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Original Research Article

Comparative Evaluation of Compressive Strength of Ketac Molar, Zirconomer, and Zirconomer Improved

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Abstract: The ability of a dental restorative material to withstand occlusal forces is one of the major properties to be taken into consideration in restorative practice. Various materials are commercially available, exhibiting harmonious bonding to withstand better masticatory forces. The aim of this study was to evaluate and compare the compressive strength of restorative materials Ketac Molar, Zirconomer, and Zirconomer Improved. For compressive strength evaluation, 30 cylindrical specimens were fabricated measuring 3 mm in diameter and 6 mm in height and grouped into three study groups (n = 10): Group I (Ketac™ Molar, 3M, ESPE), Group II (Zirconomer, Shofu Inc., Japan), and Group III (Zirconomer Improved, Shofu Inc., Japan). Data analysis and statistical differences were ascertained using one-way ANOVA with Tukey post-hoc test ($p<0.05$). Highest compressive strength was exhibited by Zirconomer (321.92 MPa) followed by Zirconomer Improved (302.23 MPa) and Ketac Molar (261.53 MPa). The results analyzed were statistically significant with p-value of <0.001. All the tested restorative materials exhibited sufficient compressive strengths with Zirconomer exhibiting significantly higher compressive strength.
Keywords: Ketac Molar, Zirconomer, ANOVA

INTRODUCTION:

The objective of the use of any restorative material is to substitute the biological, functional and esthetic harmony of the lost tooth structure [1]. Evolution of restorative materials is imperative for better delivery of treatment. Thus the newer materials should exhibit significantly better properties than its predecessors [2]. The compressive strength of a material is any important factor to be considered in relation to masticatory forces. This property is the resistance exhibited by a restorative material against intraoral compressive and tensile forces which are produced both in function and para function. It is the amount of stress required to distort the material in an arbitrary amount [3]. Hence it is essential for a material to exhibit good compressive strength.

Glass ionomer cements have been commercially available since nearly 25 years, with continuous advancements setting new standards one such material being Ketac molar which is widely used [4]. The introduction of newer materials was initially due to the diminution of the large popularity of amalgam which has been attributed to its mercury content. These newly introduced materials such as Zirconomer as per manufacturer's claims are strong and safe replacements imbibing the strength of amalgam and the various advantages of glass ionomer. The structural integrity has been attributed to the inclusion of zirconia fillers in the glass component thereby imparting better strength [5-7]. Zirconomer Improved developed as a reliable and durable self-adhesive tooth coloured zirconia reinforced posterior bulk fill restorative comprises of nano-sized zirconia fillers to enhance aesthetic properties and superior handling characteristics. [7]. The success of any material is assessed by its longevity and biocompatibility in oral environment [8]. The objective of this study was to compare and evaluate the compressive strength of the Ketac Molar, Zirconomer and Zirconomer Improved.

MATERIALS AND METHODS:

A custom made stainless steel mould was utilized to fabricate cylindrical samples of the materials measuring 3 mm diameter and 6 mm height. A total number of thirty samples were fabricated according to three experimental groups (n = 10): Group I (Ketac Molar, 3M, and ESPE), Group II (Zirconomer, Shofu Inc., Japan) and Group III (Zirconomer Improved, Shofu Inc., Japan). The test materials were manipulated

as per the manufacturer's instructions and expressed slowly to prevent formation of voids into the mould coated with Vaseline until it was slightly overfilled. The excess material was removed and surface was smoothened using a Mylar strip. All specimens were stored in distilled water for 24 hours prior to testing. The materials were subjected to compressing testing in a Universal Testing Machine (Instron 3366) at a crosshead speed of 0.5mm/min.

The data obtained subsequent to compressive strength testing were analyzed using one-way ANOVA to establish the statistical significance between the groups followed by Tukey test for post-hoc comparison.

RESULTS:

Table 1: One way ANOVA comparison of compressive strength (MPa) between the study groups

Group	N	Mean	Standard Deviation	Minimum	Maximum
Group 1 Ketac Molar	10	261.53	0.55	260.79	262.22
Group 2 Zirconomer	10	321.92	1.41	319.83	323.19
Group 3 Zirconomer Improved	10	302.23	0.91	300.32	303.25
ANOVA	F value – 9143.28, p-value <0.001*				

*p<0.05 statistically significant

The results of the study show that Group 2 Zirconomer has the highest compressive strength mean value of 321.92±1.41 followed by Group 3 Zirconomer Improved 302.23±. The least compressive strength value was exhibited by Group 1 Ketac Molar 261.53±0.55. A statistically significant p-value of <0.001 was exhibited.

Table 2: Pairwise comparison of compressive strength (MPa) between the study groups based on Tukey post-hoc test

(I) Group	(J) Group	Mean Difference (I-J)	Standard Error	p-value	95% Confidence Interval	
					Lower Bound	Upper Bound
Group 1 Ketac Molar	Group 2 Zirconomer	-60.39	0.46	<0.001*	-61.52	-59.26
	Group 3 Zirconomer Improved	-40.70	0.46	<0.001*	-41.83	-39.57
Group 2 Zirconomer	Group 3 Zirconomer Improved	19.69	0.46	<0.001*	18.56	20.82

*p<0.05 statistically significant

A statistically significant p-value of <0.001 was seen between the study groups. Highest mean difference in compressive strength value (MPa) of 60.39 was observed between Group 1 Ketac Molar and Group 2 Zirconomer. Mean difference of 40.70 was observed between Group 1 Ketac Molar and Group 3 Zirconomer Improved. Least mean difference value of 19.69 was observed between Group 2 Zirconomer and Group 3 Zirconomer Improved.

DISCUSSION:

The availability of variety of restorative materials in the field of dentistry results in continual scrutiny of the properties of the material. This is to ensure the right choice of the material for clinical purposes which would adhere optimally to the tooth structure and which can withstand the masticatory forces [10]. Compressive strength testing is commonly used as a measure by which clinicians and researchers predict the performance of a restorative material in oral environment.

The increase in compressive strength in Ketac Molar when compared to conventional glass ionomer cements has been attributed to the introduction of high concentration of glass fillers [11-14]. Zirconomer which exhibited the highest compressive strength value in this study contains zirconium oxide, glass powder, tartaric acid, polyacrylic acid with deionized water as the liquid. The superior mechanical property is ascribed to

the inclusion of zirconia fillers. The glass component in Zirconomer is subjected to finely controlled micronization to achieve optimum homogenous particle size and further leading to enhanced mechanical property such as higher strength. Homogeneity of the glass particles further reinforces the durability of the material and the strength to withstand occlusal load [14, 15]

Zirconomer Improved which exhibited better compressive strength than Ketac Molar as per manufacturer's claims has the durability of amalgam. The material reinforced with nano-zirconia fillers is responsible for imparting enhanced mechanical properties especially making it suitable for posterior load bearing areas as per various studies [14, 15]. In this study Zirconomer and Zirconomer Improved both exhibited compressive strength values of over 300 MPa after 24 hours as per the limit set by ISO for materials to be used as posterior restoratives.

CONCLUSION:

According to the results obtained in the study, best compressive strength value was exhibited by Zirconomer followed by Zirconomer Improved and Ketac Molar.

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