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Comparision of Healing of Periapical Lesion with Different Intracanal Medicament Using Mineral Trioxide Aggregate as Apical Barrier

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Abstract: *Twelve maxillary central incisors in patients aged between 15 to 30 years who suffered a traumatic injury were selected. All patients presented with incomplete development of the root apex. Conventional access cavity was prepared. The root canals were mechanically cleaned with copious irrigation using 3% NaOCl and normal saline as final irrigant. In group A, 6 patients were selected. Root canal was dried and calcium hydroxide powder mixed with normal saline in the paste form was placed for 1 week. In group B, 6 patients were selected. Root canal was dried and calcium hydroxide powder mixed with 2% Chlorhexidine in the paste form was placed for 1week . Once the canal was dry, the apical portion of the canal (4mm) was filled with MTA . The remaining portion of the root canal was obturated with gutta percha by rolled cone technique. At 6 months and 1 year follow-up period, teeth treated with calcium hydroxide powder mixed with 2% Chlorhexidine showed significantly greater percentage of healing of periapical lesion as compared to teeth treated with calcium hydroxide powder mixed with normal saline. The material MTA shows a favourable clinical significance for formation of apical plug in nonvital teeth. with open apices.*

Keywords: *Apical plug, Apexification, Calcium hydroxide, 2% Chlorhexidine, Mineral trioxide aggregate, Normal saline.*

I. Introduction

One of the aims of root canal treatment is to fill completely the root canal system in order to prevent re-infection. Injuries to immature permanent teeth due to trauma may eventually result in pulpal necrosis and the subsequent arrest of root development. These teeth are often difficult to treat as the associated open root apex hinders the placement of the root canal filling material[1]. Assessment of pulp vitality will aid in determining the proper treatment option. If vital and not irreversibly inflamed, maintenance of its vitality will allow natural continued root development. If pulpal necrosis occurs in immature teeth, completion of endodontic therapy is delayed until completion of root-end closure through apexification. Apexification is defined as "a method of inducing a calcified barrier in a root with an open apex or the continued apical development of an incompletely formed root in teeth with necrotic pulp"[2].

Long-term application of intracanal calcium hydroxide was historically the treatment of choice for necrotic teeth with open apices.[3] However, this treatment option requires patients to attend multiple clinic visits over an extended period of time, with treatment regularly extending over 3 to 21 months.[4] An alternative to apexification with calcium hydroxide is placement of an apical barrier using a material such as mineral trioxide aggregate (MTA). Treatment with MTA apexification produces comparably favorable outcomes to long-term calcium hydroxide treatment regarding the resolution of symptoms and periapical pathology. Mechanical instrumentation alone is unable to completely eradicate the root canal system from bacteria. Therefore, some form of chemical irrigation and disinfection is necessary to optimally disinfect the root canal system. Various medicaments have been widely advocated to help eliminate bacteria. Calcium hydroxide has been commonly used as an intracanal medicament.[5] The antimicrobial property of calcium hydroxide is attributed to the release of hydroxyl ions and a highly alkaline environment with a pH value of approximately 12.5.[6]Most of the microorganisms in infected root canals are unable to survive in the alkaline environment. However, calcium hydroxide is not equally effective against all the bacteria found in the root canal.[7]

Chlorhexidine gluconate can be used in endodontics as an irrigant and intracanal medicament due to its biocompatibility, substantivity and wide antimicrobial activity.[8]The antimicrobial property of Chlorhexidine gluconate is attributed to its cationic molecule, which is adsorbed to the negatively charged inner cell membrane, resulting in the leakage of intracellular components. It is an effective agent against gram-positive and gram-negative bacteria.[9] Importantly, it is effective against microorganisms resistant to calcium hydroxide.[10]

The combination of calcium hydroxide and 2% Chlorhexidine results in antimicrobial properties that are more effective than treatment with calcium hydroxide only[11] The aim of this clinical in-vivo study was to determine the formation of apical barrier and healing of periapical lesion after a period of 6 months and 1 year follow up in nonvital teeth with necrotic pulps and open apices using different intracanal medicament with mineral trioxide aggregate as apical barrier.

