lens. The specimens' surfaces were subjected to a 200g stress for 15 seconds. Three indentations had been made, evenly spaced around a circle and not more than 0.5 mm apart from one another. By using the built-in scaled microscope to quantify the indentations' diagonal lengths, values of Vickers were transformed to values of microhardness. The microhardness was calculated using the formula:

HV=1.854 P/d2

P is the load in Kgf, d is the length of the diagonals in mm, and HV is Vicker microhardness in Kgf/mm2.

**Fig 5:** Vicker Tester with diamond indenter

**Fig 6:** Vickers Micro-hardness Tester**Fracture toughness**

Indentation technique was used for measuring fracture toughness. It is depend on crack that develop around the indenter at time of the brittle material is subjected to intense pressure. The cracks created at corners of the indenter when seen from above. These cracks' surface dimension "c," which expresses their size, grows larger with increasing indentation loads and is inversely related to fracture toughness. The fracture toughness was calculated using the formula (Fahmy *et al*., 2009) below:

$$KIC = 0.016(E/H)^{0.5} (P/c^{1.5})$$

KIC is the fracture toughness, c is the crack length (measured from the center of the indentation), P is the applied indenter load, H is the Vickers hardness, and E is the elastic modulus for zirconia reinforced lithium silicate = (70.44 ± 1.97 GPa).

Crack length was assessed by using microscope at magnification 25x, then the image sent to image analysis software program within image J software, all parameters will expressed in form of pixels. So the calibration had been done by converting the pixels to real units. In order to calibrate, a known-size object (in this instance, a ruler) was compared with a scale produced by the software. The unit of the crack length was in (mm). Crack should be measured immediately to avoid recovery of the cracks after unloading.

**Results**

The results were analyzed using Graph Pad Instat (Graph Pad, Inc.) software for windows. A value of $P \leq 0.05$ was considered statistically significant. Continuous variables were expressed as the mean and standard deviation. After homogeneity of variance and normal distribution of errors had been confirmed, one-way analysis of variance was performed followed by Tukey's post-hoc test if showed significance. Paired t-test was done between main groups. Two-way ANOVA compared the effect of each factor (surface finish immersion solution). Sample size (n=18/group) was large enough to detect large effect sizes for main effects and pair-wise comparisons, with the satisfactory level of power set at 80% and a 95% confidence level.

**Vickers hardness (HV)**

Vickers hardness (HV) results (Mean±SD) for both groups before and after being submerged in treatment liquids were summarized in table (1) and figure (6).

For Glazed group, it was found that highest mean ± SD values of Vickers hardness were recorded before immersion subgroup (285.65±5.50 Kgf/mm$^2$) followed by AS immersed subgroup mean ± SD values (276.97±7.65 Kgf/mm$^2$) meanwhile the lowest mean ± SD values were recorded with Cola immersed subgroup (250.35±14.73 Kgf/mm$^2$). The difference among subgroups was statistically significant as indicated by ANOVA test followed by Tukey's post-hoc pair-wise tests (P=<0.0001<0.05).

For Polished group, it was found that the highest mean ± SD values of Vickers hardness were recorded before immersion subgroup (291.7±10.4 Kgf/mm$^2$) followed by AS immersed subgroup mean ± SD values (278.52±10.39 Kgf/mm$^2$) meanwhile the lowest mean ± SD values were recorded with Cola immersed subgroup (275.83±5.55 Kgf/mm$^2$). The difference between groups was statistically significant as proven by ANOVA test (P=0.0002<0.05). Tukey's post-hoc pair-wise tests showed non-significant (p > 0.05) difference between (AS and Cola) immersed subgroups.

**Glazed vs. Polished**

Before immersion, it was found that Polished group recorded statistically significant higher mean value (291.7±10.4 Kgf/mm$^2$) than Glazed group (285.65±5.50 Kgf/mm$^2$) as revealed with paired t-test (p = 0.0362 < 0.05).
AS immersed groups, it was found that Polished group recorded statistically non-significant higher mean value (278.52±10.39 Kgf/mm$^2$) than Glazed group (276.97±7.65 Kgf/mm$^2$) as indicated with paired t-test (p = 0.7230 > 0.05).
Cola immersed groups, it was found that Polished group recorded statistically significant higher mean value (275.83±5.55 Kgf/mm$^2$) than Glazed group (250.35±14.73 Kgf/mm$^2$) as proved with paired t-test (p = 0.0002 < 0.05).

