Content available at: https://www.ipinnovative.com/open-access-journals

IP Annals of Prosthodontics and Restorative Dentistry

Journal homepage: https://www.aprd.in/

Original Research Article

# Comparative evaluation of wear resistance between lithium disilicates and polymer infiltrated ceramics manufactured by computer aided design (CAD) computer aided manufacturing (CAM) against natural tooth enamel

**Dendi Archita Reddy[1]*, K.Mahendranadh Reddy[1]**

[1] *Dept. of Prosthodontics Crown & Bridge and Implantology, Sri Sai College of Dental Surgery, Vikarabad, Telangana, India*

ARTICLE INFO

*Article history:*
Received 11-09-2023
Accepted 22-10-2023
Available online 04-12-2023

*Keywords:*
Lithium disilicates and polymer infiltrated ceramics
Computer aided design (Cad)
Computer aided manufacturing (Cam)
Natural tooth enamel

ABSTRACT

**Background:** Advances in CAD/CAM technology led to development of monolithic all ceramic restorations with superior esthetics like Lithium disilicate. But the major concern of ceramic materials was its wear towards the opposing enamel. Polymer infiltrated ceramics were developed by incorporating resin polymer in ceramics to produce esthetic stability of ceramics and low abrasive nature of composites and very few studies were done on this material.

**Materials and Methods:** A total of 30 disc specimens were fabricated by CAD/CAM .15 discs of CAD/CAM lithium disilicate (IPS E.max CAD) and 15 discs of Polymer infiltrated ceramics of dimensions 10mmx3mm. They were named as group 1 (CAD/CAM Lithium disilicate) and group 2(Polymer infiltrated ceramics). 30 tooth specimens were mounted on auto polymerising acrylic resin blocks. Tooth specimens were placed on the upper member of the two body wear testing machine (Pin on disc wear and friction test rig, Magnum) and Lithium disilicate and polymer infiltrated ceramic disc specimens were positioned on disc of wear testing apparatus under constant load of 5kg (49N). The specimens were made to rub against one another in a rotating cycle to simulate oral wear cycle. The test was run for total of 10,000 wear cycles at 30rpm on wear machine for each sample. Wear of group 1 and group 2 and enamel wear of group 1 and group 2 was measured before and after wear test by profile projector.

**Results:** Wilcoxon test was done to compare the groups. Results showed that wear was greater in group 1 (Polymer infiltrated ceramics) compared to group 2 (CAD/CAM Lithium disilicate) and enamel wear of group 1 was greater than enamel wear of group 2.

**Conclusion:** Advances in CAD/CAM technology led to development of aesthetic all ceramic restorations with superior mechanical properties such as CAD/CAM Lithium disilicate. But the major concern of ceramic materials is wear towards the opposing enamel. To meet the above requirements polymer infiltrated ceramics are developed by incorporating resin polymer in ceramics to produce esthetic stability of ceramics and low abrasive nature of composites. The restorative materials should not cause wear to opposing enamel and also should possess wear resistance similar to enamel for its success and longevity. This study was performed to evaluate the wear resistance of CAD/CAM lithium disilicate and Polymer infiltrated ceramics against natural teeth enamel.



## 1. Introduction

Computer aided design (CAD) / Computer aided manufacturing (CAM) is used in fabrication of inlays, onlays, veneers, crowns, fixed partial dentures and

* *Corresponding author*.
*E-mail address*: architareddy96@gmail.com (D. A. Reddy).

https://doi.org/10.18231/j.aprd.2023.040
2581-4796/© 2023 Author(s), Published by Innovative Publication.