II. Materials And Methods

This clinical in-vivo study was conducted in Department of Conservative Dentistry and Endodontics, Government Dental College and Research Institute, Bengaluru. Twelve maxillary central incisors in patients aged between 15 to 30 years who suffered a traumatic injury reported to Department of Conservative Dentistry and Endodontics, Government Dental College and Research Institute, Bengaluru were selected.

The patients were selected as follows: the minimum time duration between the trauma and the first visit was 2 years. Clinical and radiographic examinations were performed and all patients presented with incomplete development of the root apex. The exclusion criteria included carious and iatrogenic exposure of pulp, teeth with dilacerated roots, maxillary central incisors with short root length(less than 13mm). Ethical approval was obtained by ethical committee of Government Dental College and Research Institute, Bengaluru. Informed consent was obtained from all patients.

After evaluating the vitality of the tooth local anesthetic solution (2% lidocaine with 1:100,000 adrenaline) was administered through infraorbital nerve block technique to anesthetize the maxillary anterior teeth. After obtaining adequate anesthesia of maxillary anterior region, the tooth was isolated with rubber dam .A conventional access cavity was prepared .In few cases, the access cavity was direct. The root canal orifice was located using sharp DG16 endodontic explorer. Gates Glidden drills were used to remove the lingual shoulder. Working length of the teeth were determined radiographically from the center of incisal edge with K-file following the Ingle's method of working length determination and recorded. The root canals were mechanically cleaned using intracanal instruments till size 80 No. K file with copious irrigation using 3% sodium hypochlorite (NaOCl). A lower strength of sodium hypochlorite was used because of the possibility of periapical extrusion through the wide apex of immature teeth. The lower strength of NaOCl was compensated by the volume of the irrigant used. The root canals were then irrigated using normal saline as final irrigant placing the needle 2 mm short of the working length. The intra-canal medication was placed when the irrigant leaving the root canal was clean of debris.

In group A, 6 patients were selected. The root canal was dried with sterile paper points and calcium hydroxide powder mixed with normal saline in the paste form was placed using a lentulo spiral. A cotton pellet was kept near the root canal orifice and access cavity was sealed with Cavit. After 1week, the calcium hydroxide paste was removed by hand instrumentation and repeated rinsing with 3% NaOCl followed by rinsing with normal saline. When there exists a root canal with exudate , calcium hydroxide mixed with normal saline to a paste form was repeated .Once the root canal was dry upto the working length, with the absence of exudate, the MTA (Dentsply Tulsa) mixed with normal saline in paste form was placed in the apical portion of root canal to create an apical plug of 3 to 5 mm depending on the working length of root canal using an amalgam carrier and was adapted to the canal walls using Schilder's anterior plugger with a size proportional to the apical gauge. A sterile cotton pellet moistened with distilled water was placed over the root canal orifice and the access cavity was sealed temporarily with Cavit. The correct placement of MTA was confirmed radiographically by intraoral periapical radiograph using paralleling angle technique. After a period of one week, the temporary filling material and the cotton pellet were removed and the set of the MTA was gently tested using Schilder's anterior plugger. The remaining portion of the root canal was obturated with gutta percha following the method of rolled cone technique using AH plus sealer. The teeth were restored with light cure glass ionomer cement. Cases were reviewed radiographically at 6 months and 1 year follow-up appointments.

In group B, 6 patients were selected. The root canal was dried with sterile paper points and calcium hydroxide powder mixed with 2% Chlorhexidine in the paste form was placed using a lentulo spiral later a cotton pellet was kept near the root canal orifice and access cavity was sealed with Cavit . After 1week the calcium hydroxide-2% Chlorhexidine paste was removed by hand instrumentation and repeated rinsing with 3% NaOCl followed by rinsing with normal saline.When there exists a root canal with exudate , calcium hydroxide mixed with 2% chlorhexidine to a paste form was repeated. Once the canal was dry upto the root canal working length, with the absence of exudate, the MTA (Dentsply Tulsa) mixed with normal saline paste was placed in the apical portion of root canal to create an apical plug of 3 to 5 mm depending on working length of root canal using an amalgam carrier and was adapted to the canal walls using Schilder's anterior plugger with a size proportional to the apical gauge. A sterile cotton pellet moistened with distilled water was placed over the root canal orifice and the access cavity was sealed temporarily with Cavit. The correct placement of MTA was confirmed radiographically by intraoral periapical radiograph using paralleling angle technique. After a period of one week, the temporary filling material and the cotton pellet were removed and the set of the MTA was

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Healing was identified when a reduction or disappearance of the periapical radiolucent area could be seen in a postoperative radiograph, also if the periodontal ligament space appeared normal in teeth without initial apical periodontitis. Clinically, treatment was considered successful when symptoms such as pain, swelling, buccal sinus tract, or tenderness to apical region and gingival palpation or percussion, would be absent.