**Table 1:** Vickers hardness results (Kgf/mm2) for both groups before and after being submerged in treatment liquids

| Variable | | Treatment solution | | | ANOVA test |
|---|---|---|---|---|---|
| | | Before | Artificial saliva | Cola | P value |
| Glazed | Mean± SD | 285.65$^A$±5.50 | 276.97$^B$±7.65 | 250.35$^C$±14.73 | <0.0001* |
| | 95% CI (low-high) | 283.11 - 288.19 | 271.97 - 281.97 | 240.72 - 259.97 | |
| Polished | Mean± SD | 291.7$^A$±10.4 | 278.52$^B$±10.39 | 275.83$^B$±5.55 | 0.0002* |
| | 95% CI (low-high) | 286.89 - 296.51 | 271.73 - 285.32 | 272.21-279.46 | |
| t-test | P value | 0.0362* | 0.7230 ns | 0.0002* | |

Different subscript letter in the same row indicating statistically significant difference between subgroups ($p$ < 0.05) CI; confidence intervals *; significant ($p$ < 0.05) ns; non-significant (p>0.05)

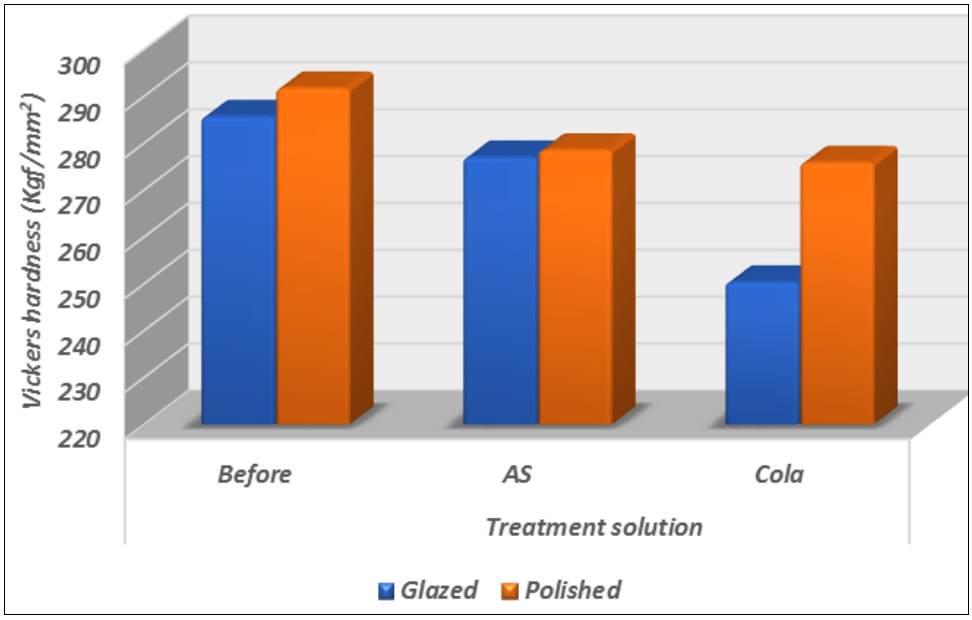


**Fig 1:** Column chart of the mean values of Vickers hardness for both groups before and after being submerged in treatment liquids

Total effect of main group (surface finish), regardless to immersion solution totally it was found that the differences between groups were statistically significant as revealed by two-way ANOVA test (p=0.004 < 0.05) where (Polished > Glazed).
Total effect of subgroups (immersion solution), irrespective of group totally it was found that immersion solutions significantly effect on mean values as revealed by two-way ANOVA test (p=<0.0001< 0.05) where (non-immersed > AS > Cola).

**Fracture toughness (MPa.m$^{1/2}$)**

Fracture toughness (MPa.m$^{1/2}$) results (Mean±SD) for both groups before and after immersion in treatment solutions were summarized in table (2) and figure (7).
For Glazed group, it was found that the highest mean ± SD values of fracture toughness were recorded before immersion subgroup (2.193±0.3403 MPa.m$^{1/2}$) followed by AS immersed subgroup mean ± SD values (2.043±0.1155 MPa.m$^{1/2}$) meanwhile the lowest mean ± SD values were recorded Cola immersed subgroup (1.6515±0.3989 MPa.m$^{1/2}$). The difference among subgroups was statistically significant as indicated by ANOVA test (P=0.0009 <0.05). Tukey's post-hoc pair-wise tests revealed non-significant (p > 0.05) difference between (before immersion and AS immersed) subgroups.
For Polished group, it was found that the highest mean ± SD values of fracture toughness were recorded before immersion subgroup (2.4501±0.3533 MPa.m$^{1/2}$) followed by AS immersed subgroup mean ± SD values (2.3756±0.2129 MPa.m$^{1/2}$) meanwhile the lowest mean ± SD values were recorded Cola immersed subgroup (2.3066±0.3141 MPa.m$^{1/2}$). The difference between groups was statistically non-significant as proven by ANOVA test (P=0.5302 > 0.05).