full mouth reconstruction.[1] Advances in CAD/CAM technology and increase in demand of esthetic materials led to development of all ceramic restorations replacing metal ceramic restorations.[2] The restorative materials should not only have good esthetic and mechanical properties but also should possess wear resistance similar to that of enamel for longevity of restoration. CAD/CAM Lithium disilicate glass ceramics (IPS E.max CAD) are widely used all ceramic restorations in anterior and posterior restorations. It was introduced in the year 2006. It is said to have high biaxial flexural strength, fracture toughness, good biocompatibility, dimensional stability and superior optical properties. The material is available as blocks of various sizes in a pre crystallized state known as "blue state," where it is composed primarily of lithium meta-silicate (Li2SiO3), which is easier to mill and results in lower bur wear. After the milling process is completed, the material is heat treated and glazed in one step, forming the final lithium disilicate restoration.[3] Recently for optimizing the performance of the restorative materials, ceramics and resin composites were combined in a single material by a manufacturer to associate the elastic modulus of resin composite, which is similar to the dentin, with the long-term esthetic stability of ceramics to form a material, called "polymer-infiltrated ceramic-network (PICN)" also called as hybrid ceramics.[4] They are used in minimally invasive restorations and posterior crowns, veneers, inlays and onlays for posterior teeth and implant-supported crowns.[5] Polymer-infiltrated ceramic networks (PICN) combines the benefits of the polymers and ceramics. Unlike conventional dental composite resins, which have ceramic filler particles in an organic matrix, Polymer- infiltrated ceramic networks are composed of a ceramic network that is infiltrated with a polymer to form a interpenetrating network in order to imitate the mechanical properties of a natural tooth. Wear is a complex cumulative process of multi factorial etiology, that is characterized by progressive loss of material from its surface.[6] Wear alters the anatomy of occlusal surface and affects the occlusal harmony and masticatory function.[7–16] There are various methods to test wear resistance among restorative materials such as pin on disc wear testing, tooth brush simulator, mastication simulator, nanoindentation test, Alabama wear test and ACTA wear testing machine. In this study wear of CAD/CAM Lithium disilicate and Polymer infiltrated ceramics were tested by pin on disc wear testing machine because of its simplicity and ease of use and wear was measured by Profile projector. The purpose of the study was to evaluate and compare wear resistance between CAD/ CAM lithium disilicate and polymer infiltrated ceramics against natural teeth enamel. The null hypothesis of the current study is that there is significant difference between CAD/CAM lithium disilicate and Polymer infiltrated ceramics in terms of wear resistance against natural teeth enamel.

## 2. Materials and Methods

Thirty freshly extracted human unrestored cariesfree non-attrited maxillary first and second premolars with complete root formation were selected for the study. The teeth were disinfected in thymol and cleaned with an ultrasonic scaler and stored in saline solution to prevent dehydration.

A prefabricated wax block of dimensions 20mm x15mm x 15mm was carved into wax block of length 15mm and width 10x10mm and a putty index of this wax block was made. In that putty index auto polymerising acrylic resin was poured and the teeth were embedded such that the roots were embedded into the resin and the tooth above the cervical margin was exposed. A groove was placed on the teeth specimens with diamond disc which acted as a fixed point of reference to measure the height before and after testing. Care was taken that the teeth were placed perpendicular to the base of the mould.

All the teeth specimens were viewed under profile projector to assess the height prior to testing. The teeth specimens were placed on the worktable of the profile projector and the X, Y, and Z axes were adjusted and the profile of each tooth specimen was traced. A perpendicular was dropped from the height of the cusp tip to the groove which was marked on the teeth as a point of reference. This height was measured as the baseline height of that particular tooth.

### *2.1. Specimen preparation*

CADCAM milled IPS E.max CAD and Vita enamic were used for the study. A STL file of dimensions 10mm diameter and 3mm thickness was prepared for this purpose using the software (Meshmixer software).

### *2.2. Fabrication of IPS E.max CAD specimens (Group 1)*

15 IPS E.max CAD C14 blocks with dimensions 12x14x18mm were milled by CAD/CAM into the dimensions of 10mm diameter and 3 mm thickness discs. After milling the specimens were crystallized in the Programat CS ceramic furnace at temperature of $850^0$C for 25 minutes. Specimens were steam cleaned followed by ultrasonic cleaning for 10minutes and were airdryed. After the specimens were dried, they were polished with medium grit Edenta Exa-Cerapol polishing wheel to attain a smooth surface followed by fine grit Edenta Exa-Cerapol polishing wheel at a speed of 3000 rpm followed by polishing with Renfert polishing paste using cotton buff. Care was taken that the finishing and polishing procedure were done in a unidirectional manner and excess contact time and force was avoided during the polishing procedure to avoid heat generation.

### *2.3. Fabrication of Vita enamic (Group -2)*

15 Vita Enamic blocks with dimensions 12x14x18mm were milled into dimensions of 10mm diameter and 3mm thickness discs. Specimens were steam cleaned followed by ultrasonic cleaning for 10 minutes and were airdryed. After the specimens were dried, they were polished with medium grit Edenta Exa- Cerapol polishing wheel to attain a smooth surface followed by fine grit Edenta Exa- Cerapol polishing wheel at a speed of 3000 rpm followed by polishing with Renfert polishing paste using cotton buff, Care was taken that the finishing and polishing procedure was done in a unidirectional manner and excess contact time and force was avoided during the polishing procedure to avoid heat generation.

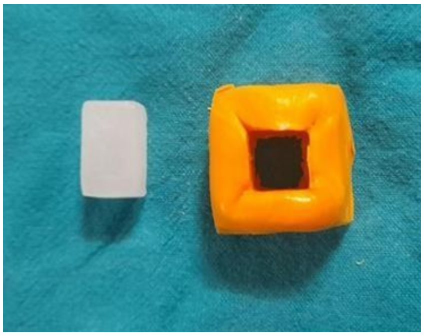

**Figure 1:** Wax block of 15mm x10mm x 10mm with its putty index

**Figure 2:** Teeth specimens mounted on self cure acrylic

### *2.4. Test procedure*

Wear tests were conducted on a pin on disc wear and friction test machine. It has an upper fixed pin holder available of various sizes. For the present study a pin holder of 10-12mm was selected to suit the needs of the tooth specimens. The tooth specimens were inserted into the upper specimen holder. A screw inside the slot was used to adjust the specimen vertically and the specimen projected at least 3mm from the opening of the holder.


