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Comparative analysis of four direct post endodontic restorations: A short term study

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Abstract: *Aim: The restoration of endodontically treated teeth is a topic that is extensively studied and yet remains controversial from many perspectives. This study aimed to evaluate the compressive strength of direct post endodontic restoration.*
Materials and methods: 40 extracted maxillary molars were selected. Root canal treatment was done for the teeth and then divided into 4 groups for direct post endodontic restoration: i) silver amalgam, ii) high strength glass ionomer cement, iii) composite resin iv) Cention N (a new alkasite material). The teeth were then subjected to compressive stress in a Universal Testing Machine.
Results: The compressive strength of silver amalgam, Cention N and composite resin were comparable. The compressive strength of glass ionomer cement showed lesser compressive strength to the other groups.
Conclusion: Silver amalgam, composite resin and Cention N showed no difference in compressive strength. Glass ionomer cement showed lesser compressive strength compared to the others.

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I. Introduction

A successful clinical outcome of endodontically treated teeth depends on adequate root canal treatment as well as on adequate restorative treatment performed afterwards[(1)]. Recently, attention has been focused on procedures performed after the completion of root canal treatment and their impact on the prognosis.[(2)(3)] Numerous problems are present in endodontically treated because of coronal destruction from dental caries, fractures, and previous restorations or endodontic techniques. This results in a loss of tooth structure and a reduction in the capability of the tooth to resist a myriad of intraoral forces. Conservation of dentin is mandatory, and restorations that support this concept are preferable.[(4)]

Ray and Trope observed that a combination of good coronal restorations and endodontic treatment resulted in fewer periradicular inflammatory lesions, whereas poor coronal restorations and endodontic treatment resulted in the absence of periradicular inflammation in only 18.1% of the teeth examined. Furthermore, when poor endodontic treatments were followed by good permanent restorations that, the resultant success rate was 67.6%.The authors concluded that apical periodontal health depends significantly more on the coronal restoration than on the technical quality of the endodontic treatment[(1)(3)(5)].

Compressive strength of core materials is important because they usually replace a large bulk of tooth structure and therefore must resist multidirectional masticatory forces.

Amalgam has been the core of choice because it is strong and dimensionally stable.[(6)]Improvements in composites and the development of enamel–dentine bonding systems have stimulated trends towards more conservative techniques.[(7)]With amalgam, the clinician may be confident of an acceptable long-term performance, given the substantial documented evidence of success for amalgam as a direct core build-up restorative material.

New formulations of GIC cements have resulted in an increasing range of applications for such materials in posterior teeth, which now enjoy substantial acceptance as an alternative core build-up material.[(7)]Glass-ionomer cements have certain characteristics that are superior to those of resin-based materials and dental amalgam. These include chemical adhesion to mineralized dental tissues and biological sealing of the cavity interface.[(8)]

CentionN, is a new basic filling alkasite material. It has advantages like being cost-effective, fluoride releasing, quick and easy to use without complicated equipment and that offers both strength and good aesthetics.[(9)]

The purpose of this study was to compare the compressive strengths of four direct post enododontic restorations.

II. Material And Methods

Forty extracted human molars were collected for the purpose of this study from the Department of Oral and Maxillofacial Surgery, DAPM RV Dental College, Bangalore. The teeth extrcated for orthodontic and periodontal reasons only were collected.

Inclusion Criteria:
Teeth without root fracture
Teeth with completely formed roots
Teeth without caries or restoration
Exclusion Criteria
Teeth with root caries, cracks or fractures
Teeth with open apices
Teeth with curved roots

Curettes were used to remove calculus mechanically from the root surfaces. The teeth were immersed for 1 hour in 3% sodium hypochlorite to disinfect them for operator safety.

Standard coronal access cavity was prepared in all teeth using Endo-Access bur (DentsplyMaillefer, Ballaigues, Switzerland), in a high-speed hand-piece. The patency was confirmed by size 10 K-file(Mani, Tochigi, Japan). Any non-patent tooth was immediately replaced.

The #15 size K-files were inserted till the file tip was seen at the root apex with a microsopeand the length measured. The working length was determined at 1mm short of this length. The canals were instrumented till #25 K files and were enlarged till #25 0.06 taper with Neoendoflex files (Neoendo, London, England). The canals were constantly irrigated with 3% Sodium hypochlorite and normal saline. The canals were dried with paper points. Obturation was completed with #25 0.06 taper guttapercha cones and zinc oxide eugenol sealer. All samples were prepared by the same operator to reduce chances of inter operator variability.

