CHAPTER 2
MATERIALS & METHODOLOGY
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MATERIALS

The following are the materials used in the study along with their composition and other details:

1. Para Core – Flowable, dual cure buildup material

| Composition of Paracore: Methacrylate + fluorides + barium glass + amorphous silica |

2. Luxacore Z Dual – Flowable, automix, dual curing composite material

| Composition of Luxacore Z Dual: Barium Glass + Pyrogenic Silicic Acid + Nano fillers + Zirconium oxide in a Bis-GMA based dental resin matrix |

3. Fluorocore – Flowable, fluoride releasing dual cured resin core buildup material

| Composition of Fluorocore: Urethane Dimethacrylate + Barium Boron Fluoroaluminiosilicate Glass + Camphorquinone + Photoaccelerators + Silicon Dioxide + Benzoyl Peroxide |

4. Multi Core - Flowable, Dual curing core buildup material

| Composition of Multicore: Dimethacrylates + Barium Glass fillers + Barium Alumino Silicate glass + highly dispersed silicon dioxide + Ytterbium trifluoride + catalysts + stabilizers + pigments. |

Other armamentarium required:

- Mould
- Measuring Scale
- Glass Slab
- Petroleum Jelly
- LED Curing Light
• Mylar Matrix
• Freshly extracted incisor teeth
• Air rotor handpiece
• X Smart
• Different shapes of Burs
• K file
• Protaper file
• Normal saline
• 5% sodium hypochlorite
• GuttaPercha
• Paper points
• Ball burnisher
• Spirit lamp
• Etchant
• Bonding Agent
• Glass fibre posts
• Resin Cement
• Cement spatula
• Composite placing instruments
• RVG unit
• Universal Testing Machine
• Distilled Water

**Inclusion Criteria:** Recently developed flowable composite resins (specifically developed for direct core build up) - Paracore, Fluorocore, Luxacore and Multicore.

**Exclusion Criteria:** Materials not specifically used for direct core build up- Amalgam, Glass Ionomer Cement.

**Type of Study:** Comparative, In Vitro study.
METHODOLOGY

In the first step, a total of 300 specimens were made -75 of each material namely Paracore, Luxacore, Fluorocore, Multicore. They were divided into three subgroups of 25 each for measuring compressive strength, tensile strength and flexural strength respectively. Variables used in the study such as specimen dimensions, testing configuration, strain rate, procedure of fabrication, temperature, storage and setting time were all standardized in the study. All specimens were treated uniformly throughout the work (as per Specification No. 27 of American Dental Association (ADA)).

Preparation of Specimens

The specimen dimensions and shape for each property were selected according to International Standards Organization (ISO, 4049), (ISO, 1992). Compressive strength was measured from cylindrical specimens, 4 × 6 mm (d.h.), tensile strength was measured from dumb bell shaped specimens of size 25× 5mm and flexural strength was measured from rectangular specimens, 40 × 10× 3 mm (l.b.h.).

To prepare the specimens, a stainless steel cylindrical and rectangular mold in two parts was used which was provided by the laboratory. The mold was kept on a glass slab. A flat surface was obtained by keeping a mylar matrix under the mold. Flowable composite resins selected for the study ie, Para Core, Luxacore Z Dual, Multi Core and Flurocore. They were applied in the mold in 2 mm layers until the mould was filled. On reaching the top, again a mylar matrix was placed on top to obtain a smooth surface. Light curing was done for 40 seconds per layer with a light curing unit. Each specimen was cured 10 minutes after preparation for 60 seconds in all directions in order to achieve maximum curing. All the teeth were kept at 37 ± 1°C in distilled water prior to testing.
FIGURE 1: CYLINDRICAL SPECIMENS
FIGURE 2: DUMB BELL SHAPED SPECIMENS
FIGURE 3: RECTANGULAR SPECIMENS
Evaluation of properties

A universal testing machine was used to perform all tests. A Universal testing machine is also known as the material testing machine or materials test frame. We tested the compressive strength, tensile strength and flexural strength of materials using this machine. It is named “Universal” because it can universally carry out all types of standard compression and tensile tests.

Compressive and flexural strength was determined at a-cross head speed of 0.5mm/min and 1 mm/min speed was kept for tensile strength testing. Load was applied on the lateral portion of the cylinder vertically, producing tensile stresses at 90 degrees to the vertical plane passing through the centre of the specimen.

Formula used to calculate compressive strength:
S=F/A
where \( S \) denotes compressive strength in MPa, \( F \) stands for force or load needed to break the specimen in Newton, and \( A \) is the area of the surface where the force is applied in mm\(^2\).

Formula used to calculate tensile strength:

\[
T = \frac{2F}{\pi dh},
\]

Where \( F \) stands for maximum applied load in Newton; \( d \) for mean diameter of the specimen in mm; and \( h \) the length of specimen in mm.

Specimens were made to undergo the three point bending test in the Instron universal testing machine.

Formula used to calculate flexural strength:

\[
\sigma = \frac{3Fl}{2bh^2}
\]

where \( \sigma \) is the flexural strength in MPa, \( F \) is the maximum load in Newton exerted on the specimen; \( l \) is the distance (mm) between the supports \( \pm 0.01 \) mm; \( b \) is the width (mm) of specimen just before subjecting to test; and \( h \) is the height (mm) of specimen measured just before subjecting to test.

