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Evaluation of periapical healing after apexification with MTA using radiographic Grid :An in vivo study

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ABSTRACT

Introduction

Creation of apical plug in blunderbuss apices with repeated intracanal application of calcium hydroxide has been outweighed by MTA due to its sealing ability in the interface and opening of dentinal tubules, through precipitation of hydroxyapatite crystals. Antibacterial property due to its alkaline ph and biocompatibility and its propensity for cementogenesis and osteogenesis, all leads to true apical healing.

AIM

present study is designed to evaluate healing of periapical tissue after creating apical plug with MTA in tooth with wide open apex.

MATERIAL METHOD

The present study was a prospective study. 27 patients aged 15 to 40 years having open apex in maxillary anterior teeth participated in this study. Root Canal Treatment of the selected teeth was done: MTA apical plug applied; Obturation of rest of the canal done with gutta percha & composite. Access cavity closed with composite. Clinical and radiological evaluation done for periapical healing.

RESULT AND CONCLUSION

In summary, 91% of teeth treated with MTA apical plug healed in our study.

Radiographic success occurred in 25 patients; Out of these in 7 cases periapical radiolucency didn't disappear completely but decreased in size. So, it was considered as success according to the criteria adopted.

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I. INTRODUCTION

Periradicular lesions of endodontic origin are associated with the presence of bacteria and their byproducts in infected root canal system [(1)]. Successful sealing of root canal space after cleaning and shaping prevents ingress of bacteria and multiplication of remaining microorganisms in the dentinal tubules by obstructing their nutrient supply.

Conventional root canal filling techniques rely on the presence of apical constriction to prevent gutta-percha and sealer extrusion into the periapical tissues. But the absence of the apical constriction in tooth with open apex presents a management challenge.Thus, apexification or root end closure has been advocated.

Mineral trioxide aggregate (MTA) has emerged as a reliable bioactive material for creating apical barrier in tooth with wide open apex. It is a hydraulic cement that sets in the presence of water producing colloidal silica hydrate gel that sets in 3-4 hours.Moisture at the initial phase of setting is required to achieve optimum flexural strength which is achieved after 24 hours. [2,3,4]A study reported that MTA apical plug of 5mm thickness is sufficient to prevent bacterial leakage.[(5)]

Fluid tight seal by apical plug of MTA creates an environment conducive to the production of mineralized tissue in the apical region. The aim of this study was to evaluate radiographically the healing of the periapical tissues in teeth where MTA apexification was performed.

II. MATERIAL AND METHOD

27 patients aged 15 to 40 years were selected for this study. Teeth with incomplete root development and open apex due to trauma/failed apexogenesiswith calcium hydroxide/radiographically evident apical resorption due to chronic apical periodontitis andwhere apical foramina had been inadvertently enlarged as a result of over instrumentation were selected.

Medically compromised persons with cardiacdisease, immunocompromisedpatients,teeth with root fracture and signs of active pathological root resorption were excluded.

Study protocol was approved by institutional ethical committee. Informed consent was taken from every patient.

Access cavity was preparedfollowing Rubber Dam Isolation.Working Length was established with Apex locator and confirmed radiographically. Rootcanals were cleaned and shaped with hand K-type files and intermittently irrigated with 3% NaOCL using side vented needles. Additional irrigation was performed with2%Chlorhexidine. Interappointment calcium hydroxide dressing was placed for 7 days.[6]In asymptomatic teethMineral Trioxide Aggregate (MTA)plug of 5mm was placed in the next appointment.[7,8] In symptomatic teeth irrigation and intracanal medicament placement was repeated.

A freshly prepared mix of MTA in distilled water waspushed apically by MTA plugger. Placement of MTA was repeatedly checked radiographically.A root end barrier of 5 mm was achieved and confirmed with immediate post operative radiograph. A moist cotton pellet was left in canal in close contact withMTA to facilitate its setting for 24 hours. Access opening was sealed with Interim Restorative material.[9]

After 24-48 hours access was reopened & cotton pellet was removed.Apical plug of MTA was checked for its hardness and set with the help of a reamer. Obturation of the root canal was carried out by warm vertical condensation of gutta-percha(E&Q). Access cavity was sealed withcomposite.

Tooth without adequate corona-apical structure was restored with glass fiber post placed directly over MTA apical plug using resin cement as a luting agent.They were then restoredwith ceramic crown.

Immediate post operative radiograph was taken and assigned as 0 monthsPostoperative Evaluation of each tooth was done every 4^{th}, 8^{th}, 12^{th}&18^{th}monthsclinically and radiographically.