**Glazed vs. Polished**

Before immersion, it was found that Polished group recorded statistically significant higher mean value (2.4501±0.3533 MPa.m$^{1/2}$) than Glazed group ((2.193±0.3403 MPa.m$^{1/2}$) as revealed with paired t-test (p = 0.0330 < 0.05).
AS immersed groups, it was found that Polished group recorded statistically significant higher mean value (2.3756±0.2129 MPa.m$^{1/2}$) than Glazed group (2.043±0.1155 MPa.m$^{1/2}$) as indicated with paired t-test (p = 0.0008 < 0.05).
Cola immersed groups, it was found that Polished group recorded statistically significant higher mean value (2.3066±0.3141 MPa.m$^{1/2}$) than Glazed group (1.6515±0.3989 MPa.m$^{1/2}$) as proved with paired t-test (p = 0.0014 < 0.05).

**Table 2:** Fracture toughness results (MPa.m$^{1/2}$) for both groups before and after being submerged in treatment liquids

| Variable | | Treatment solution | | | ANOVA test |
|---|---|---|---|---|---|
| | | Before | Artificial saliva | Cola | P value |
| Glazed | Mean±SD | 2.193$^{A}$±0.3403 | 2.043$^{A}$±0.1155 | 1.6515$^{B}$±0.3989 | 0.0009* |
| | 95% CI (low-high) | 2.0358-2.3503 | 1.9676-2.1185 | 1.3909-1.9122 | |
| Polished | Mean±SD | 2.4501$^{A}$±0.3533 | 2.3756$^{A}$ ±0.2129 | 2.3066$^{A}$±0.3141 | 0.5302 ns |
| | 95% CI (low-high) | 2.2869-2.6133 | 2.2365-2.5147 | 2.1014-2.5118 | |
| t-test | P value | 0.0330* | 0.0008* | 0.0014* | |

Different subscript letter in the same row indicating statistically significant difference between subgroups ($p < 0.05$)
CI; confidence intervals *; significant ($p < 0.05$) ns; non- significant ($p > 0.05$

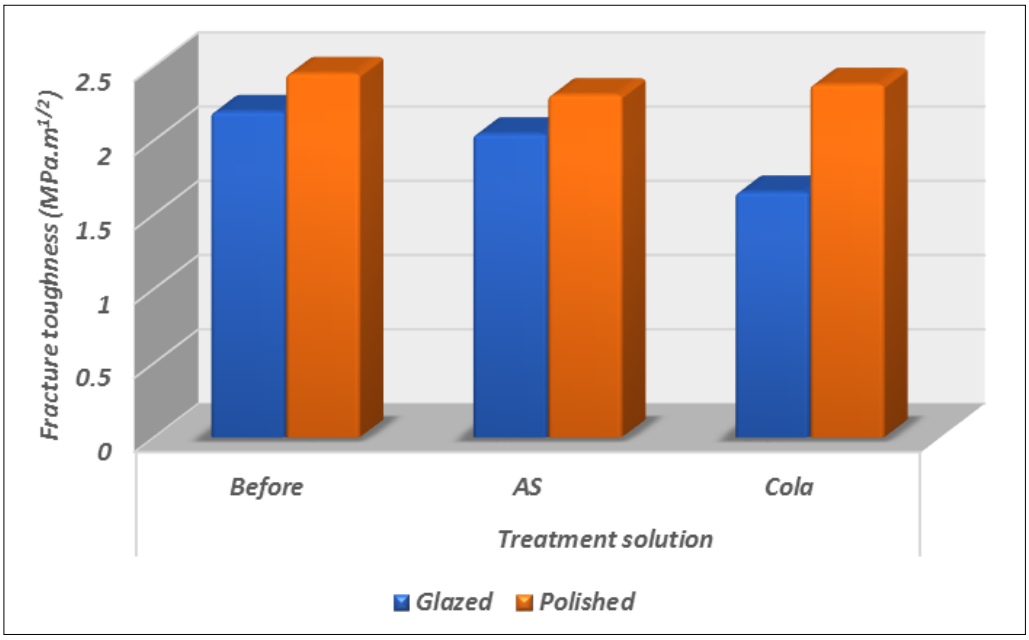


**Fig 7:** Column chart of the mean values of fracture toughness for both groups before and after being submerged in treatment liquids

Total effect of main group (surface finish), regardless to immersion solution totally it was found that the differences between groups were statistically significant as revealed by two-way ANOVA test (p=0.0001 < 0.05) where (Polished > Glazed).

