Surface Nanohardness of Normal and Fluorosed Enamel Adjacent to Restorative Materials: An *In Vitro* Study and Polarized Light Microscopy Analysis

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**Abstract**

**Aim and objective:** To evaluate nanohardness of normal and fluorosed enamel in teeth restored with Cention N (CN), Equia forte (EF), glass ionomer cement (GIC), and resin composite using the nanoindentation test.

**Materials and methods:** Eighty freshly extracted human premolars were selected. Standardized cavities were prepared on the buccal surface of normal (40) and fluorosed (40) teeth. Based on the type of the restorative material, the teeth were subgrouped into \( n = 10 \): CN, EF, Type VIII GIC, and Tetric N-Ceram (TNC). The teeth were subjected to pH cycle (progressive caries test), which consisted of alternative demineralization (18 hours) and remineralization with artificial saliva (6 hours) for 3 consecutive days. Surface nanohardness was determined using a nanoindenter at distances of 100, 200, and 300 μm from the restoration-tooth margin. A polarized light Microscope was used to correlate the effect of remineralization on the enamel. Data were analyzed by one-way ANOVA with the Scheffe's post hoc and independent t-test.

**Results:** Nanohardness values of the fluorosed/normal enamel adjacent to various materials in descending order were as follows: EF 3.67/2.95 GPa, GIC 3.33/3.15 GPa, CN 3.13/3.23 GPa, and TNC 1.17/1.82 GPa, respectively. Statistically significant differences were found among various materials in both types of the enamel \( (p < 0.05) \).

**Conclusion:** Based on the nanohardness test, EF can be a better choice for restoration in fluorosed teeth, followed by CN and GIC; GIC was better in normal enamel; however, this was not significant compared to CN and EF. Tetric N-Ceram composite resin had least influence on increasing the nanohardness of the adjacent enamel.

**Clinical significance:** The surface nanohardness of normal and fluorosed enamel can be influenced by the type of restorative material used. The results of present study deserve clinician's attention while selecting restorative materials especially in dental fluorosis.

**Keywords:** Cention N, Elastic modulus, Equia forte, Fluorosis, Laboratory research, Nanohardness.

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**Introduction**

Histologically, it has been found that fluorosed teeth are different from a normal tooth and the mechanical properties also have been found to be variable. Though few studies state that the incidence of caries is less in people with dental fluorosis, certain clinical studies claim against it.¹ Fluoride-releasing restorative materials, like glass ionomers and compomers, have shown protective action against secondary caries on normal teeth.² However, clinical studies have not proven if the incidence of secondary caries in fluorosed teeth can be reduced significantly by the release of fluoride from restorative materials.

According to Angker et al., the mechanical properties of calcified tissue have shown to reflect the level of mineralization.³ Dental caries can alter the tooth mineral assemblages and compositions, which alter the physical and mechanical behavior of the teeth.⁴,⁵ The commonly used method to assess the enamel remineralization is the microhardness tests like the Vickers microhardness test and Knoop microhardness test.⁶ However, to further understand the mechanical behavior of the enamel, nanoindentation has been recommended. Unlike traditional tests to determine the hardness, which only take into account permanent (plastic) deformation and require the visualization and measurement of indents, nanoindentation takes into account both plastic and elastic deformation, as well as time-dependent effects.⁷ Nanoindentation also have been utilized to access the changes occurring in the dental hard tissues during the demineralization-remineralization.⁸

Saliva is the source of ions required for natural remineralization following early enamel demineralization. However, not much literature is available regarding the influence of various restorative materials on the remineralization of the acid-demineralized...
enamel adjacent to these materials. Habelitz et al. found that the nanohardness and elastic modulus of the acid-etched enamel were lower than the unetched enamel. Min et al. found that the enamel fluorosis presents distinct gradient nanomechanical behaviors that differ from the normal tooth. Fan et al. found the nanomechanical properties of mild enamel fluorosis were inferior to the normal enamel.

Recently, two new restorative materials, the Cention N (CN) (Ivoclar Vivadent AG, Liechtenstein, Germany) and Equia Forte (EF) Fil (GC Corporation, Tokyo, Japan), have been introduced. These bulk-filled restorative materials claim to have improved strength and better remineralization properties. However, not much literature is available regarding these properties especially in fluorosed teeth. Hence, the objective of the present study was to evaluate and compare the surface nanohardness of the enamel adjacent to CN and EF restoration in normal and fluorosed teeth using nanoindentation.

