IP Annals of Prosthodontics and Restorative Dentistry 2024;10(3):220–223

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IP Annals of Prosthodontics and Restorative Dentistry

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

Original Research Article

Comparative evaluation of the fracture resistance of different core build up materials – An ex vivo study

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ARTICLE INFO

Article history:
Received 10-05-2024
Accepted 17-07-2024
Available online 16-08-2024

Keywords:
Fracture resistance
Paracore
Muticore luxacore

ABSTRACT

Aim: The aim of this study was to evaluate and compare the fracture resistance of ParaCore, luxacore, multicore in permanent anterior teeth using universal testing machine.
Materials and Methods: Eighty recently extracted intact caries free Human Permanent Mandibular Premolars and disinfected according to CDC guidelines on infection control in dental health-care setting 2003. The teeth were then randomly assigned to four groups on the basis of material used (Group A – Multicore, Group B – Luxacore, Group C – Paracore, and Group D – control group, without any core buid up), each group consisting of 20 samples. The dentin surface was treated with the respective adhesives of the groups and then bulk filled with core build-up materials. The attained samples were than subjected to shear loading in Instron Universal Testing Machine. The data were tabulated and statistically analyzed using analysis of variance, Tukey's HSD test.
Results: MultiCore material had the greatest fracture resistance followed by Group B and then group C. The least strength exhibited was by Group D – Control group preceded by Group A – ParaCore.
Conclusion: MultiCore showed the highest fracture resistance followed by Luxacore, ParaCore, and control group

1. Introduction

Tooth structure has been substantially compromised by fracture, widespread caries, or other factors; core build up is required as a framework for post-endodontic restorations.[1] The core needs to provide resistance and retention for the coronal restoration as well as sufficient capacity to withstand occlusal forces since it becomes a vital feature of the tooth's load-bearing structure.[2]

The physical properties of a core build-up material should imitate tooth structure. When a tooth has been restored, a complicated pattern of stress distribution is permitted along the tooth and restoration interface, creating compression, tension, or shear stress.[3,4]

Various dual-cured versions of resin composite build-up restoratives that combine the advantages of light curing and self-curing mechanism have been introduced, with the rationale to develop a material capable of reaching higher degree of polymerization in either the presence or absence of light, and overcome the limitations of reduced interlayer strength.

Dual cure core build up materials provide appropriate properties as, for instance, sufficient flexural and compressive strength and flexural modulus to resist multidirectional masticatory forces. Improvements in fracture resistance accompanied by a paradigm shift from

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https://doi.org/10.18231/j.aprd.2024.042

"post-and core stabilization" to "adhesively restored core retention" have stimulated the increasing use of resin-based materials for core build-up.[5]

2. Materials and Methods

Eighty recently extracted intact caries free Human Permanent Anterior teeth with single straight root canals and mature apices were selected. The teeth were sectioned horizontally with a carborundum disk beneath the dentinoenamel junction to expose the coronal dentin surface and later finished with silicon carbide paper to create a uniform flat surface. The teeth were then randomly assigned to four groups on the basis of material used (Group A – multicore, Group B – luxacore, Group C –paracore, and Group D – control group), each group consisting of 20 samples.

2.1. Group A

The prepared dentin surface was treated using Tetric N-bond self-etch followed by light-curing for 10s using curing light. Readymade polyvinyl molds of 5 mm internal diameter and 5 mm height, coated with non-reactant lubricant (petroleum jelly) on inner walls, were placed on the treated dentin surface and subsequently bulk filled with Multicore at room temperature. These were then initially light-cured for 10 s per surface to initiate polymerization and to achieve final set, left for 8 min for autopolymerization.

2.2. Group B

Dual-cure adhesive system LuxaBond Total Etch is used. It is essential to etch the affected dentine surfaces. Apply bonding agent, followed by light-curing for 10 s using curing light (550 mW/cm2). Readymade polyvinyl molds of 5 mm internal diameter and 5 mm height, coated with nonreactant lubricant (petroleum jelly) on inner walls were placed on the treated dentin surface and subsequently bulk filled with luxacore at room temperature. These were then initially light-cured for 10 s per surface to initiate polymerization and to achieve final set, left for 8 min for auto-polymerisation.