**Figure 3:** IPS E.max CAD block of dimensions 12x14x18mm


**Figure 4:** Vita enamic block of dimensions 12x14x18mm

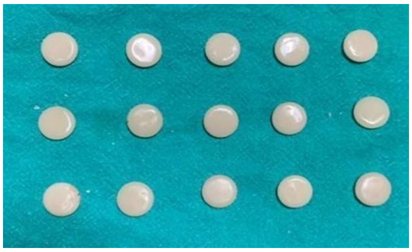

**Figure 5:** Polished IPS E.max CAD specimens (group 1)

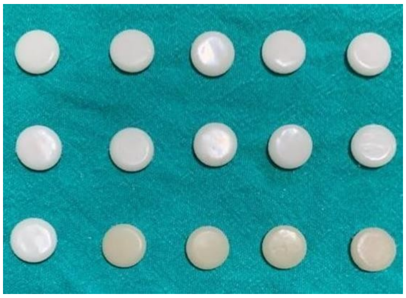

**Figure 6:** Polished Vita enamic specimens (group 2)

**Figure 7:** Pinon disc wear test machine

**Figure 8:** Enamel pin against IPS Emax CAD disc specimens.

**Table 1:** Showing baseline data of wear of IPS E.max CAD material (group 1)

| Height of specimen before wear (in mm) | Height of specimen after wear (in mm) | Difference (in mm) |
|---|---|---|
| 3.135 | 2.981 | 0.154 |
| 3.012 | 2.967 | 0.045 |
| 3.095 | 2.821 | 0.274 |
| 2.918 | 2.708 | 0.210 |
| 2.845 | 2.823 | 0.022 |
| 2.965 | 2.825 | 0.140 |
| 3.128 | 2.801 | 0.327 |
| 3.136 | 3.043 | 0.093 |
| 3.021 | 2.872 | 0.149 |
| 3.095 | 3.069 | 0.026 |
| 3.124 | 2.843 | 0.281 |
| 2.945 | 2.804 | 0.141 |
| 2.825 | 2.756 | 0.069 |
| 3.127 | 2.868 | 0.259 |
| 2.889 | 2.820 | 0.069 |

**Table 2:** Showing the baseline data of vita enamic material (group 2)

| Height of specimen before wear (in mm) | Height of specimen after wear (in mm) | Difference( in mm) |
|---|---|---|
| 2.969 | 2.840 | 0.129 |
| 3.080 | 2.793 | 0.287 |
| 3.117 | 2.835 | 0. 282 |
| 3.166 | 2.974 | 0.192 |
| 2.948 | 2.873 | 0.075 |
| 3.018 | 2.777 | 0.241 |
| 2.934 | 2.575 | 0.359 |
| 2.898 | 2.790 | 0.108 |
| 2.881 | 2.504 | 0.377 |
| 2.912 | 2.594 | 0.318 |
| 3.024 | 2.810 | 0.214 |
| 2.980 | 2.663 | 0.317 |
| 3.143 | 2.856 | 0.287 |
| 3.054 | 2.661 | 0.393 |
| 3.136 | 2.854 [i] | 0.282 |

**Table 3:** Showing the baseline data of enamel wear in group 1.

| Baseline height of teeth specimen before wear in mm | Baseline height of teeth specimen after wear in mm | Difference in mm |
|---|---|---|
| 3.969 | 3.189 | 0.780 |
| 4.627 | 4.387 | 0.240 |
| 4.863 | 3.599 | 1.264 |
| 3.753 | 3.232 | 0.521 |
| 4.271 | 3.389 | 0.882 |
| 4.794 | 4.029 | 0.765 |
| 3.548 | 2.918 | 0.630 |
| 3.303 | 2.635 | 0.668 |
| 3.091 | 2.758 | 0.333 |
| 3.903 | 3.798 | 0.105 |
| 4.576 | 3.807 | 0.769 |
| 4.621 | 3.574 | 0.847 |
| 3.876 | 3.641 | 0.235 |
| 3.845 | 3.189 | 0.656 |
| 3.742 | 3.321 | 0.421 |

The lower member has a disc which rotates at the selected speed. For this study, a metal disc made of NK steel of diameter 165mm and 5mm thickness was fabricated. To hold the test specimens, a provision was given in the centre of the disc of dimensions 10mm in diameter and 2mm depth such that the specimens were securely seated in the rotating disc and 4 holes were made in the periphery of disc to which screws were fixed to secure the disc to the machine. The test specimens were attached to the disc, that ran in a rotational movement. The contacting surfaces of the specimens were made parallel to each other and the test was performed with a load of 5kg(49N) at 30 cycles per minute for 10,000 cycles.The water was renewed after each test to remove the wear debris from the wear track. The loss of height of all the tooth specimens after testing was determined using the profile projector. The teeth specimens were placed onto the work table of the profile projector in the same orientation as that of the first measurement. The axis was adjusted accordingly and the height of the tooth specimen was measured again up to the groove placed on teeth and obtained results were subjected to statistical analysis.