**Materials and Methods**

**Specimen Selection**

The study was approved by the institutional committee for research on human subjects or specimens. The study was carried out at the Department of Conservative Dentistry and Endodontics. A total of 80 intact, unrestored, and caries-free human premolars (40 normal and 40 mild fluorosis) from either gender, aged 16–40 years extracted due to orthodontic reasons, were selected for the study. Teeth with cracks, fractures, incipient caries, intrinsic staining, or depressions on buccal surfaces were excluded. The teeth were stored in 10% formalin solution for 10 minutes, and then cleaned and stored in distilled water at 4°C until use. Teeth with mild enamel fluorosis were selected according to the Thylstrup and Fejerskov index (TFI 1–3).

**Specimens’ Preparation**

Standardized class V cavities (3 mm wide, 2 mm high, and 1.5 mm deep) were prepared on the buccal surface of each tooth under 3.4× magnification (OPMI PICO, Carl Zeiss, Oberkochen, Germany) with a flat-end straight diamond point (MANI, Tochigi, Japan) using a high-speed air rotor handpiece with water as a coolant. The diamond points were replaced after every fifth preparation. The specimens were polished with felt paper (3M, USA) moistened with 0.5-μm diamond polishing paste (Ultradent Products, South Jordan, USA).

Eighty specimens were restored with either CN (normal n = 10 and fluorosed n = 10), EF (normal n = 10 and fluorosed n = 10), Tetric N-Ceram (TNC) (normal n = 10 and fluorosed n = 10), or Type VII glass ionomer cement (GIC) (normal n = 10 and fluorosed n = 10) following manufacturer’s instructions. The compositions of the various restorative materials used in the study are listed in Table 1. All restorations were gross finished with fine grit diamond points (ISO 237/019 MANI, EX-21 EF) following manufacturer’s instructions. The compositions of the various restorative materials used in the study are listed in Table 1. All restorations were gross finished with fine grit diamond points (ISO 237/019 MANI, EX-21 EF) using a high-speed handpiece under water spray and were stored in distilled water at 37°C. The specimens were further finished with coarse, medium, fine, and extrafine Soflex discs (3M Dental Products, St Paul, MN, USA), at 10,000 rpm. All the specimens were evaluated under 3.5x magnification to ensure no overhanging restoration was present at the enamel margins. The specimens were polished with felt paper (3M, USA) moistened with 0.5-μm diamond polishing paste (Ultradent Products, South Jordan, USA).

The specimens were decoronated at the level of the cementoenamel junction and the crown was sectioned into two halves using a diamond disc (NTI Diamond Disc, Kavo Kerr, USA) under constant water coolant. Two layers of acid-resistant nail varnish were applied on the buccal surface, except for the area of restoration and 1 mm short of junction of tooth and restorative interface (Fig. 1A).

**pH Cycling**

For inducing mineral loss, the specimens were subjected to pH cycling according to previous studies. The 3-day pH cycle consisted of following steps: (i) demineralization by immersing in acetic acid solution (pH 5.0) for 18 hours; (ii) 5-minute rinse

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**Table 1: Chemical composition of different restorative materials used in the study**

| Material   | Manufacturer                          | Chemical composition                                                                 | Lot #   |
|------------|---------------------------------------|--------------------------------------------------------------------------------------|---------|
| CN         | Ivoclar Vivadent AG, Liechtenstein, Germany | Light-cured self-adhesive wear resistant coating                                     |         |
| EF         | GC Corporation, Tokyo, Japan           | Novel glass hybrid technology (capsule form). Consist of a new ultrafine, highly reactive glass particle, dispersed within the conventional glass ionomer (GI) structure. Liquid contains addition of a higher-molecular-weight polyacrylic acid | 1805171 |
| EF Coat    | GC Corporation, Tokyo, Japan           | Light-cured self-adhesive wear resistant coating                                     | 1706121 |
| Type VII  | GC Corporation, Tokyo, Japan           | A high-fluoride-releasing glass ionomer with a free-flowing consistency to ensure effective wetting and intimate adhesion to tooth surfaces The fine fluorooxaluminosilicate glass filler allows a smooth surface finish and the incorporation of strontium in the glass provides radiopacity, enhanced remineralization capabilities, and a sharp snap set | 1805071 |