Total effect of subgroups (immersion solution), irrespective of group totally it was found that immersion solutions significantly effect on mean values as revealed by two-way ANOVA test (p=0.0016< 0.05) where (non-immersed ≥ AS > Cola).

N.B. non-immersed ≥ AS; statistically non-significant higher.

## Discussion

Celtra press is type of glass ceramic, its composition is zirconia reinforced lithium silicate, can be used for fabrication dental restoration e.g. inlay, onlay, overlay, partial coverage crown, veneer, crowns and also crowns for implant abutment [25]. Celtra press is a multiphase ceramic made of glassy matrix and crystals of lithium silicate, and nanoscale crystals of lithium-phosphate. It also contains 10% zirconia oxide, which is completely dissolved in glass phase [25]. Fracture toughness is an important factor for dependability evaluation for ceramic materials however; high fracture toughness of ceramics is not only important for prevention of crack initiation or propagation but is also responsible for the prevention of breakdown of the margin and responsible for wear resistance. All dental ceramics have inherent surface flaws that degrade the mechanical properties. One of the significant ceramic qualities that may be measured is hardness. Its value aids in defining resistance to scratches and deformation [10]. The use of *in-vitro* models was advantageous because it has been established that an increase in consumption frequency is correlated with an increase in the degradative potential of many foods and beverages, due to variety in intraoral environments, *In vitro* models are important for understanding the fundamental mechanisms of biodegradation. The dimensions of the plates used in this study were 3x12x14mm, thickness of the plates was important to be 3mm according to Eugene *et al*., 2007, who reported that the thickness of the ceramic plates used should be 3mm which allowed indentation test without fracture of the samples according to the 10% rule which includes that the sample thickness should be 10 times more than the indentation depth to allow accurate and correct testing procedures. So plates' dimensions were verified by digital caliper after fabrication. All samples were fabricated according to the instructions of manufactured, using the light blue modeling wax which exhibits optimum hardness and characterized by high positioning accuracy, and using Dentsply Sirona's Celtra press investment which characterized by smooth surface, minimal reaction layer and rapid heating (saving time). The pressing program was used (starting temperature was 700 degree Celsius with heating rate 40 °C per min and the final temperature was 860 °C, holding time was 30 min and pressing time was 3min) as recommended by the manufacture and used before by Hallmann *et al*., 2019. Surface smoothness was achieved by finishing the samples because if the surface roughness is larger than the indentation depth, may lead to inaccurate results [7]. Polishing of the ceramics decrease the imperfections and flaws on the surface of the ceramics which is inhibiting the propagation of the crack. And also polishing of the ceramics creates residual compressive stresses that