Radiographic Examination:

- Both the diagnostic andcontrol radiographs were taken with paralleling technique.Radiographs were taken with radiovisiograph and conventional ultra-speed dental X-ray film by Dental X-Ray machine.To overcome the clinical problems of distortions and to enable accurate measurement on a radiograph, radiographic grids were used. [10]
- The grid and the anatomic features were exposed at the same time. Even if the radiograph was distorted, distancebetween consecutive grid lines underwent same changes. The size of each square area on the grid was $1mm^2$. Number of squares of the grid involved in the periapical radiolucent area was calculated in length and width regardless of elongation or foreshortening.
- Areas of periapical lesion for each tooth were measured as $L \times B$ mm^2.
- IOPA imageswere visualized in X-Ray view box. Digital images wereanalyzed in LCD monitor.

Parameters:

* Symptomatic teeth was considered as clinical failure.
*Absence of them was recorded as clinical success.

Periapical radiographs were assessed by using the criteria published by European society of Endodontology [11] as success, uncertain outcome and failure according to the criteria discussed below.

a) Success:

• Radiographic evidence of normal periodontal ligament space.
•Decreased size of the periapical lesion as compared with preoperative radiographs.
• No evidence of inflammatory external root resorption.
In cases where an existing extensive periapical lesion had healed but had left a locally widened periodontal ligament space, defect was considered to be scar tissue rather than a sign of persisting disease.Such situations were considered a success.

b) Uncertain outcome:

• periapical radiolucent area had remained the same, not diminished in size.

c) Failure:

• Evidence that an existing periapical lesion had increased in size.
a new lesion that had appeared subsequent to the placement of the root filling,
• Signs of continuing root resorption.
Outcome measures in this study were subjective symptoms, objective clinical findings and radiographic evidence.
Preoperative data included sex, age, pulp status, cause of open apex, initial or retreatment,periapical radiolucency, symptoms of pain tenderness.

Intraoperative data included the Date of treatment completion, backfill technique,pain and tenderness, MTA extrusion.

III. Result

Statistical Analysis was performed with the help of Epi Info (TM) 3.5.3. EPI INFO is a trademark of the Centers for Disease Control and Prevention (CDC).

Descriptive statistical analysiswas performed to calculate the means with corresponding standard errors (s.e). Mann-Whitney U-test was used to compare the treatment groups.One Way Analysis of variance (ANOVA) followed by Turkey's Testwas performed with the help of Critical Difference (CD) or Least Significant Difference (LSD) at 5% and 1% level of significance to compare the mean values. $P<0.05$ was taken to be statistically significant.

Sample Size:

A total number of 27 patients with 33 teeth were included in the study. The patients were reviewed every 4^{th}, 8^{th}, 12^{th}, 18^{th} month. Maximum review was18 months in all cases except in 1 patient who did not return for follow up after 4 months.

Based on preoperative variables (i.e., age, sex, cause of lesion, preoperative signs and symptoms, pulp status etc.)no variation in success of healing was seen.

The mean size of lesion diminished over 18 months in 23 patients. In 2 patients the lesion size remained same. In 1 patient the lesion increased in size. (Table1) One patient did not report after 4 months.

ANOVA showedsignificant differences between months ($F_{4,145}$=9.51, CD_5 = 23.27 and CD_1= 27.42) ($p<0.05$). As per the CD there was significant difference between 0 & 12^{th} month ($p<0.05$) and also between 0 & 18^{th}month (Table 2).With reference to patients in relation to signs & symptoms after obturation, 1 patient was recorded as failure. Rest25 patients did not have any subjective or objective symptoms.

IV. Discussion and Conclusion

Composed of tricalcium silicate, tricalcium aluminate, tricalcium oxide, and silicate oxide, resultantend product of MTA on adding water is a calcium hydroxide (CH phase) enclosed in the form of a complex gel of crystalline substance. pH of MTA after mixing was 10.2, which rises to 12.5 at 3 hours;thereafter, it remains constant. [12,13]

It generates a highly alkaline environment by leaching of calcium & hydroxyl ions rendering it bioactive, forming hydroxyapatite in the presence of phosphate-containing fluids. [14]Concentration of the calcium ions increases with time as the material cures.These regulate the growth of osteoblast cells,type1 collagen,bone sialoprotein,osteocalcin taking part in formation of mineralized matrix. [15]MTA is biocompatible,osteoconductive non-cytotoxic,stimulatescementogenesis.[16]Hence healing was evident radiographically whether it was first time or retreatment case.