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in deionized water; and (iii) specimens were immersed in a remineralizing solution (artificial saliva) with pH 7.0 for 6 hours each day. The demineralizing solution consisted of acetic acid buffer with 2.2 mM calcium (CaCl$_2$), 2.2 mM phosphate (Na$_2$HPO$_4$), and 0.05 M acetic acid. The remineralizing solution included 1.5 mM of calcium, 0.9 mM of phosphate, and 0.15 M KCl. During the pH cycling, fresh solutions were used between the cycles. The pHs of acetic acid and artificial saliva were recorded using the Bench-top digital pH meter (Mettler-Toledo India Ltd. Mumbai, India). After the completion of pH cycling regimen, the specimens were washed with deionized water and stored in distilled water at 4°C until nanomechanical properties could be determined.

**Determination of Nanohardness and Elastic Modulus**

The specimens were embedded in self-cure acrylic resin such that the flat surface of tooth was obtained. The specimens were cleaned in ultrasonic bath filled with distilled water. In the present study, indentation was performed parallel to the enamel rod direction and on the occlusal enamel margin of the restoration at a distance of 100, 200, and 300 μm from the restorative margin (Fig. 1A).

A nanoindenter (Hysitron Triboscope, Minnesota, USA) (Fig. 1B) equipped with a 10-μm spherical indenter tip was used to measure nanohardness and elastic modulus of the specimens. A single load of 5 microNewton was applied on the enamel. The load function consisted of a linear loading segment (16s at 312.5 nN/s), a holding segment (10s) at peak load, and a linear unloading segment (16s at 312.5 nN/s). During the indentation test, the indenter was driven into the enamel specimen and then withdrawn by decreasing the applied force. The displacement of the indenter into the enamel was measured and the size of the contact area at full load was estimated from the depth of penetration with the known geometry of the indenter.\(^{17}\)

The mean contact pressure, and, hence, indentation hardness ($H$), for an impression made with a spherical indenter is given by following equation:

$$H = \frac{P}{A} = 4\frac{P}{\pi d^2}$$

where $P$ is maximum indentation load and $d$ is the diameter of the contact circle at full load.\(^{17}\)

When load is removed from the indenter, the material (enamel) attempts to regain its original shape, but it is prevented from doing so because of plastic deformation. However, there is some degree of recovery due to the relaxation of elastic strains within the material. An analysis of the initial portion of this elastic unloading response gives an estimate of the elastic modulus of the indented material.\(^{17,18}\)

The Hysitron TriboScan computer software incorporates the basic instrument operation, data collection, and analysis tools. The applied load and depth of penetration into the specimen were continuously monitored and a load vs displacement plot was produced, from which the surface hardness and elastic modulus were determined (quasi-static mode) and data tabulated (Fig. 2).\(^{18}\)

**Polarized Light Microscopic Assessment**

Representative specimens from each subgroup were selected for light microscopy. Longitudinal sections in the buccolingual direction (130 ± 20 μm thickness) were made through the restoration by mounting the specimens on an acrylic block using a hard tissue microtome (Leica SP1600, Leica Biosystems Nussloch GmbH, Heidelberger Str). A polarized light microscope (AxioScope A1, Carl Zeiss Microscopy GmbH, Germany) was used to view the specimens and enamel photographed at a magnification of 40× in an imbibition media of distilled water with a digital color video camera (AxioCam ICc 1, Carl Zeiss Microscopy GmbH, Germany).

**Statistical Analysis**

The mean surface hardness and elastic modulus of normal and fluorosed enamel were analyzed by one-way ANOVA and Scheffe’s post hoc test. The Student’s $t$-test was used to compare normal and fluorosed enamel adjacent to various restorative materials. The analysis was performed with Statistical Package for the Social Sciences (SPSS 22.0, SPSS Inc., Chicago, IL, USA), and $p < 0.05$ was considered significant.

**Results**

The mean and standard deviation of nanohardness and elastic modulus for normal and fluorosed enamel adjacent to various restorations are given in Tables 2 and 3. Within the normal enamel group, significant differences were noted between various restorative materials. The nanohardness values in the enamel adjacent to CN, EF, and GIC were statistically similar at 100 and 200 μm distance from the margin of the restoration. The least nanohardness was found in the enamel...
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restored with TNC, which was statistically significant (p < 0.05). However, at 300 μm the nanohardness of the enamel adjacent to TNC and GIC were similar (Fig. 3A).

