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RESEARCH ARTICLE

COMPARATIVE EVALUATION OF CORONAL LEAKAGE PREVENTIVE ABILITY OF FOUR ORIFICE BARRIER MATERIALS IN ENDODONTICALY TREATED TEETH: AN IN VITRO DYE LEAKAGE STUDY.

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Abstract

It is often stated that the quality of root canal fill in is the deciding factor between success and failure in endodontic treatment. The lack of coronal seal (by inappropriate or absent temporary or permanent restoration) allows bacteria and bacterial factors (metabolites and structural components, such as endotoxin) from the oral cavity to penetrate the obturating materials and eventually reach the apical foramen. Some of these bacterial factors, particularly endotoxin, can cause inflammation of the periapical tissues, there by requiring retreatment or periradicular surgery. Marginal leakage due to poor coronal/apical seal results in swelling, pain and the usual symptoms of an acute abscess of endodontic infections. Weak coronal sealing may occurin a variety of clinical cases such as a fracture in one of the components of leakage in the final restoration, occurrence of relapsing caries and hence the occurrence of a subsequent coronalleakage. To avoid the contamination inthe endodontically treated root canalsin any of the aforementioned clinicalcases, root canal intra-orifice must besealed using various restorative materialsbefore placing the final restoration.This procedure helps to a greatextent in protecting the root canalsfrom contamination. The aim of the present study wasto compare the ability of four restorativematerials (a self-adhesiveflowablecomposite;Perma Flow Purple (Ultradent), GrayProRoot MTA (Dentsply Tulsa Dental, Tulsa, OK) Cavit(Amdent)and glass ionomer cement (Fuji IX ,GC Corporation, America) to sealthe root canal entry of endodonticallytreated teeth and to prevent leakagefrom the crown along the canal reachingthe apex.

Introduction

The importance of the marginal sealing ability of restorations is appreciated with great significance and many techniques have been used to assess this phenomenon both in vivo and in vitro. One of common reason for endodontic failure is poor coronal seal and sometimes apical seal also which leads to post endodontic infections. reported that the quality of coronal restoration might be a more important factor than the quality of obturation in maintaining the periradicular health of the tooth.[1] It has been reported that 59.4%of endodontically treated teeth

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failed because oflack of an adequate post endodontic restoration.[2]Hovland andDumsha observed that most of the leakage took place at thecement-canal wall interface or the gutta-percha cement interface,implicating the sealer as the weak link in long-term successfulobturation of the root canal. Because no sealer or obturationtechnique consistently prevents percolation through the canal, it is critical to maintain a coronal seal to prevent microleakageinto the canal space.[3]The intra-orifice barrier is an efficient alternative method to decrease coronal leakage in endodontically treated teeth. This procedure includes placing additional material into the canal orifice immediately after removal of the coronal portion of gutta-percha and sealer.[4]The addition of another barrier between the oral environment and the root canal system appeared to have a positive effect in reducing leakage and increasing possibilities for success. A variety of ex vivo methods have been applied to assess the sealing ability of root canal filling materials. Theyinclude mainly leakage methodologies, such as dye penetration,bacteria leakage test, fluid filtration and a glucosepenetration model.[5,6]Several materials have been used in an attempt to provide an intra-coronal seal to prevent microleakage. Of these materials amalgam, Geristore (compomer), Fuji-plus,Tetric flow,glass ionomer cement, resin-modified glass ionomer cement and Cavit were all examined. [7]

Despite research supporting the effectiveness of coronal barriers, a universally accepted protocol that incorporates a coronal barrier after root canal therapy is non-existent.[8]The purpose of this investigation was to evaluate and compare the sealing ability of four experimental materials as an intra-orifice barrier after obturation of root canal system.

Materials and methods:-

Ninety recently extracted, human mandibular premolars which were extracted for orthodontic reasons were used in the study. Teeth were cleaned free from calculus and submerged in sodium hypochlorite for four hours to remove soft tissue attachment. X-rays were taken to ensure that the teeth had a single canal and were free from irregularities. The teeth were preserved in a saline solution until their use. Teeth were decoronated using diamond discs under copious irrigation. Standard lengths were adjusted for all teeth roots to be 14 mm. Access cavities were opened, the pulpal tissue was removed and the working length was determined using a K-file (Mani Inc., Japan), sizes #10K file or #15K file to ensure its penetration through the apical constriction. The working length was determined by means of radiographs. After that, the canals were prepared up to size #40K file. We follow the standard irrigation protocol using sodium hypochlorite5.25% at a rate of 5ml for everycanal and EDTA at a rate of 2ml ata concentration of 17%.Root canal specimens were then dried with paper points and obturated using warm lateral compaction with gutta-percha and resino seal. The teeth were left for 24 hoursto ensure the complete hardeningof the filling material.