Under X ray diffraction and scanning electron microscopy, dentin MTA interfacial layer resembled hydroxyapatite in composition. [13]It was also observed that due to particle sizeMTA can occlude and penetrate dentinal tubules that might harbor microorganisms even after cleaning and shaping. Along with this indirect bacteriostatic effect it might have potential bactericidal properties. The release of hydroxyl ions, a sustained high pH for extended periods, and the formation of a mineralized interstitial layer might provide a challenging environment for bacterial survival. These properties can be a potent inhibitor of bacterial growth against species such as Entercoccocusfaecalis. Moreover, Candida albicans, commonly present in refractory endodontic disease, is susceptible to the antifungal activity of freshly mixed MTA.[17,18]

In this study in 3 cases MTA was extruded beyond apex. In 2 cases (No5,7) where MTA was extruded, the tooth was asymptomatic clinically. Radiological evaluation showed diminishing size of radiolucency over the months. Similar observation of MTA extrusion and periapical healing was made by ErhanTahanet. al.[19]The lack of adverse effects from extrusion could be attributed to the good tissue compatibility of MTA, as suggested in several studies.[20,21]MTA permits the growth of cementum over its surface and reattachment of the periodontal ligament. Therefore, contact of extruded MTA with the periapical tissue is not an obstacle to healing.

One case in this present study with extrusion of MTA showed unsatisfactory healing and was categorized as uncertain outcome. Lesion size showed no changed in 18 months. It was recorded as uncertain outcome (no 25).Studies by Sarris et al reviewed that extrusion of MTA might have poor marginal adaptation and result in incomplete healing. [22]

Another case (patient no.9) displayed incomplete healing.This was also recorded as uncertain outcome.However, arguments have been presented to follow root filled teeth until complete healing is seen on

radiographs, sometimes for 7 or more years and 4 years has been proposed as standard. [23]Since the lesion did not increase in size it was assumed long term follow up wasrequired to evaluate healing in this case.

Following final obturation patients with uncertain outcome did not have any sign or symptoms.So, they were clinically successful.

Failure was recorded in one case [Case16]. On radiographic evaluation MTA plug could not be identified. The tooth was tender on percussion with reappearance of pus. It was assumed disinfection of the canal was not achieved prior to application of MTA.Studies have reported that the setting of MTA is adversely affected by an acidic ph.[24-26]

Therefore 25 patients were assessed as Successful clinically.

In 7 cases periapical radiolucency did not disappear completely but decreased in size and they were considered successful.

So follow up of 18 months revealed successful healing of periapical radiolucency in 91% patients. Uncertain outcome was recorded in 6% patients and failure was recorded in 3% patients.

Overall, these results indicate that the apexification of teeth with pulp necrosis and immature apices by MTA allows apical bone healing with no evident objective or subjective symptoms and signs.