Within the fluorosed enamel, significant differences were noted between the nanohardness values in cavities restored with various restorative materials at all nanoindentation distances. The highest values were observed in cavities restored with EF and CN, while TNC and GIC showed lower nanohardness values. The nanohardness values for normal enamel were consistently higher than those for fluorosed enamel.

Table 2: Mean (SD) of nanohardness (GPa) of normal and fluorosed enamel adjacent to the different restorative materials

| n = 10 | Normal enamel | Fluorosed enamel |
|--------|---------------|------------------|
|        | 100 μm | 200 μm | 300 μm | 100 μm | 200 μm | 300 μm | p value |
| TNC    | 1.8259A | 1.6250A | 1.5230A | 1.1750B | 1.2010B | 1.2150B | p < 0.05 |
| (0.61881) | (0.51528) | (0.51554) | (0.05017) | (0.07680) | (0.12510) |
| CN     | 3.2370A | 2.9040A | 2.4380A | 3.1330B | 2.7580B | 2.5680B | p < 0.05 |
| (0.26725) | (0.18075) | (0.45912) | (0.31081) | (0.33349) | (0.42066) |
| EF     | 2.9554A | 2.6560A | 2.3250A | 3.6700B | 3.4150B | 3.0690B | p < 0.05 |
| (0.35656) | (0.36710) | (0.38965) | (0.21380) | (0.30668) | (0.36580) |
| GIC    | 3.1500A | 2.9880A | 1.9380A | 3.3340B | 2.8050B | 2.5100B | p < 0.05 |
| (0.56218) | (0.62762) | (0.54613) | (0.22036) | (0.24204) | (0.28154) |

Mean values with different superscripts are significantly different from each (p < 0.05) as indicated by Scheffe’s post hoc test and independent t-test. Different small letters in superscript represent the significance among materials in a group (fluorosed or normal enamel). Different capital letters in superscript represent the significance among respective restorative material in normal and fluorosed enamel.

Table 3: Mean (SD) of elastic modulus (GPa) of normal and fluorosed enamel adjacent to the different restorative materials

| n = 10 | Normal enamel | Fluorosed enamel |
|--------|---------------|------------------|
|        | 100 μm | 200 μm | 300 μm | 100 μm | 200 μm | 300 μm | p value |
| TNC    | 59.7870A | 48.2580A | 45.7800A | 53.1560B | 52.5960B | 45.7730B | p < 0.05 |
| (3.92700) | (4.46453) | (2.01158) | (4.18328) | (5.08234) | (1.98822) |
| CN     | 66.0900A | 55.3050A | 49.8360A | 65.4710B | 60.3930B | 56.7210B | p < 0.05 |
| (1.82723) | (2.84077) | (5.73121) | (4.59394) | (2.84900) | (3.58522) |
| EF     | 65.6230A | 61.6590A | 54.9440A | 62.086B | 57.5650B | 47.3150B | p < 0.05 |
| (2.68366) | (3.29097) | (5.31988) | (2.39491) | (3.27241) | (3.40217) |
| GIC    | 64.920A | 61.046A | 57.341A | 65.7130B | 58.4520B | 50.5230B | p < 0.05 |
| (2.34279) | (2.51193) | (5.63215) | (1.98577) | (2.70683) | (5.45896) |

Mean values with different superscripts are significantly different from each (p < 0.05) as indicated by Scheffe’s post hoc test. Different small letters in superscript represent the significance among materials in a group (fluorosed or normal enamel) at various distance from the restoration margin. Different capital letters in superscript represent the significance among respective restorative material in normal and fluorosed enamel.
The nanohardness values were found in the enamel restored with EF and least for TNC ($p < 0.05$). The nanohardness values of the enamel adjacent to CN and GIC were statistically similar (Fig. 3B).

Comparing the enamel nanohardness in normal vs fluorosed teeth restored with similar material, the following conclusions can be drawn. In cavities restored with EF, the enamel nanohardness of fluorosed teeth was higher than the normal teeth and was statistically significant ($p < 0.05$). With CN and GIC, no significance was noted in enamel nanohardness for fluorosed and normal teeth ($p > 0.05$). However, enamel nanohardness in normal teeth restored with TNC was better than fluorosed teeth ($p < 0.05$).