Radiographic Outcomes and Analysis

In the absence of clinical signs and/or symptoms, healing was classified according to the postoperative radiographic appearance against the following criteria: (i) complete healing: healing of periapical lesion more than or equal to 50% (ii) incomplete healing: healing of periapical lesion less than 50% and (iii) unsatisfactory healing: no reduction or an increase in the diameter of the periapical lesion.

Pre-operative radiographs were evaluated for the presence or absence of periapical radiolucency, stage of root development and signs of resorption. Post-operative radiographs were assessed for the presence or absence of periapical radiolucency, signs of resorption. In cases where a periapical radiolucency was present in the preoperative radiographs, the postoperative radiographic images were assessed to determine if the radiolucency appeared larger or smaller on the follow up.

Individually customized bite blocks and the parallel angle technique were used to obtain standardized radiographs. All radiographs were reviewed in a single reference center by a masked evaluator. For assessment, radiographs were scanned with a scanner (HP Scanjet). For the measurement of periapical lesion , distance from cementoenamel junction (CEJ) to root end, CEJ to outer border of lesion and root end to the outer border of lesion was considered for both preoperative and postoperative radiographs.(Fig 1) The radiographic distance was measured by a computer-aided software program (Scion Image Analyzer, Scion, Frederick, MD). The data collected where statistically analysed using Statistical Package for Social Sciences (SPSS) version 17.0. Mann Whitney U test and Chi square test .Statistical significance was defined as p value <0.05.

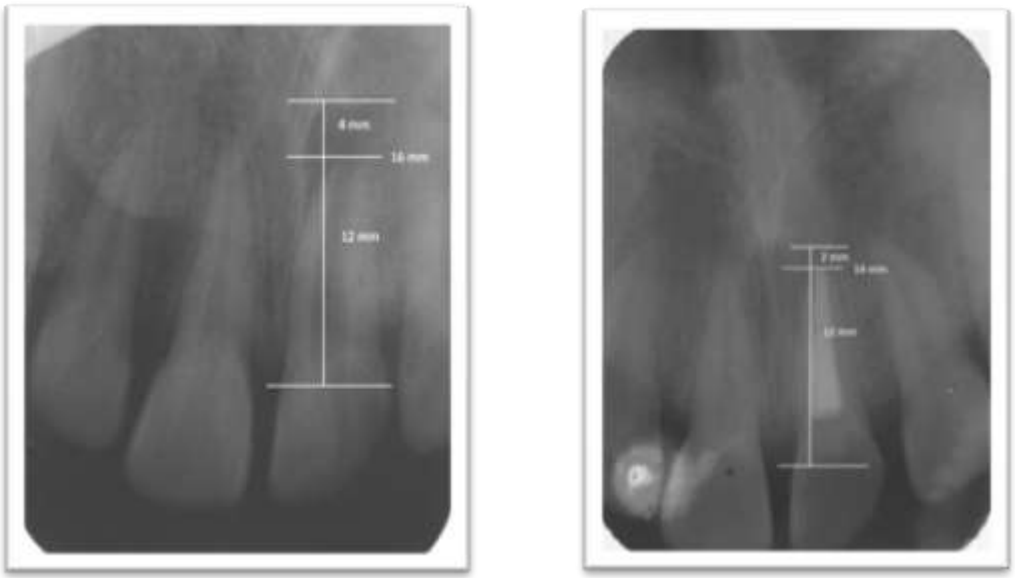

Fig 1: For the measurement of periapical lesion , distance from cementoenamel junction (CEJ) to root end, CEJ to outer border of lesion and root end to the outer border of lesion was considered for both preoperative and postoperative radiographs.

