Comparative Evaluation of microhardness of type 2 Glass Ionomer Cement (restorative) and Zirconia based GIC - An In-Vitro Study

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Abstract:

Aims: To evaluate the microhardness of type II glass-ionomer cement (GIC) (restorative) and zirconia based glass –ionomer cement.

Materials and Methods : Twenty cylindrical samples measuring 5mm (diameter) and 5mm in length were prepared with type II glass-ionomer cement that is restorative (n=10) and zirconia based glass-ionomer-cement (n=10). Finishing and polishing was made with coarse grit to fine grit. Then samples were subjected to Vickers hardness tester by using digital micro hardness tester (Zwick/Roell) under a load of 300 grams for 15 seconds. The data obtained was subjected to statistical analysis and unpaired't' test was used to compare the micro hardness between two groups.

Result: Zirconia based glass-ionomer cements showed better micro hardness values as compared to that of type II glass-ionomer cement (restorative).

Conclusion: Better material with increased hardness like zirconia based GIC should be used in today's clinical practice. Further studies should be carried out to check other physical properties of zirconia based GIC.

Keywords: Glass-ionomer-cement (GIC), Vickers hardness (VHN), Zirconia based GIC.

Introduction

The facts regarding hardness and the way of its measuring should be known. In mineralogy the relative hardness of a substance is based on its ability to resist scratching. In metallurgy and most other disciplines, the concept that is most generally accepted is that of "Resistance to Indentation". Modern hardness test depends on "Resistance to Indentation" method. The indentation produced by the machine on the material is useful to calculate the hardness of the material. The properties related to hardness are compressive strength, proportional limit, and ductility.1 Micro-hardness is one of the most important physical characteristic for a comparative study of dental materials.3The test most frequently used in dentistry are Barcol, Brinell, Rockwell, Shore, Vickers, and Knoop. The Brinell hardness are used to determine hardness of metal and metallic materials used in dentistry.

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The Vickers and Knoop hardness are used as micro-hardness tests. In Vickers a square based pyramid is used for indentation. Vickers hardness number usually abbreviated as HV (or) VHN. The length of the diagonals of the indentation are measured and averaged. The Knoop and Vickers test employ loads less than 9.8 N. The resulting indentations are small and limited to depth of less than 19 µm. Hence they are capable of measuring the hardness in small regions of thin objects.[1] As we know, GIC are widely used before and at present era. The use of polyacrylic acid makes GIC capable of bonding to tooth structure. It is considered superior to other in sense of adherence and translucency. GIC can be cured chemically, light or both. They are available in powder/liquid form (or) single capsule system. They are used as intermediate restoration, luting, liners and bases.[1,2] Type II – GIC(Restorative) is used for class III and class V cavities. The advantage of using type II GIC in this study is because of widely used, improved properties, adherent, translucent and release of fluoride, which act as an anticariogenic.[1,2] Zirconia based material are widely used alone or in combination with other materials because of its excellent property. The good mechanical property of this material is a result of a very small grain size, extremely low porosity and transformation toughening. The Zirconia based materials are biocompatible. No local or systemic cytotoxic effects or adverse reactions have been traced to zirconia.[1] Zirconia has been used in various

biomaterials for its strength and hardness. It is used in composites, in finishing strips, prophylaxis paste and in machined restoration.[1,2] Therefore the present study was undertaken to compares the differences in micro-hardness of restorative GIC type II and zirconia based GIC.

Materials and Methods

Twenty cylindrical samples measuring 5mm (diameter) and 5mm (length) were prepared with type II GIC (restorative) (n=10) [GC company, 76-1 Hasunuma -Cho, Itabashi-Ku, Tokyo, Japan] and Zirconia based GIC i.e. , Zirconomer [Shofu Inc, Kyoto, Japan] (n=10) (Fig1).

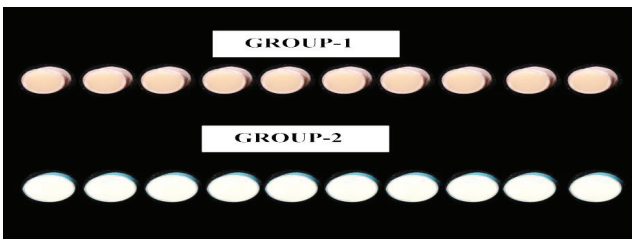


Fig. 1:
Group 1: cylindrical samples of type 2 GIC,
Group 2: cylindrical samples of zirconia based GIC.

The GIC for both group i.e., group I: Type – II GIC and group II i.e., Zirconia-based GIC were in powder and liquid form. Both cements were mixed (manipulated) according to the manufacturer instruction and allowed to set in plastic mould. After material was set it was finished with coarse to fine grit abrasive paper.

Group I: 10 cylindrical samples with type II GIC
Group II: 10 cylindrical samples with Zirconia based GIC (Fig.1)

Then the samples were subjected to Vickers micro hardness tester (Zwick/Roell). The load applied was 300 Gram for 15 sec. Four indentations were made on each sample with the Vickers microhardness indentor and the values were calculated accordingly depending on the depth of indentation and measuring the diagonals of the indentation and average value for each samples were taken (Table 1).