**Table 4:** Showing the baseline data of enamel wear in group 2.

| Baseline height of teeth specimen before wear | Baseline height of teeth specimen after wear against Vita Enamic | Difference |
|---|---|---|
| 3.409 | 3.262 | 0.147 |
| 3.659 | 3.017 | 0.642 |
| 3.316 | 3.262 | 0.054 |
| 4.407 | 3.586 | 0.821 |
| 3.269 | 3.046 | 0.223 |
| 3.751 | 3.566 | 0.185 |
| 2.880 | 2.782 | 0.098 |
| 4.594 | 3.988 | 0.606 |
| 4.551 | 4.378 | 0.173 |
| 4.807 | 4.526 | 0.281 |
| 3.589 | 3.126 | 0.463 |
| 3.897 | 3.705 | 0.192 |
| 4.489 | 4.197 | 0.292 |
| 4.231 | 3.854 | 0.377 |
| 3.745 | 3.462 | 0.283 |

## 3. Results

The maximum wear was found to be 0.327mm and the minimum wear was found to be 022mm.Table 1

The maximum wear was found to be 0.393mm and the minimum wear was found to be 075mm.Table 2

The maximum wear was found to be 1.264mm and the minimum wear was found to be 105mm.Table 3

The maximum wear was found to be 0.821mm and the minimum wear was found to be 0.054mm.Table 4

The mean of group 1 before wear test was 3.01 with standard deviation of 0.11 and the mean of group 1 after wear test was 2.86 with standard deviation of 0.10. The mean of group 2 before wear test was 3.01 with standard deviation of 0.09 and the mean of group 2 after wear test was 2.75 with standard deviation of 0.13. The mean of enamel wear in group 1 before wear test was 4.05 with standard deviation of 0.54 and the mean wear of enamel wear in group 1 after test was 3.43 with standard deviation of 0.47. The mean of enamel wear in group 2 before wear test was 3.90 with standard deviation of 0.57 and the mean of enamel wear in group 2 after test was 3.58 with standard deviation of 0.57. Paired T test was performed to know mean difference before and after wear test between the groups, there was significant mean difference for all the groups before and after wear test with P value <0.001.Table 5

The mean of mean difference of IPS E.max CAD(group 1) was 0.15 and standard deviation of 0.09. The mean of mean difference of Vita Enamic (group 2) was 0.24 and standard deviation of 0.09. Wilcoxon signed rank test was performed to compare the significant difference between the groups. It was observed that there was significant difference between two groups with P value of 0.001.Table 6

The mean of mean difference of group 1 teeth specimens was 0.62 and standard deviation of 0.31. The mean of mean difference of group 2 teeth specimens was 0.32 with standard deviation of 0.22. Wilcoxon signed rank test was performed to compare the significant difference between the groups. It was observed that there was significant difference between two groups with P value of 0.001. Table 7

## 4. Discussion

With the development of metal free restorative materials the concept of monolithic, full contour restorations were introduced.[17–21] These restorations are fabricated from a single block of restorative material, without the veneer layer. The fabrication of the structure in one block reduces breakage possibilities and avoids chipping. Moreover, high strength, minimal wear and accuracy are some of its advantages. Lithium disilicate and hybrid ceramics were among ceramic materials suggested for fabrication of monolithic restorations as suggested by Kanat B et al (2014),[22] Guess PC et al (2011),[23] which is in accordance with our study.

In present study CAD/CAM Lithium disilicate and polymer infiltrated ceramics were chosen, the reason for choosing Lithium disilicate over zirconia is because of its superior esthetics and transluceny, The reason for choosing polymer infiltrated ceramic in present study is that its density, elastic modulus and hardness are considered to be more closer to natural tooth properties, when compared with other existing dental restorative materials as suggested by Coldea A(2013),[24] Xie et al (2018),[25] Banh W et al (2021)[25] and very few studies were done on properties of this material as it was recently introduced.