Statistically significant differences were also found for elastic modulus of the enamel adjacent to various materials in both normal and fluorosed teeth ($p < 0.05$) (Table 3 and Fig. 4).

Nanohardness results were correlated with the polarized light microscopy, and outer surface lesions were observed. The enamel birefringence was observed, and area of demineralization was appreciated. For composites, in both fluorosed and normal teeth, demineralization could be observed (Fig. 5).

**Discussion**

The mechanical behavior of normal and fluorosed enamel is important both for the clinicians as well as the material scientists. Difference between the mechanical properties of the enamel and the restorative material can cause excessive wear of the opposing natural tooth or the restorative material itself. Hence studies have emphasized the importance of understanding the nanomechanical properties of the normal or fluorosis enamel for appropriate selection of the restorative material.

Nanoindentation testing was used in the present study to evaluate the hardness due to the various advantages like evaluation of mechanical properties of very small, submicrometer volumes that can be measured with fine spatial resolution, nondestructive method, and the specimens can be prepared in a less time. The spherical indenter used for nanoindentation has advantages like the blunt smooth geometric tip ensured the initial penetration on contact is limited, especially for soft materials, and ability to follow the transition from elastic to plastic behavior of the test material.

Significant attention is given to the remineralization repair of acid-demineralized enamel. Many of the studies focused on morphological change of the enamel surface caused by remineralization, while there is a limited research on the microtribological behavior of the remineralized enamel. Hence, the present study was aimed to determine and compare the nanohardness and elastic modulus of normal vs mild fluorosis enamel.

Studies have shown that fluoride-containing restorative materials effectively protected the tooth tissues from demineralization in the region near to the restorative materials due to release of fluoride ions. The aqueous phase of fluoride surrounding dental tissues inhibits demineralization much more effectively than fluoride incorporated into crystals of apatite. Also, when the pH drops, fluoride precipitated onto the tooth surfaces in the form of CaF$_2$, which acts as a reservoir of fluoride.

The calcium released from calcium-fluorosilicate glass could facilitate mineralization and also has the ability to improve remineralization in conjugation with fluoride. Release of hydroxide along with fluoride and calcium in response to a drop in the pH value of the oral cavity has been claimed to further prevent demineralization.
demineralization and facilitate enamel rehardening.\textsuperscript{10} However, more studies are required to confirm the beneficial properties of calcium release.\textsuperscript{27}

Among the various materials evaluated, the nanomechanical properties of the enamel adjacent to EF, CN, and glass ionomer were better compared to the composite resin.

The fluorosed enamel adjacent to EF had significantly more nanohardness values compared to the normal enamel. Equia forte is based on a newly developed hybrid filler technology, in which the more voluminous glass fillers are supplemented by smaller, highly reactive fillers that strengthen the restoration. An \textit{in vitro} study comparing the fluoride release and uptake in Type IX GIC, EF fill, Beautifil Bulk, Dyract XP, and TNC concluded that EF exhibited higher nanohardness value, and this is related to more ion release and remineralization.\textsuperscript{28} The enamel nanohardness of fluorosed teeth adjacent to EF was better than CN and was statistically significant.

Cention N had equal influence on the remineralization of normal and fluorosed enamel. An \textit{in vitro} study reported that the microhardness value of the enamel adjacent to CN was higher than TNC restorations.\textsuperscript{10}

GC Fuji VII is a high-fluoride glass ionomeric restorative material. It is claimed to have additionally enriched ionic potential as it contains strontium (Sr) and calcium (Ca). It has high ionic release potential and is indicated in patients with high caries risk.\textsuperscript{29} Thuy et al. proposed the formation of the strontium-apatite complex due to the action of strontium. This can be further supported by the fact that Sr is a homologous element of Ca and acts in a similar way to promote mineralization as an substitute.\textsuperscript{30} Strontium is also known to act in conjunction with fluoride and enhance enamel remineralization.\textsuperscript{31} Ten cate et al. reported the mineral content of the glass ionomer-associated hypermineralized layer to be threefold greater than those for the lesions adjacent to amalgams and resins.