Table1: Values of microhardness of samples (VHN)

GROUPS	1	2	3	4	4	6	7	8	9	10
GROUP 1	31.2	32.5	31.8	33.2	30.3	32.9	34.6	33.3	31.1	32.6
GROUP 2	53.1	55.6	56.2	59.1	53.8	55.2	54.4	56.8	52.2	57.2

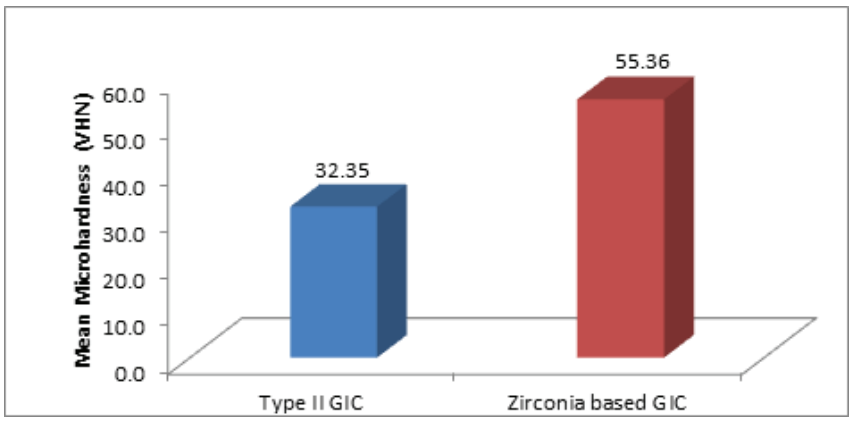
Results were presented as mean, standard deviation (SD) and range values. Unpaired‘t’ test was used to compare between two groups (Table 2). The current study showed better Vickers microhardness values (VHN) for Zirconia based GIC (55.36) which is group 2 as compared to that of type II GIC (32.35) (Graph 1).

Table1: Values of microhardness of samples (VHN)

Groups	Microhardness (VHN)				Type II GIC v/s Zirconia based GIC		
	Mean	SD	Min	Max.	Mean Diff	t value *	P value
Type II GIC	32.35	1.27	30.30	34.60	23.01	29.94	<0.001, HS
Zirconia based GIC	55.36	2.07	52.20	59.10			

*** Unpaired t test**

Graph 1: Micro hardness between two types of GIC



Discussion

The current study evaluated the microhardness of type II GIC and zirconia-based GIC. Microhardness is one of the most important physical characteristic for comparative study of dental materials.[3] The importance of microhardness test lies in the fact that it throws a light on the mechanical properties of a material. Hardness is the resistance of a material to plastic deformity typically measured under an indentation load. There are various test to check hardness like Barocal, Brinell, Rockwell, Shore, Vickers and Knoop. Most commonly used macrohardness test are Brinell and Rockwell. Vickers and Knoop are most commonly used microhardness test in dentistry. Both Vickers and knoop test employ loads less than 9.8 N. The resulting indentation are small and are limited to a depth of 19 µm. Hence they are capable of measuring the hardness in small regions of thin objects.[1] Vickers and Knoop hardness tests seem to be preferred choice of test among majority of the investigators.[4,5,6,7] In the current study Vickers microhardness testing (VHN) was done with digital microhardness tester (Zwick/Roell). The load applied was 300 grams with a dwell time of 15 seconds.The load applied from the various studied ranged from 200 gm to 500 gm with dwell time from 10-20 seconds.[8,9]In the current study, we used type II GIC as it is widely used before and at present era. The use of polyacrylic acid makes GIC capable of bonding to tooth structure. GIC is used as restorative and for other uses like luting, liners and bases. GIC has got improved physical properties, adherent to tooth structure, translucent and release of fluoride, which act as an anticariogenic.[1,2] GIC from past has been modified either in powder or in liquid to have an added advantage of properties of the same. There are various modification in GIC like resin-modified GIC, metal-modified GIC, high-viscosity GIC, cermet and so on.[2] In this study the modified GIC that is addition of zirocnia to GIC has been utilized. As we know zirconia based matrials are widely used alone or in combination with other materials because of its excellent property. The good mechanical properties of this material are a result of a very small grain size, extremely low porosity, and transformation toughening. The zirconia based material are biocompatible. No local or systemic cytotoxic effects or adverse reaction have been traced. It is used in composite, in finishing strips, prophylaxis paste and in machined restoration.[1,2] From the current study, it showed that zirconia based glass-ionomer showed better Vickers microhardness(55.36 VHN) as compared to that of type II GIC(32.35). The zirconia incorporated in GIC is in the form of zirconium-oxide.[1] The current study emphasized the addition of zirconia to conventional type II GIC resulted in the improved physical properties of the GIC with respect to its hardness. Further research is needed to carryout to check other physical and chemical properties of zirconia based GIC.

Conclusion

With certain limitations of this study, it can be concluded that zirconia-based GIC showed better microhardness as compared to that of type II GIC.

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How to cite this article:
Lokhande P, Shivanna V. Comparative evaluation of micro hardness of type 2 Glass Ionomer cement (restorative) and Zirconia based GIC- An in vitro study. CODS J Dent 2015;7: 4 -7

Source of support: Nil. **Conflict of interest**: None Declared.