Usingsuitable size pluggersthe filling material wasremoved vertically at to depths of 4mm. Nextthe intra-orifice was dilated usingGates Glidden drills (#2- #6) (Mani, Inc.,Japan). This empty space was cleanedfrom the remnants of the filling materialand the gutta-percha cones usingpaper points and alcohol, then rinsedwith saline solution and dried usingpaper points. Afterward obturated teeth specimens were preserved in 100% humidity in a humidifier for 48 hrs to allow for complete setting of sealer. Specimens are randomly grouped into four groups of 20 teeth each for the four tested orifice barrier materials. The remaining 12 teeth specimens were subdivided into 2 control groups to serve as positive and negative controls. Groups 1–4 were allocated for orifice barrier filling using four restorative materials ,a self-adhesiveflowable composite;Perma Flow Purple (Ultradent), GrayProRoot MTA (Dentsply Tulsa Dental, Tulsa, OK) Cavit (Amdent)and glass ionomer cement ;Fuji IX (GC Corporation, America). For each specimen, root apex was blocked by sticky wax. Following the complete hardeningof the four intra-orifice filling materials,the outer surfaces of the roots ofthe teeth were coated carefully withtwo layers of varnish. The teeth werecoated completely with the exceptionof 1mm around the intra-orifice inorder to insulate the teeth and preventthe incidence of dye leakage exceptfrom the area of the intra-orifice. All restorations were placed by a single examiner. Theteeth were immersed in methyleneblue dye at a concentration of 2% forfive minutes, to be later rinsed withcopious water to remove the dye.

Theteeth were left for a sufficient time todry. In order to evaluate the extent ofcoronal microleakage, longitudinalsections were made in the bucco-lingualdirection using a diamond discand water spray. Root sections were observed using a stereomicroscope (Olympus) with a camera attached. To evaluate the linear dye penetrationat the inter-surface (filling material-tooth), sections of the teethin every group were examined understereomicroscope (magnification 20X).

Statistical Analysis:-

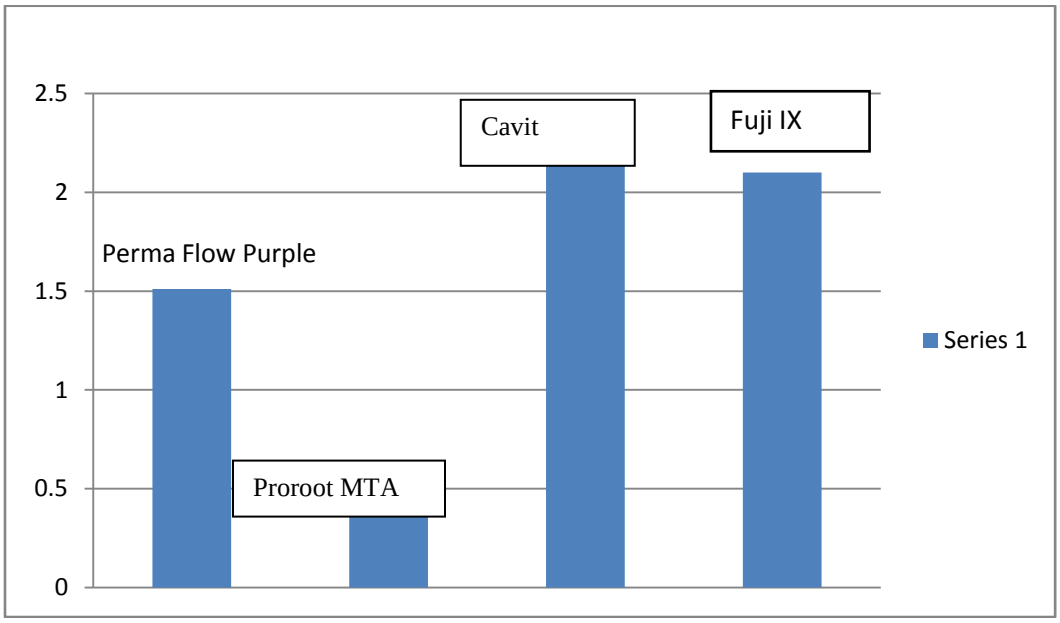
The extent of leakage was measuredusing a millimetre ruler designed byAutoCAD 2013. The measurementswere taken starting from the intra-orificeup to the last area were a dye leakagewas noticed in the apical direction.The highest reading was recorded as the dye penetration depth.The penetration depth was estimatedin millimeters and a score assessment was done.Mean and standard deviations were calculated for all measuredparameters. Data were tabulated and subjected to statistical analysis using Kruskall-Wallis test at a confidence level of 95%.