Lithium disilicate specimens and polymer infiltrated ceramics were fabricated as discs with dimensions of 10mm diameter and 3mm thickness by creating a STL file by Meshmixer software. Based on the STL file CAD/CAM milling machine mills the discs in that dimensions which is in accordance to studies done by Abouelenien DK et al (2020),[26] Ghoveizi R et al (2021).[27] The reason for using 10mm x 3mm dimensions was to ensure that the cusp tips are in contact with only test specimen and not any other surface at any point of testing during rotation. Test specimens fabricated using CAD/CAM Lithium disilicate are named as Group 1 and test specimens fabricated using polymer infiltrated ceramics are named as Group 2.

In the present study, to assess the wear behaviour, CAD/CAM Lithium disilicate glass ceramic and polymer infiltrated ceramics were polished with medium grit Edenta grey exacerapol polishing wheel to remove surface irregularities and to achieve smootheness followed by polishing with fine grit Edenta pink exacerapol polishing wheel to achieve luster which is in accordance to Silva CS (2020),[28] Sasany R et al (2022)[29] The reason for using Exacerapol polishing wheel is because of its versatility and

**Table 5:** Showingmean and standard deviation of loss of height of group 1, group 2 and enamel wear in group 1 and group 2 before and after wear test

| Object | Group | Before(B) Mean±SD | After(A) Mean±SD | p-value | Inf |
|---|---|---|---|---|---|
| IPS E.max CAD Specimens | Group 1 | 3.01±0.11 | 2.86±0.10 | <0.001 | B>A |
| Vitaenamic specimens | Group 2 | 3.01±0.09 | 2.75±0.13 | <0.001 | B>A |
| Teeth specimens | Group 1 | 4.05±0.54 | 3.43±0.47 | <0.001 | B>A |
| Teeth specimens | Group 2 | 3.90±0.57 | 3.58±0.52 | <0.001 | B>A |

**Table 6:** Showing comparison of mean of mean difference and standard deviation in IPS E.max CAD (group 1) , Vita Enamic (group 2)

| Material | IPS E.max CAD (I) Mean±SD | Vita Enamic (V) Mean±SD | P-value | Inf |
|---|---|---|---|---|
| Specimen | 0.15±0.09 | 0.24±0.09 | 0.001 | V>I |

**Table 7:** Showing comparison of mean of mean difference and standard deviation in enamel wear in group 1 and group 2

| Material | Group 1 Mean±SD | Group 2 Mean±SD | P-value |
|---|---|---|---|
| Teeth | 0.62±0.31 | 0.32±0.22 | 0.001 |

ease of use.

After polishing of Lithium disilicate discs and polymer infiltrated ceramics by Exacerapol polishing wheels, final polishing was done by Renfert polishing paste using cotton buff which is in accordance with the study done by Duraes I et al (2016).[30] The reason for using Renfert diamond polishing paste is to attain high gloss.

Natural teeth specimens were taken as antagonists in present study. Thirty freshly extracted Maxillary first and second premolars were collected and preserved in saline. First and second premolars which were extracted for orthodontic treatment were selected for present study. The teeth which were caries free, non attrited and were in healthy state were selected for present study preventing variability among teeth specimens which is in accordance with studies done by Hassan S,Gad N (2017).[31]

Teeth were then mounted in autopolymerising acrylic resin of dimensions 15mm length x 10mm width x10mm thickness in accordance with Rupawala A et al (2017).[32] These teeth specimens served as pin in pin on disc wear testing apparatus. The reason for using 15mmx10mmx10mm was because these dimension were compatible with pin holder dimensions of wear testing machine and to securely hold it in place during testing.

Two body wear test is performed in present study the reason for choosing Two-body wear is that was brought about by machine with a combined action of impact, followed by sliding that matches the inherent action of closure during mastication of the mandibular teeth onto the maxillary teeth for a total of 10,000 cycles as stated by El-Meliegy E.[33] The reason for choosing pin on disc wear tester over other two body wear test is its simplicity and ease of use in comparision to other testing methods.Pin on disc is the most common and simplest method of wear testing used. The base of this method is the use of two-component wear. During the analysis using this method, on the disc-shaped sample surface a ‘pin body in the form of a roller is applied. At a chosen distance from the sample centre the pin is stressed by a predetermined force. The disc starts to rotate with selected speed and executes the predetermined number of rounds. This test is very simple, standardised and inexpensive.

A NK steel disc was fabricated by milling of dimension 165 mm ×8 mm thickness. The circular stainless steel die was having eight counter bores equidistant from each other at an angle of 45° to precisely fit into the slots in the wear testing machine. A circular slot of dimension 10mm in diameter ×3mm in thickness in the center of the metal die was made. Two equidistant holes, of dimension 2mm in diameter ×3mm in depth, were made in the metal disc as locking device for the ceramic specimen which is in accordance with study done by Singh A et al (2016).[34] The reason for choosing 165 mm diameter and 8 mm diameter thickness of metal disc as these dimensions are ideal to fit the disc to wear testing machine and the reason for choosing slot of dimensions 10mm x3mm is to fit and secure the ceramic discs of 10mmx 3mm for wear testing.