The teeth were then randomly divided into 4 groups for direct post endodontic restoration (n=10):

- Group 1: Silver amalgam
- Group 2: high strength glass ionomer cement(GC Corporation, Tokyo, Japan)
- Group 3: Composite resin (Spectrum, DentsplySirona, Germany)
- Group 4: Cention N (Cention N, IvoclarVivadent, Schaan, Liechtenstein)

The materials were mixed according to the manufacturer's instructions and the core build up done with the help of plastic carrying instruments. Cylindrical moulds were made with putty material. Self cure acrylic resin blocks were made and the teeth embedded in these blocks till the level of CEJ.

Compressive strength measure

The specimens were then subjected to compressive loading with a custom made stainless steel plunger with a 1mm diameter mounted on an Universal Testing Machine (Indian Institute of Science, Bangalore, India). The load was applied at a cross head speed of 1mm/min in a coronal to apical direction until the restoration fractured.

Statistical analysis

Statistical analysis was performed using SPSS (Statistical Package for Social Sciences). One way ANOVA test followed by Tukey's HSD post hoc analysis was used to compare the mean compressive load (in Newtons) between four groups.

III. Result

The ANOVA test revealed that significant difference was there between the groups in terms of compressive load strength (Table 1). The Tukey's HSD post hoc analysis revealed statistically significant difference between the GIC group and the other groups (Table 2). There was no difference between silver amalgam, composite resin and Cention N.

Table 1: Comparison of mean compressive load (in N) between different groups using One-way ANOVA test

Groups	N	Mean	SD	Min	Max	F	P-Value
Amalgam	10	302.80	51.86	254	379	8.527	0.001*
GIC	10	170.40	13.33	153	187		
Composite	10	268.00	41.16	228	325		
Cention	10	278.00	58.02	205	343		

*statistically significant

Table 2: Multiple comparison of mean differences between groups using Tukey's HSD Post hoc Analysis

(I) Group	(J) Group	Mean Diff	95% CI for the diff		P-Value
			Lower	Upper	
Amalgam	GIC	132.40	51.84	212.96	0.001*
	Composite	34.80	-45.76	115.36	0.61
	Cention	24.80	-55.76	105.36	0.82
GIC	Composite	-97.60	-178.16	-17.04	0.02*
	Cention	-107.60	-188.16	-27.04	0.007*
Composite	Cention	-10.00	-90.56	70.56	0.98

IV. Discussion

The outcome of endodontic treatment is influenced by several factors, and among these, microbial contamination is one of the major causes of endodontic failure. For many years, apical leakage was thought to be the main cause of endodontic treatment failure. Based on their study using radioactive isotopes, Marshall and Masseler (1961) were the first to report the effects of coronal leakage. Torabinejad et al. (1990) then found bacterial products at the apex of root-filled tooth after 3 months in the absence of coronal restoration.[(5)]Salivary microleakage is considered to be a major cause of endodontic failure due to bacteria and endotoxins penetration along the root canal filling. The penetration of saliva through obturated root canals increases with the longer exposure period.[(3)]

Tooth restoration is the final step in root canal treatment[[5]]. Numerous studies have been conducted to determine the ideal method to restore endodontically treated teeth as these teeth have decreased fracture resistance due to the loss of tooth structure during endodontic access and cavity preparation procedures.[(10)]Safavi et al suggested that an appropriate and prompt permanent restoration after completion of endodontic treatment should be performed [(1)]

Restoring root-filled teeth is a challenge because they are thought to be weaker and more susceptible to fracture than vital teeth. Several factors were evaluated as reasons for reduced fracture strength, including changes in the mechanical properties of dentine, changes in moisture content, time and reduced levels of proprioception. Endodontically treated teeth have reduced coronal and radicular tissue as a result of dental caries, operative procedures, intra-radicular procedures, and previous restorations, and restorative procedures

that require extensive reduction of the tooth lead to further tissue loss. [5]Hunter A.J. in 1989 stated that 80% of endodontically treated teeth with conservatively enlarged root canals can be restored without a post, provided sound treatment goals are followed.[11]Compressive strength is considered to be a critical indicator of success because a high compressive strength is necessary to resist masticatory and parafunctional forces.