Results

The results revealed the occurrence of microleakage at the surface level between the restorative material on one side and the canal walls on another side. This was true for all the examined restorative materials. The resulting linear leakage in mm for the four tested materials is compared (Table 1). Positive control teeth showed complete full intra-orifice cavity depth leakage while specimens of the negative control did not show leakage. Results of our study reveal that all of the experimental materials show leakage with Cavitshows the maximum and ProRoot MTA the least. The results showed that statistically significant differences existed among thefour materials regarding the extent of the coronal leakage ($p<0.001$). It was observed that among the four materials, temporary restorationshowed the highest percentage of coronal leakage when used to seal the root canal intra-orifices. MTA leaked the least among the studied materials. This difference was highly significant (P value <0.001).

Table 1:- Descriptive statistics of linear leakage results in mm for the four orifice barrier materials

Orifice barrier	Mean of leakage in mm	Standard deviation	P value
Perma Flow Purple	**1.51**	**0.070**	**<0.001**
ProRoot MTA	**0.56**	**0.08**	**<0.001**
Cavit	**2.14**	**0.035**	**<0.001**
Fuji IX	**2.10**	**0.107**	**<0.001**



Comparison between the linear leakage scoresin mm is graphically depicted in graph 1.

Discussion:-

Endodontic failure has beenassociated with coronal leakagewithin the canal system followingobturation. The literature suggeststhat coronal leakage is far morelikely a determinant of clinical successor failure then apical leakage. It has been reported that 59.4%of endodontically treated teeth failed because oflack of an adequate post endodontic restoration.[9, 10]Therefore maintenance of a durable seal of the root canal system is necessary to prevent leakage, and coronal restorationis an important requisite for long-term endodonticsuccess.[11,12]Although the useof adhesive sealers may play animportant role by minimizing coronalleakage, sealing root canal orifices becomes mandatory for prevention of leakage. So in our present study we took four different classes of materials to check

their sealing propertiesas root canal orifice barriers. Non-adhesivetemporaries show an increasedpercentage of marginal breakdownand increased micro leakageafter thermocycling and loading.There was no significant improvementwith increased thicknessof the temporary material. In a studyBailón-Sánchez et al., showed that 4 mm intra-orifice depth for orifice sealer is adequate, so we standardized our accesspreparations at 4mm.[11]Glass-ionomer cement in the orifice may prevent bacterial penetration into the periapex compared to Cavit. This is also shown by the studies ofBarthel et al.[13]GIC and Perma Flow Purple haveshown more leakage than MTA .This could be due to weakerbonding of conventional GIC and more polymerization shrinkage ofFlowablecomposite. Results of our study are consistent with those of MotazAG et al and Bailón-Sánchez ME.[11,14]The results of this study are also consistent with the results of the studyby Stephens J et al but opposite to those of Abhishek P et al and Basem S et al. [9,15,16]MTA comes out to be a superior material to be used as intra orifice barrier material as in the studies of Cummings et al. who compared MTA with IRM and zinc phosphate as a coronal barrier for internal bleaching. Theirresults also demonstrated that MTA had superior performance as a barrier.[17]All the studies differ in their design, making comparisons difficult. In the present study, dye penetration was used because penetration test is the most popular method of studying leakage as it is easy to conduct, it is inexpensive and it has a high degree of staining.[18]

Conclusion:-

MTA might be suitable as an intra-orifice barrier because it has most of the ideal properties.In summary, immediate placement of a suitable intra-orifice barrier like MTA or a flowable composite like Perma Flow Purple, before final restoration, could help minimize leakage.

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