III. Observations And Results

Data collected from the in-vivo study were computerized and analysed using Statistical Package for Social Sciences (SPSS) version 17.0. Results were expressed as the mean and standard deviation of different measurements measured in preoperative and postoperative radiographs of two groups. The two groups were compared with respect to healing of the periapical lesion after a period of 6months and 1 year using Mann Whitney U test and Chi square test. A probability value (p value) of <0.05 was considered to be statistically significant.

Null Hypothesis: There is no significant difference in the values between the groups i.e. $\eta_1=\eta_2$
Alternate Hypothesis: There is a significant difference in the value recorded between the groups i.e. $\eta_1\neq\eta_2$
Decision Criterion: The p-value is compared with the level of significance. If p value <0.05, the null hypothesis is rejected and alternate hypothesis is accepted. If p value ≥0.05, the null hypothesis is accepted.

	Pre operative radiographic measurement from CEJ to root end (in mm)	Preoperative radiographic measurement from CEJ to outer border of lesion (in mm)	Preoperative radiographic measurement from root end to outer border of lesion (in mm)	Post operative radiographic measurement from CEJ to root end (in mm)	Post operative radiographic measurement from CEJ to outer border of lesion (in mm)	Post operative measurement from root end to outer border of lesion (in mm)	Total healing (in mm)	Total healing (in %)
GROUP A								
CASE 1	15	22	7	15	19	4	3	42.85
CASE 2	13	18	5	13	16	3	2	40
CASE 3	14	24	10	14	20	6	4	40
CASE 4	12	16	4	12	14	2	2	50
CASE 5	16	25	9	16	19	3	6	66.60
CASE 6	12	15	3	12	13	1	2	66.60
GROUP B								
CASE 1	17	25	8	17	18	1	7	87.50
CASE 2	15	24	9	15	15.5	0.5	8.5	94.40
CASE 3	15	20	5	15	15.5	0.5	4.5	90.00
CASE 4	13	19	6	13	13.5	0.5	5.5	91.66
CASE 5	15	20	5	15	16	1	4	80
CASE 6	14	2	6	14	15	1	5	83

TABLE 1: Comparision of Periapical Lesion Healing Between Group A and Group B

Out of the two groups, group B (calcium hydroxide powder mixed with 2% Chlorhexidine) showed greater percentage of healing of periapical lesion when compared to group A (calcium hydroxide powder mixed with normal saline). (TABLE 1) Statistical analysis was done using Mann Whitney U test and Chi Square test which showed a significantly higher rate of healing of periapical lesion in group B when compared to group A with p value < 0.05.Thus null hypothesis was rejected.

IV. Discussion

The completion of root development and closure of the apex occurs upto 3 years following eruption of the tooth (Nolla 1960)[12].Dental injuries are very common in children between six and nine years old. The serious complication of these traumas is the pulp necrosis, the prevalence of the injury which varies with the type of trauma from 1-6% for crown fractures to nearly 100% for intrusions[13].

When teeth with incomplete root formation suffer pulp necrosis, the root development ceases and apical closure cannot be achieved. Root canal treatment at this time is a significant challenge, because of the size of the canal, the thin and fragile dentine walls and the large open apex. Apexification is defined as 'a method to induce the formation of a calcified barrier in a root with a wide open apex of a nonvital tooth with incomplete root formation or the continued apical development of an incomplete root in teeth with necrotic pulp' (American Association of Endodontists 2003).

Conventional apexification procedure is inducing the formation of an apical barrier while the recent approach is to form an artificial apical barrier by the placement of an apical plug. An apical barrier aids the obturating material to confine within the root canal system [14]. In conventional apexification procedures, the most advocated medicament is calcium hydroxide. Calcium hydroxide was introduced to the field of endodontics by Herman in 1930 as a pulp capping agent. Because of its enhanced success rate, easy availability for clinician and affordability for patients, $Ca(OH)_2$ gained widest acceptance in literature[15].

However, the suitability of calcium hydroxide paste use for apexification has been questioned because it involves a long treatment time and the prognosis is always uncertain..Long-term exposure of the tissue to calcium hydroxide may weaken the root structure, resulting in cervical fractures, as well as inducing periapical bone necrosis when there is overfilling of the material.[16]

The artificial apical barrier technique is a contemporary approach for managing open apices cases. This technique uses a apical barrier material that is placed at the open apex facilitating obturation by confining it within the canal. The material of choice for this procedure is MTA has been reported in literature because of its superior biocompatibility and less cytotoxicity due to its alkaline pH and presence of calcium and phosphate ions resulting in capacity to attract blastic cells and promote favorable conditions for cementum deposition.[17] MTA was first described in dental scientific literature in 1993 by Torabinejad M and was given approval for endodontic use by the US Food and Drug Administration in 1998.