In this in vitro study, enamel was used as pin opposed to CAD/CAM Lithium disilicate and Vitaenamic fabricated in the form of discs at 30rpm for 10,000 cycles. These control parameters were determined according to ASTM International standard test method forwearing with a pin on disc apparatus ASTM (2010).[35] The number of cycles selected were in conformity with the studies conducted by Mulay G et al (2015).[36] The reason for choosing 10,000 wear cycles is because it simulates the masticatory cycles in an year in order to estimate wear rate per year.

A weight of 5 kg (49 N) was exerted onto specimens in accordance with studies conducted by Jung YS et al (2010).[37] The reason for choosing load of 5kg (49N) is because it is comparable to normal chewing force.

Group 1 and group 2 specimens and teeth were measured before and after 10,000 wear cycles using profile projector. The reason for choosing profile projector over other modes of assessing wear is because it has high precision and accuracy and vertical substance loss can be measured in micron level.

Polymer infiltrated ceramics(group 2) comparatively showed greater wear than CAD/CAM lithium disilicate(group 1) which is in conformity with the studies done by Kamel MA et al (2019).[38]

The probable reason for higher wear in polymer infiltrated ceramics than CAD/CAM Lithium disilicate in present study is due to the fact that higher the hardness of material lesser the wear of that particular material. Lithium disilicate has higher hardness in comparison to polymer infiltrated ceramics causing less wear of Lithium disilicate.This was in agreement with what was stated by Ludovichetti FS et al(2018),[30] Sripetchdanond J, Leevailoj C (2014).[39] Greatest values of hardness were obtained for lithium disilicate glass–ceramic (5.83 GPa) and hardness of Polymer Infiltrated Ceramics (1.15 GPa) which was near to dental tissues as suggested by Albero A et al (2015).[40] Other probable reasons could be weaker polymer infiltration in polymerinfiltrated ceramics. The glass ceramics used have a finer microstructure and more crystalline content compared to Vita Enamic. Asperities on the ceramic and enamel surfaces cause reciprocal abrasive scratching as suggested by Lawson NC (2016),[41] Baldi A et al (2022).[42]

The mean of mean difference of enamel wear in group 1 was 0.62mm and standard deviation of 0.31. The mean of mean difference of enamel wear in group 2 teeth specimens was 0.32mm with standard deviation of 0.22. Wilcoxon signed rank test was performed to compare the significant difference between the groups. It was observed that there was significant difference between two groups with P value of >0.001. The probable reason could be the mismatch of the elastic modulus and the strength between the enamel and restorative materials are large, the enamel suffers high stress concentration and consequently, stress abrasion.

The reason for high wear in antagonist of lithium disilicate was not only by mechanical abrasion but also by chemical degradation caused by the hydrolysis reaction in water.the other probable reason for higher wear of antagonist enamel by IPS E.Max CAD was lower strength matrix which is worn-out by fracture prior to the high strength crystals which will then act as asperities causing further wear of the antagonist enamel. These asperities will themselves fracture after further conduction of the wear test as they are also brittle causing the process to be repeated thus resulting in material loss. Meanwhile, glass particles that detach during the wear process behave as an abrasive medium and lead to a 3-body wear mechanism.

## 5. Conclusion

Advances in CAD/CAM technology led to development of aesthetic all ceramic restorations with superior mechanical properties such as CAD/CAM Lithium disilicate. But the major concern of ceramic materials is wear towards the opposing enamel. To meet the above requirements polymer infiltrated ceramics are developed by incorporating resin polymer in ceramics to produce esthetic stability of ceramics and low abrasive nature of composites. The restorative materials should not cause wear to opposing enamel and also should possess wear resistance similar to enamel for its success and longevity. This study was performed to evaluate the wear resistance of CAD/CAM lithium disilicate and Polymer infiltrated ceramics against natural teeth enamel. 15 Lithium disilicate and 15 polymer infiltrated ceramics were fabricated by CAD/CAM in the form of discs of dimensions of 10mmx3mm. They were named as group 1 (CAD/CAM Lithium disilicate) and group 2 (Polymer infiltrated ceramics). 30 tooth specimens were mounted on autopolymerising acrylic resin blocks. Teeth specimens were attached to the upper member of the pin on disc wear testing machine. Lithium disilicate and polymer infiltrated ceramic disc specimens were positioned on disc of wear testing apparatus under constant load of 5kg (49N). The specimens were made to rub against one another in a rotating cycle to simulate oral wear cycle. The test was run for total of 10,000 wear cycles at 30rpm on wear machine for each sample. Wear of group 1 and group 2 and enamel wear in group 1 and group 2 was measured before and after wear test by profile projector. Results showed that wear was greater in group 2 (Polymer infiltrated ceramics) compared to group 1 (CAD/CAM Lithium disilicate) and Enamel wear was greater in group 1 specimens than group 2.