Amalgam has been considered to be the material of choice for cores. Amalgam has been used as a direct restoration because of many clinical, practical and ergonomic advantages: optimal marginal seal, wear resistance and compression strength, good polishability, excellent costs-benefits ratio[1]. Both mechanical tests and finite element analyses have indicated that amalgam cores have superior performances in comparison to resin composite cores.(6) The dark colour of amalgam may not be esthetic, but helps to differentiate the tooth structure during tooth preparation. Unfortunately, the relatively slow set of amalgam delays rotary preparation of amalgam cores and has limited its use.[6]Amalgam is not an appropriate material for the final restoration of root-filled teeth, because it does not adhere to tooth structures. Moreover, it must be retained in cavity preparations by retentive features that often require removal of a sound tooth structure.[5] Hence, we need to look for other materials that have more favourable properties to be used as direct post endodontic restorations.

Glass ionomer cement has a long history of use in dentistry. Currently, several commercial hand-mixed and encapsulated GICs are available for various clinical purposes.[5]These cements possess certain unique properties that make them useful as restorative and adhesive materials, including adhesion to moist tooth structure and base metals, anticariogenic properties due to release of fluoride, thermal compatibility withtooth enamel because of low coefficient of thermal expansion similar to those of tooth structure, biocompatibility and low cytotoxicity.[12] Although glass-ionomer cement has favourable characteristics, it suffers the limitations of being the weakest of the materials tested in terms of tensile, flexure and modulus values. Glass ionomer materials cannot be considered to be particularly suitable material for large core build-up procedures in posterior teeth.[7] Glass ionomers are also less fatigue resistant than resin composites; thus, the role of glass ionomers and glass ionomer based materials as cores must be questioned.[6] However, this is a good example of a material, which despite its apparent limitations as a core build-up material is widely considered to enjoy good clinical success in this application.[7]

Restoration using direct composite resin is an excellent treatment option to conserve more tooth structure in root-filled teeth[5] Modern composite materials have got high compressive strength for posterior restorations. It has been suggested that the use of resin composite in restorations reinforces dental stiffness as the adhesive nature of the composite binds the cusps and decreases their flexion.[10] The results of a study indicate that, on the basis of strength alone, some resin composites may be used as alternatives to amalgam cores. Direct restoration with composite resin provides more resistance against tooth fracture than amalgam, as well as providing intra-coronal reinforcement.[5]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 against tooth structure, to facilitate tooth preparation for crowns. They can be bonded to teeth using dentinal adhesives. As they set quickly, core and tooth preparations can be completed using rotary instrumentation without delay.[6] the major shortcomings of composite resins, such as fracture within the body, margins of restoration, and polymerization shrinkage, remain a concern for clinicians.[5]

Cention N is a recently introduced tooth-coloured, basic filling material for bulk placement in retentive preparations with or without the application of an adhesive. It is an "alkasite" restorative which is a new category of filling material, like compomer or ormocer and is essentially a subgroup of the composite resin. Cention N is a UDMA based, self curing powder/liquid restorative with optional additional light-curing. It is radio opaque and contains alkaline glass fillers capable of releasing fluoride, calcium and hydroxide ions.[13] In a study done by Dedania et al,[14] there was no significant difference between amalgam and Cention N, when comparing the compressive strength in class I restorations. Cention N score was clinically excellent or good for over 90% of the restorations in most categories and the results were largely similar to the amalgam restorations.[9] In this study, Cention N, composite resin and silver amalgam showed no significant difference in compressive strength. As there is demand in tooth colored restorations, this material of choice can be a cost-effective way to deliver a high-quality, predictable restoration, and less time.[15]

Amalgam showed the highest strength compared to the rest. GIC showed the least compressive strength among all the groups

V. Conclusion

It has been stated that root canal therapy saves the root whereas restoration reinstates the tooth as a functional member of the masticatory system. To accomplish this objective, the restorative procedure should be primarily concerned with prevention of tooth fracture.[11]Coronal leakage is thought to be as important asapical leakage and has a significant effect on the outcome ofendodontic treatment. Therefore, immediate restoration afterroot canal treatment is recommended.[5]

In the current study, it was found that amalgam had the highest compressive strength. Amalgam, composite and Cention N showed comparable compressive strength. GIC showed the least compressive strength.

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