2.3. Group C

The dentin surface was treated with ParaBond Non-Rinse Conditioner, scrubbed for 30 s, followed by application of premixed adhesive A and adhesive B on conditioned dentin surface for 30 s and air drying for 2s. Readymade polyvinyl molds of 5 mm internal diameter and 5 mm height, coated with non-reactant lubricant (petroleum jelly) on inner walls were placed on the treated dentin surface and subsequently bulk filled with ParaCore at room temperature. These were then initially light-cured for 10s per surface to initiate polymerization and to achieve final set, left for 8 min for autopolymerization. Molds were disassembled and will be stored at 100% humidity at 37°C and samples were subjected to SBS testing using Universal Testing Machine.

2.4. Statistical analysis

The data obtained were subjected to statistical analysis using the Statistical Package for the Social Sciences (SPSS Version 23; Chicago Inc., IL, USA). Data comparison was done by applying specific statistical tests to find out the statistical significance of the comparisons.

Variables were compared using mean values and standard deviation. The mean for different readings between the groups was compared using one-way analysis of variance (ANOVA), and the intercomparison between each group was done using Tukey's post hoc analysis. $P < 0.05$ was considered to be statistically significant [Figure 1 and Table 1].

3. Results

One-way ANOVA analysis showed that Group A – Multicore material had the greatest Fracture Resistance with a mean of 19.0414 + 0.44929, followed by Group B – Luxacore with 10.1526 + 0.99155 which was statistically significant at P = 0.000. The least strength exhibited was by Group D – control group at a mean of 4.2548± 0.32298 preceded by Group C – ParaCore.

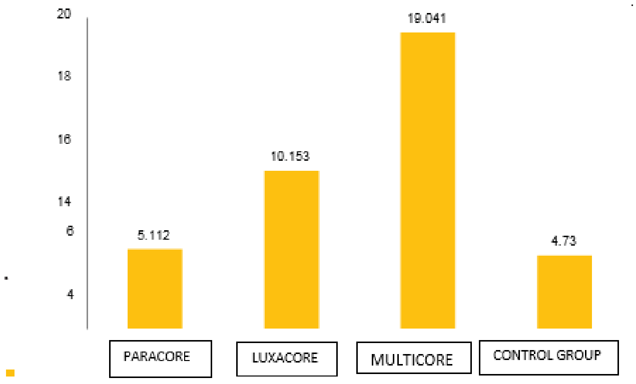

Figure 1: Fracture resistance of different core build up material.

4. Discussion

Fracture resistance are gross assessing tools for evaluating the efficacy of strength of restorative materials to dentin. Fracture resistance values are a general way of measuring how well restorative materials resist fracture of teeth. The Fracture resistance test, is the least technique-sensitive of the several tests.[1]

Resin composites have several practical advantages. They can be translucent and tooth-colored. Thus, they do not darken teeth. They can also be selected for color contrast

Table 1: Comparative evaluation of shear bond strength among different materials

Variable	Mean	SD	SE	ANOVA statistic	Df	P -value
Group C – ParaCore	5.1120	0.20870	0.09333	690.978	3	0.000*
Group B – Lxacore	10.1526	0.99155	0.44344			
Group A – MutliCore	19.0414	0.44929	0.20093			
Group D – Control	4.2548	0.32298	0.14444			

against tooth structure, to facilitate tooth preparation for crowns. They can be bonded to teeth using dentinal adhesives. For the convenience, either light initiated or auto-curing materials can be selected. As they set quickly, core and tooth preparations can be completed using rotary instrumentation without delay. Excellent adhesion to tooth structure can be achieved with dentinal bonding agents, the long-term stability of such bonds is unknown.[6]