In the second step, 100 freshly removed maxillary central incisors were obtained from Oral & Maxillofacial Surgery Section of Rama Dental College, Hospital & Research Centre. Ethical clearance was taken to use them for the study. Teeth which were of approximately similar dimensions (minimum 18mm measured from root tip to coronal portion) which were free of cracks, caries, fractures and with single root canal were selected. Teeth were observed under magnification for cracks and radiographed for the presence of single canal. All the teeth were scaled using an ultrasonic scaler to remove calculus. Normal saline was used to store the teeth until use.

All 100 maxillary central incisors were randomly divided in 4 groups of 25 teeth each, one group each for the materials ie: Para Core, Luxacore Z Dual, Fluorocore, Multi Core.
FIGURE 5: RADIOGRAPH OF EXTRACTED MAXILLARY CENTRAL INCISOR
FIGURE 6: SCALING OF THE EXTRACTED TEETH
FIGURE 7: SEGREGATING THE EXTRACTING TEETH
FIGURE 8: TEETH DIVIDED INTO FOUR GROUPS
Root canal treatment of selected teeth and preparation

All 100 teeth were sectioned 2-mm coronally from the cemento-enamel junction (CEJ) with a wheel-shaped diamond bur and air rotor along with water spray. A torpedo-shaped diamond point was used to prepare the teeth above the cemento-enamel junction. They were prepared to acquire a 2 mm ferrule and chamfer finish margin of 1.5mm depth.

The first step of root canal treatment is the access opening which was done with a round diamond bur at a high speed with air rotor having water spray. A K file#15 was moved into the canal to check the patency. A barbed broach was used to extirpate the pulp. Crown Down technique was followed for the treatment.

Establishment of length of canal was done by making use of a Rotary Protaper file 6mm*25mm. From the apical end, the working length was kept 1 mm short. Chemo mechanical preparation or the cleaning of the canals of the teeth was done with Protaper file upto F3 in crown down technique. Irrigation was done with 5% sodium hypochlorite solution. Frequent recapitulation with irrigation was done to maintain patency and to avoid clogging of the canal. Finally distilled water was used to irritate the canal.

For obturation, the root canal was first dried with paper points. All the teeth were obturated with protaper gutta-percha F 3 using a root canal sealer which was non eugenol based. Extra gutta-percha sticking out at the canal opening was secured with the help of a heated ball burnisher instrument.
FIGURE 9: ROOT CANAL THERAPY ON EXTRACTED TEETH
FIGURE 10: MASTER CONE ON RADIOGRAPH
Preparation of post space

For preparing the post space, a universal drill to which a silicone stopper was attached was used. Firstly gutta-percha was removed. Space for post was prepared as deep as 10 mm from coronal dentin apically. Some other drills were also used to prepare this space further and the required diameter and length for the posts was established. To remove debris, the canal was irrigated with normal saline.

Glass fibre posts (prefabricated) were inserted in the prepared space in the canal to check the length and fitting. The posts were cut short from apical end at 13 mm mark to get the correct dimensions, 10 mm inside the tooth that is 8 mm below the cemento-enamel junction and 2 mm ferrule plus 3 mm above the prepared coronal dentin.

Teeth were radiographed using radiovisuography (RVG) to check the fit of the post inside the canal.

FIGURE 11: POST WITH PREPARED TOOTH
FIGURE 12: TOOTH WITH POST
**Silanation and cementing of the posts**

As per instructions of the manufacturer, a layer of silane was applied to the glass fiber post. This was done using a brush. Then it was dried in air for 1 minute. This process is known as silanation. The post space which was prepared and the part of the coronal dentin which was exposed was subjected to process of etching and priming for 10 seconds. After drying, bonding agent was applied in a thin layer. A light blast of air was passed on it for this purpose. Then it was light cured for duration of 20 seconds. All the 100 posts were bonded in the same way.

For cementing the posts in the canal, resin based cement was used. Base and catalyst of resin cement were mixed in equal amounts. The canal and the post were smeared with the cement. The posts were placed in the canal and held for sometime under compression. Then light curing was done for 20 seconds. All the posts were cemented with the same procedure.

![Universal Testing Machine During Procedure](image)
Core build-up

A commercially available premade core former was used to form the core for each of the specimens for the build-up. Modification of the core formers was done at the gingival end so that the standard dimensions for the core can be achieved.

Base and catalyst were mixed in equal amounts and then dispensed into this core former from the syringe. The core former filled with core build-up material was adjusted on the post and prepared tooth. Light curing was done for 40 seconds. The core formers had to be held in place for 5 minutes to achieve polymerization of the entire material, because all four materials are dual cured composite resins. Thus there were 25 prepared teeth in each group. The whole of the described procedure was done by one person only to avoid errors.
Mounting the samples

For mounting the teeth in acrylic resin (self polymerizing, cold cure), a split mould was used. A lubricant in the form of petroleum jelly was applied on the inner surface of the mould so that the acrylic block can be separated easily from the mould. The teeth were mounted in such a manner that they were at 90 degree angle to the base of the mould and embedded in the acrylic resin. The crown to root ratio was not considered, but the cervical finish line was kept above acrylic resin. Mounting was done in the above described manner.

Specimen testing

Specimens on the acrylic block were placed on the Instron Universal Testing Machine for testing the fracture resistance of each.

Samples were positioned on the Universal Testing Machine. A customized mounting fixture was fabricated into which the acrylic blocks with specimens could ideally fit. The fixture positioned the specimens in a way that the load was directed at an angle of 130 degrees to the long axis of the tooth.

Specimen blocks were attached to the base of the Universal Testing Machine using the fixture. The tip of the plunger was approximated in contact with the notch on the palatal side of the core build-up. Specimens were loaded at a crosshead speed of 0.5 mm/min until there was a noticeable sign of fracture in the post and core. The site at which the failure occurred was noted and results were tabulated.