## 6. Conflict of Interest

None.

## 7. Source of Funding

None.

## References

1. Davidowitz G, Kotick PG. The Use of CAD/CAM in Dentistry. *Dent Clin N Am*. 2011;55(3):559–70.
2. Li RK, Chow TW, Matinlinna J. Ceramic dental biomaterials and CAD/CAM technology: state of the art. *J Prosth Res*. 2014;58(4):208–16.
3. Willard A, Chu TG. The science and application of IPS E.Max dental ceramic. *Kaohsiung J Med Sci*. 2018;34(4):238–42.
4. Bona AD, Corazza PH, Zhang Y. Characterization of a polymer-infiltrated ceramic-network material. *Dent Mater*. 2014;30(5):564–9.
5. Petrini M, Ferrante M, Su B. Fabrication and characterization of biomimetic ceramic/polymer composite materials for dental restoration. *Dent Mater*. 2013;29(4):375–80.

6. Lewis R, Dwyer-Joyce R. Wear of human teeth a tribiological perspectives. *J Tribol Int*. 2005;219(1):1–19.
7. Elhomiamy E, Aboushady Y, Malakh BE. Wear behavior and Surface roughness of polymer infiltrated ceramic material compared to pressable glass ceramics. *Alex Dent J*. 2015;40(1):65–70.
8. Tokunaga J, Ikeda H, Nagamatsu Y, Awano S, Shimizu H. Wear of Polymer-Infiltrated Ceramic Network Materials against Enamel. *Materials (Basel)*. 2022;15(7):2435. doi:10.3390/ma15072435.
9. Mandour MH. Wear performance of monolithic dental ceramics with different surface treatments. *Egypt Dent J*. 2017;1:63–75.
10. Ludovichetti FS, Trindade FZ, Werner A, Kleverlaan CJ, Fonseca RG. Wear resistance and abrasiveness of CAD-CAM monolithic materials. *J Prosthet Dent*. 2018;120(2):318.e1–e8.
11. Elhomiamy E, Aboushady Y, Malakh BE. Wear behavior and Surface roughness of polymer infiltrated ceramic material compared to pressable glass ceramics. *Alex Dent J*. 2015;40(1):65–70.
12. Jones DW. A brief overview of dental ceramics. *J Can Dent Assoc*. 1999;64(9):648–40.
13. Sharkey S. Metal ceramic versus all ceramic restorations: part 3. *J Ir Dent Assoc*. 2011;57(2):110–3.
14. Krejci I, Albert P, Lutz F. The influence of antagonist standardization on wear. *J Dent Res*. 1999;78(2):713–9.
15. Zarone F, Russo S, Sorrentino R. From porcelain-fused-to-metal to zirconia: clinical and experimental considerations. *J Prosthet Dent*. 2002;27(1):451–9.
16. Kanat B, Çömlekoğlu EM, Dündarçömlekoğlu M, Sen BH, Ozcan M, Güngör MA, et al. Effect of various veneering techniques on mechanical strength of computer-controlled zirconia framework designs. *J Prosthet Dent*. 2014;23(6):445–55.
17. Jones DW, Jones PA, Wilson HJ. A simple abrasion test for composites. *J Dent*. 1972;1(1):28–34.
18. Sharkey S. Metal ceramic versus all ceramic restorations: part 3. *J Ir Dent*. 2011;57(2):110–3.
19. Wohlwend A, Strub JR, Schärer P. Metal ceramic and all-porcelain restorations: current considerations. *Int J Prosthodont*. 1989;2(1):13–26.
20. Zarone F, Russo S, Sorrentino R. From porcelain-fused-to-metal to zirconia: clinical and experimental considerations. *Dent Mater*. 2011;27(1):83–96.
21. Banh W, Hughes J, Sia A, Chien DCH, Tadakamadla SK, Figueredo CM, et al. Longevity of Polymer-Infiltrated Ceramic Network and Zirconia-Reinforced Lithium Silicate Restorations: A Systematic Review and Meta-Analysis. *Materials (Basel)*. 2021;14(17):5058. doi:10.3390/ma14175058.
22. Jones DW, Jones PA, Wilson HJ. A simple abrasion test for composites. *J Dent*. 1972;1(1):28–34.
23. Guess PC, Schultheis S, Bonfante EA, Coelho PG, Ferencz JL, Silva NR, et al. All- ceramic systems: laboratory and clinical performance. *Dent Clin North Am*. 2011;55(2):333–52.
24. Coldea A, Swain MV, Thiel N. Mechanical properties of polymer-infiltrated- ceramic-network materials. *Dent Mater*. 2013;29(4):419–26.
25. Xie C, Zhang JF, Li S. Polymer Infiltrated Ceramic Hybrid Composites as Dental Materials. *Oral Health Dent Stud*. 1;1(2):1–11.