There are many composite build-up materials available; most of them are either self-cured, light cured or dual-cured. As the core build up restorations are thicker restorations, the chemical curing capability is considered an added advantage. This is because during the build-up of a restoration, material is placed incrementally and can reach several millimeters in thickness. On light curing, however, the intensity of the light is greatest at the surface and generally decreases as it penetrates deeper within the material.[7]

Restorative composites can be regularly employed for core build-up material. Nowadays, there are many resin composites that are specifically designed for core build-up with increase in fillers for higher strength and enhance for easy manipulation. These materials are different in amount and types of filler, viscosity, curing mode, build-up technique, among others, while their physical properties have been investigated in many aspects.[2]

This study compared the fracture resistance of three different, resin based dual-cure core build-up materials with respective dentin bonding adhesives as provided and recommended by the manufacturer, to achieve the maximum effect of bonding procedure. The present study was done Ex vivo, as the clinical functions and characteristics of dental materials are difficult to evaluate under in-vivo conditions, and clinical trials cannot estimate mechanical properties of restored teeth. Whereas, exvivo tests give the possibility to evaluate mechanical properties of restored teeth, and are considered as a predictor of the possible clinical performance of a material.[1]

Fracture resistance is a pivotal factor in determining the success of dental restorations, particularly when it comes to core build-up materials like MultiCore, ParaCore, and LuxaCore. Each of these materials exhibits unique properties that influence their fracture resistance, making them suitable for different clinical situations.[1]

MultiCore is a dual-cure, resin-based composite material known for its high compressive strength and excellent bonding properties. Its dual-curing mechanism allows for controlled working time and complete curing, even in areas not exposed to light. This ensures a strong, durable build-up capable of withstanding significant masticatory forces. Studies have demonstrated that MultiCore offers robust fracture resistance due to its high flexural strength and elastic modulus, making it an ideal choice for restorations in posterior teeth where mechanical stress is highest.[8]

ParaCore is another dual-cure, resin-based composite designed specifically for core build-ups and post cementation. It combines the benefits of self-curing and light-curing, ensuring thorough polymerization and a strong, reliable bond. ParaCore is reinforced with glass fibers, which significantly enhances its fracture resistance. The presence of these fibers helps to distribute stress more evenly throughout the material, reducing the likelihood of fractures. Additionally, ParaCore's high bond strength to dentin and enamel provides a stable foundation for the overlying restoration, further contributing to its overall durability.[9–12]

LuxaCore, a nano-filled, dual-cure composite, stands out for its exceptional handling properties and superior mechanical strength. The nano-filler technology used in LuxaCore results in a dense, homogenous structure that offers excellent fracture resistance. This material is designed to mimic the natural dentin in terms of both physical properties and handling characteristics. Its high compressive strength and resistance to wear and tear make it particularly suitable for core build-ups in teeth subjected to heavy occlusal loads. Furthermore, LuxaCore's excellent adhesive properties ensure a strong bond to both dentin and post materials, enhancing the overall integrity and longevity of the restoration.[5]

The choice between MultiCore, ParaCore, and LuxaCore should be based on specific clinical requirements. MultiCore is ideal for situations demanding high compressive strength and reliable curing. ParaCore, with its fiber reinforcement, offers enhanced fracture resistance and is excellent for post cementation. LuxaCore, with its nano-filled composition, provides superior mechanical properties and ease of handling. Each material's unique attributes contribute to their suitability for various dental restoration scenarios, ultimately aiming to ensure the longevity and success of the restoration.[6,13–15]

5. Conclusion

Highest fracture resistance shown by Group A (Multicore) followed by luxacore and then Paracore. Least fracture reistance shown by Group D.

6. Source of Funding

None.

7. Conflict of Interest

None.

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Cite this article: Singh A, Gupta P, Rajput R, Dhingra A, Dixit S, Grover S. Comparative evaluation of the fracture resistance of different core build up materials – An ex vivo study. *IP Ann Prosthodont Restor Dent* 2024;10(3):220-223.