In addition, the hypermineralized area extended up to 300 µm into the underlying tooth structure.\textsuperscript{32}

The significantly lower nanohardness values of TNC in the present study could be due to poor remineralizing property on the adjacent enamel as well as the etching of the enamel during placement of composite. Etching of the enamel could affect the elastic-plastic response of the enamel to nanoindentation. In etched enamel, there is a dramatic increase in indentation depth, resulting in lower hardness. The hardness of unetched enamel was 3.3 GPa compared to 2 GPa of etched enamel.\textsuperscript{9,33}

The typical load-displacement curves in Figure 1 show successful and comparable indentations. The graphical representation of increased indentation depth is correlated to the less dense prism structure in the projected contact area due to the mineral loss after pH cycle regimen and less remineralization.\textsuperscript{9}

Factors like the crystal characteristic of the mineral deposition may strongly influence the remineralization of the enamel. For normal enamel, the mineral substances are mostly the hydroxyapatite (HA) crystal with a high crystallinity, and crystals oriented along the rod axis, allowing the enamel to have excellent mechanical property. However, in enamel fluorosis, the mechanical behavior is altered due to structural changes as a result of high fluoride content.\textsuperscript{10} This is mostly attributed to interferences from excess fluoride intake during tooth formation.\textsuperscript{1} This results in excess matrix protein retention, enamel rod hypomineralization, a loose crystalline arrangement of the enamel rod, and a chemical change in the HA crystal.\textsuperscript{2}

The role of minor organic components of the enamel on the mechanical properties has been emphasized by various studies.\textsuperscript{10,34} Fejerskov et al. have reported that increased fluoride in the enamel leads to subsurface porosity, due to widening of space between the enamel rods and the elimination of the interprismatic substance between the enamel rods.\textsuperscript{35} A study found that the porous
microstructure of fluorosed enamel decreased the nanohardness values of the enamel to 3.894 ± 0.763 GPa, 10% less than the normal enamel with 4.372 ± 0.454 GPa. The elastic modulus of mild mottled enamel (74.532 ± 8.117 GPa) was 14.6% lower than that of normal enamel (87.254 ± 5.421 GPa).11

In the present study, the elastic modulus of the enamel adjacent to various materials was statistically significant in both fluorosed and normal teeth (p < 0.05). Enamel adjacent to CN exhibited higher elastic modulus, and least was found for TNC. Studies have concluded that under selected conditions, only partial remineralization of the softened enamel surface layer occurs where some pores remain unrepaired. Hence, the nanoindentation elastic modulus shows an improvement following remineralization but nanohardness values do not improve.36 In the present study, EF exhibited less elastic modulus but better hardness values than CN and glass ionomer probably due to its hybrid fillers that could better repair and remineralize fluorosed enamel than other materials. Waidyasekera et al. in an in vitro study determined the impact of dental fluorosis severity on demineralization and remineralization of the human enamel and dentin and concluded that the moderately fluorosed enamel showed a significant resistance to caries, but mild and moderately fluorosed dentin was susceptible to demineralization.37

A polarized light microscope was used for qualitative assessment of remineralization. The polarized light microscope can give a high degree of differentiation between demineralized area and the normal area of the tooth sample.14 When seen under the polarized light microscope, areas of demineralization were observed as the dark band outlining the enamel. The dark zones were more prominent in samples restored with the composite resin compared to those restored with EF, CN, or GC Fuji VII (Fig. 5). These findings corroborate to the results of a previous study by Gonzalez et al.16 Some specimens lost the restorative materials during specimen processing.

It is important to understand that studies on nanoindentation can have variable results based on the direction of enamel rods.7 In the present study, the nanoindentation test was done parallel to the enamel rods, i.e., on the enamel surface.9 Another variable is the load applied during the nanoindentation. The nanohardness results are unique to this study, given the methodology related to the pH cycling, the type of indenter, different load applied, the surface of enamel utilized for evaluation, and the rate and type of remineralizing components released from different restorative materials. Hence, the results of the present in vitro study have to be interpreted with caution and the results cannot be directly correlated to clinical situations.

There is a need for future in vivo and in vitro controlled studies on the nanomechanical behavior of fluorosed enamel and the role of newer restorative materials on remineralization and prevention of secondary caries.

**Conclusion**

Within the limitations of the present study, we conclude the nanomechanical behavior of fluorosed and normal enamel was influenced by the type of restorative material. Equia forte could be used as an appropriate restorative material in fluorosed teeth, followed by CN and GIC. In normal teeth, any of the three ion-releasing materials could be used; however, CN imparted higher hardness among others. Surface nanohardness of the enamel adjacent to TNC was least indicating poor remineralizing property.

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