26. Abouelenien DK, Nasr HH, Zaghloul H. Wear behavior of monolithic zirconia against natural teeth in comparison to two glass ceramics with two surface finishing protocols: An in-vitro study. *Braz Dent Sci*. 2020;23(2):12–20.
27. Ghoveizi R, Parsirad R, Tavakolizadeh S, Beyabanaki E. Effect of different Nd: YAG laser power outputs on bond strength of resin cement to zirconia in comparison to sandblasting. *Lasers Med Sci*. 2021;12:e6. doi:10.34172/jlms.2021.06.
28. da Silva T, Salvia A, Carvalho RF, Silva E, Pagani C. Effects of Different Polishing Protocols on Lithium Disilicate Ceramics. *Braz Dent J*. 2015;26(5):478–83.
29. Sasany R, Kunt GE, Koca M. Influence different polishing systems on roughness and colour stability of chairside CAD/CAM blocks with laminate veneer thickness. *J Appl Biomater Funct Mater*. 2022;p. 22808000221086493. doi:10.1177/22808000221086493.
30. Duraes I, Macedo GL, Carvalho CF, Oliveira VM, Lima EM. Effects of different polishing systems on the surface roughness of two ceromers. *Braz Dent Sci*. 2016;19(2):56–63.
31. Hassan S, Gad N. Two-body wear and surface roughness of three different ceramic systems and their enamel antagonist: An in vitro study. *Al-Azhar Dent J Girls*. 2017;4(4):347–57.
32. Rupawala A, Musani SI, Madanshetty P, Dugal R, Shah UD, Sheth EJ, et al. A study on the wear of enamel caused by monolithic zirconia and the subsequent phase transformation compared to two other ceramic systems. *J Indian Prosthodont Soc*. 2017;17(1):8–14.
33. El-Meliegy E, Noort R. Glasses and Glass Ceramics for Medical Applications. New York, NY: Springer; 2011.
34. Singh A, Nagpal A, Pawah S, Pathak C, Issar G, Sharma P, et al. Qualitative Assessment of Wear Resistance and Surface Hardness of Different Commercially Available Dental Porcelain: An in vitro Study. *J Contemp Dent Pract*. 2016;17(9):755–61.
35. ASTM International. Standard test method for wear testing with a pin on disk apparatus. ASTM Standard G99. West Conshohocken: ASTM Int; 2010. Available from: https://webstore.ansi.org/standards/astm/astmg99052010.
36. Mulay G, Dugal R, Buhranpurwala M. An evaluation of wear of human enamel opposed by ceramics of different surface finishes. *J Indian Prosthodont Soc*. 2015;15(2):111–8.
37. Jung YS, Lee JW, Choi YJ, Ahn JS, Shin SW, Huh JB, et al. A study on the in-vitro wear of the natural tooth structure by opposing zirconia or dental porcelain. *J Adv Prosthodont*. 2010;2(3):111–5.
38. Kamel MA, Hassan MR, Hashem RM. Assessment of wear of three CAD/CAM ceramics against natural tooth structure in a chewing simulator (in vitro study). *Dent J*. 2019;65:403–16.
39. Sripetchdanond J, Leevailoj C. Wear of human enamel opposing monolithic zirconia, glass ceramic and composite resin: An in vitro study. *J Prosthet Dent*. 2014;112(5):1141–50.
40. Albero A, Pascual A, Camps I, Grau-Benitez M. Comparative characterization of a novel cad-cam polymer-infiltrated-ceramic-network. *J Clin Exp Dent*. 2015;7(4):495–500.
41. Lawson NC, Bansal R, Burgess JO. Wear, strength, modulus and hardness of CAD/CAM restorative materials. *Dent Mater*. 2016;32(11):275–83.
42. Baldi A, Carossa M, Comba A, Alovisi M, Femiano F, Pasqualini D, et al. Wear Behaviour of Polymer-Infiltrated Network Ceramics, Lithium Disilicate and Cubic Zirconia against Enamel in a Bruxism-Simulated Scenario. *J Biomed*. 2022;10(7):1682–98.


## Author biography

**Dendi Archita Reddy,** Student https://orcid.org/0009-0000-5843-6104

**K.Mahendranadh Reddy,** HOD

**Cite this article:** Reddy DA, Reddy KM. Comparative evaluation of wear resistance between lithium disilicates and polymer infiltrated ceramics manufactured by computer aided design (CAD) computer aided manufacturing (CAM) against natural tooth enamel. *IP Ann Prosthodont Restor Dent* 2023;9(4):214-221.