Torabinejad reported the ingredients in MTA as tri calcium silicate, tricalcium aluminate, tricalcium oxide and silicate oxide with some other mineral oxides that were responsible for the chemical and physical properties of aggregate. The powder consists of fine hydrophilic particles that set in the presence of moisture. The hydration of the powder results in a colloidal gel with a pH of 12.5 that will set in approximately 3 hours.

Calcium hydroxide [$Ca(OH)_2$] is the most commonly used intracanal dressing. Its antimicrobial action is related to its high pH, which results in the inactivation of bacterial membrane enzymes.A pH of about 8 to 11 is required for biological action of calcium hydroxide pastes, favoring the activation of alkaline phosphatase. This enzyme allows phosphate to react with calcium ions from the bloodstream, forming calcium phosphate, which is closely related to the mineralization process[18]. Calcium hydroxide has been found to be insufficient for elimination of both facultative anaerobes and yeasts.

Chlorhexidine gluconate (CHX), a cationic bis-biguanide with optimal antimicrobial action over the pH range 5.5-7.0, has been suggested as an irrigation solution and for intracanal medication because of its strong antibacterial activity against gram-positive and gram-negative bacteria .Chlorhexidine was introduced to increase the antibacterial effect of intracanal medications and to eliminate microorganisms associated with persistent infections and treatment failure.In addition to its exceptional antimicrobial activity, another favorable property of Chlorhexidine is substantivity[19].These characteristics have led to the possibility to use Chlorhexidine as an intracanal medication.

The vehicles like 2% Chlorhexidine and normal saline mixed with the calcium hydroxide determines the velocity of ionic dissociation,solubility, and diffusibility, and although some vehicles provide faster dissociation, and, consequently, faster alkalinity of dentin and apical and periapical tissues, they may make the paste more caustic and aggressive in direct contact with tissues[20] From this present clinical in-vivo study, it is evident from the clinical observation , that apexification can be successfully induced in adults. The clinical cases reported here demonstrate that when MTA material is used as an apical plug in necrotic teeth for the formation of apical barrier of the immature apices, the root canal can be effectively sealed. Both clinical and radiograph follow-ups in the reported 12 cases showed healing of the apical periodontitis and new hard tissue formation in the apical area of affected teeth.

Prior to the placement of MTA as apical plug for apexification, the combination of $Ca(OH)_2$ powder with normal saline was used in Group A and the combination of $Ca(OH)_2$ powder with 2 % Chlorhexidine was used in Group B. The combination of $Ca(OH)_2$ powder with 2 % Chlorhexidine showed a better healing of periapical lesion after a follow up period of 6 months and 1 year with p value < 0.05 than the combination of $Ca(OH)_2$ and 0.9 % saline which can be attributed to the increased antimicrobial properties of Chlorhexidine. As MTA shows good sealing ability, good marginal adaptation, a high degree of biocompatibility, reasonable setting time (about 4 hours), pulpal and periodontal tissue regenerating capabilities, MTA has been widely recommended for apical plugging of open apices. MTA can be used in presence of moisture in root canal. This property is important in teeth with necrotic pulps and inflamed periapical lesions.

V. Conclusion

To conclude, from this clinical, in-vivo study the material MTA shows a favourable clinical significance by the formation of apical barrier when an apical plug is induced for the apexification procedure in nonvital teeth with open apices.In agreement with several clinical studies, it is prudent to use MTA as the material of choice as apical plug for the initiation of apexification procedure in nonvital teeth with open apices which has the added advantage of speed of completion of therapy.The combination of $Ca(OH)_2$ powder with 2 % Chlorhexidine showed a better healing of periapical lesion after a follow up period of 6 months and 1 year with p value < 0.05 than the combination of $Ca(OH)_2$ and normal saline which can be attributed to the increased antimicrobial properties of Chlorhexidine.

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