inhibit the growth of the crack as suggested by Alkhiary *et al*., 2003. The term auto glazing is a layer of thin thickness about four micrometer of glass formed at 2 minute hold time at final temperature, which decrease size of defects on ceramic surface and seal the cracks but it easily removed from the surfacetro, less resistance to indentation and low resistance to masticatory force (Thaworanunta *et al*., 2019). Several authors like SaikiO *et al*, LevyH *et al*. and Sulik WD *et al*. investigated and described various ceramic restoration polishing processes, they advocated that polishing can be used as an alternative to glazing with greater strength values. It was reported that ceramics had lower sensitivity to blunt indentations compared to sharp indentations made by Vickers indenter. And also because all ceramic crown failure is thought to be mostly caused by radial cracking, which most frequently affects the ceramics [9]. According to Karl-Johan *et al*., 2022 the amount of load used in the tests was constant for ceramic materials which were a load of 200 g for 15 second. The changes in the micro hardness were assessed to determine the degradation of dental materials subjected to various pH solutions. Also can be used for determine the fracture toughness via technique of indentation. The indentation fracture toughness (IF) equations had been frequently utilized to obtain the fracture toughness (KIC) of brittle materials [1]; Determining fracture toughness from equation make it more accurate [2]. Using this equation prevent the chipping for the samples which occur in other measuring techniques [3]. The error percentage by this equation is less than 10% which making it better method than other technique e.g. SEVNB, SENB and CNB [4]. The indentation technique had a number of benefits, including reproducible, simple, and nondestructive [20]. According to Awliya *et al*,.2010 drinking of acidic beverages like coffee and tea and soft drinks (Cola), alcoholic beverages and also fluoridated water affect on the micro hardness and fracture toughness of the ceramic materials, the effect depend on the inherent quality of ceramics and chemical composition. Therefore in our study we used Cola beverage as an acidic medium. The acidic medium used in this study is Cola beverage due to the fact that it is frequently consumed in daily life, there are 6.2 billion people on the earth and that each of them consumes at least one cola beverage product every four days, according to Slater, J. S. *et al*. 2001. According to Zhang *et al*., 2013 Ceramics materials undergo dynamic fatigue and stress corrosion which is surface degradation for the ceramic materials after exposure to aqueous environment, this reduce the energy required for crack propagation, making easy crack propagation and decrease in the material microhardness and fracture toughness. Chemical breakdown of the silica-oxygen bond (-Si-O-Si-) in ceramic material causes crack formation. The (-Si-O-Si-) network is theoretically disrupted and hydroxyl ions are produced as a result of water interacting at the crack tip. OH ions that are produced when the silicate bonds are hydrolyzed serve as catalysts, that is why we used artificial saliva in current study to evaluate its effect on microhardness and fracture toughness of pressed zirconia reinforced lithium silicate ceramics. The storage period for cola beverage was 8 continuous hours at 37 degree Celsius [10], while in artificial saliva for 14 days at 37 degree Celsius as it simulates 2 years in [17]. Although distilled water has often been used as a storage medium in *in-vitro* experiments, in this study artificial saliva had been used to resemble clinical settings, simulate the oral environment, and offer data that is more realistic [17]. So the results of current study showing decrease in the microhardness and also fracture toughness of Celtra press after aging which may be caused by two main possible mechanisms. First, breakage of silica-oxygen bond (Si-O-Si), at the crack tip water interact with the molecules and disrupt (Si-O-Si) bond and produce OH ions, so change in the composition of the material and various ions were leached out at the tip of the crack causing increase in crack length and decrease the hardness and fracture toughness. Second, to maintain the electrical neutrality hydrogen ions pass into the ceramics while loss of alkali ions from the ceramics into the aqueous solution. The leaching out of these ions from the ceramics were causing increase crack growth and decrease in the microhardness and fracture toughness, this results were coincided with previous study by Kukiattrakoon *et al*., 2010 who found that for the acetic acid and citrate buffer solution groups of all types of ceramics (VMK 95, Vitadur Alpha and IPS emax ceram), the microhardness values significantly decrease during the first 24 and 96 hours. The wet corrosion of alkali silicate glasses in acidic corrosive environments occurs because of selective loss of alkali ions and the decrease in PH value of the moisture environment causing more increase in the loss of the silicon from the glass network so increase in crack length and decrease fracture toughness and micro hardness, this explain significant and the more decrease in fracture toughness and microhardness values of Celtra press in acidic medium (cola beverage with PH = 3) compared to fracture toughness and microhardness values in the artificial saliva (PH = 7,2) [17]. According to the results of this study polished specimens had best microhardness and fracture toughness compared to auto glazed specimens regardless to immersion solutions. This may be because of a region of compressive stress is created during the polishing process. So during the crack propagation, the crack should overcome this compressive stress first before propagation, thereby preventing crack extension and improving hardness and fracture toughness as suggested by Incesu E *et al*., 2020. The results of the microhardness of artificial saliva immersed groups, it was found that polished group recorded statistically non-significant higher mean value than Glazed group, this results similar to results of previous study by Turken and Biskin *et al*., 2019 who suggested that alkali ions leached out process in the saliva was slow and leaded to creation of area of strongly hydrogen-bonded hydroxyl group on the outer surface. This area is thought to not be as rigid as full polymerized glass network, so material deform plastically instead of brittle fracture.

## Conclusion

Within the limitation of this *in vitro* study, the following conclusion can be drawn:

1. Ageing in acidic medium (Cola beverage) negatively impact both microhardness and fracture toughness for both polished and glazed zirconia reinforced lithium silicate (Celtra press)
2. Polished zirconia reinforced lithium silicate (Celtra press) has prominent hardness and fracture toughness and less crack length compared to auto-glazed Celtra press.
3. Patients with Celtra press restoration should be advised to decrease their consumption of acidic beverage like Cola beverages however these values accepted clinically.

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