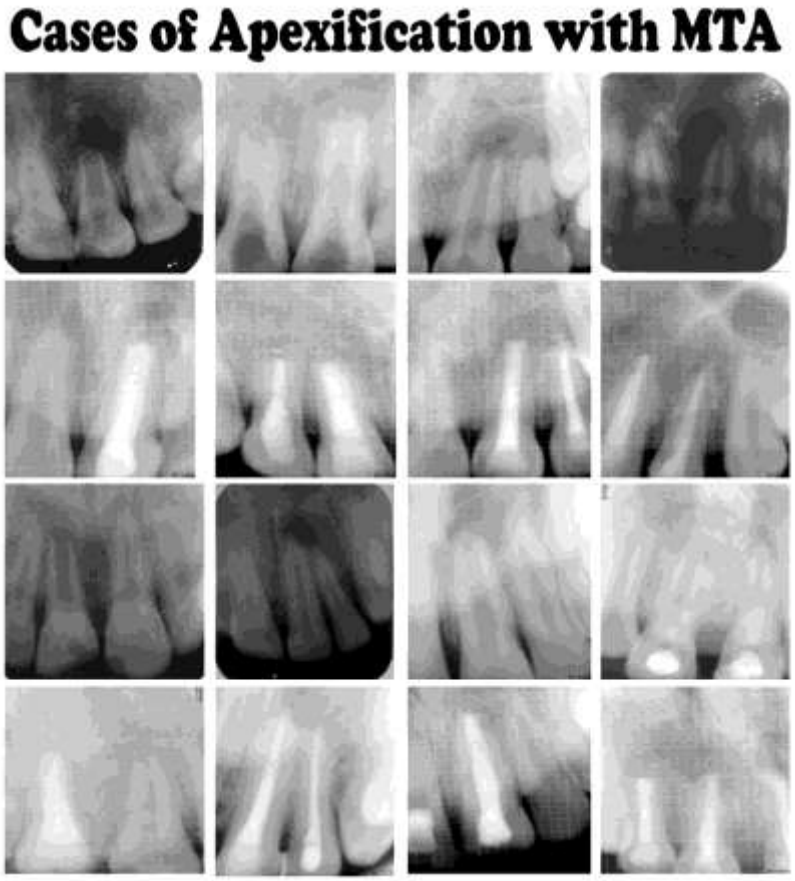
TABLE-1

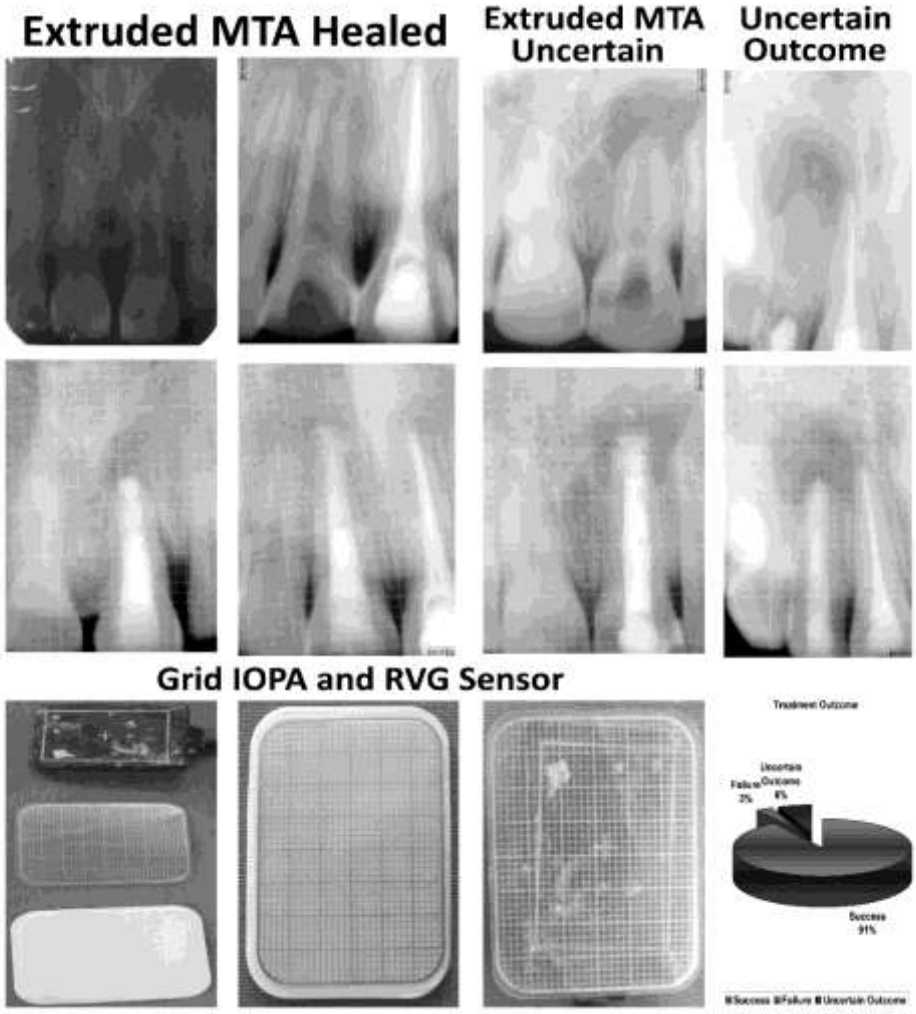
DIMINISHING SIZE OF PERIAPICAL LESION (in mm^2)					
0 MONTH		**4 MONTHS**	**8 MONTHS**	**12 MONTHS**	**18 MONTHS**
1	a) 56	42	19	5	0
	b) 49	35	12	2	0
2	70	58	46	32	20
3	90	78	66	54	40
4	6	3	0	0	0
5	a) 35	13	6	0	0
	b) 42	30	18	8	0
	c) 4	2	2	0	0
6	12	4	0	0	0
7	40	30	25	20	15
8	70	56	42	30	15
9	72	60	57	50	40
10	40	30	20	15	12
11	10	5	0	0	0
12	90	80	65	47	30
13	6	4	0	0	0
14	20	12	6	0	0
15	30	18	12	6	0
16	0	0	0	0	0
17	a) 6 b) 4 c) 4	0 0 0	0 0 0	0 0 0	0 0 0
18	42	30	20	10	0
19	a) 50	40	30	15	0
	b) 36	26	14	12	0
20	50	29	12	2	0
21	6	0	0	0	0
22	36	36	0	0	0
23	6	2	0	0	0
24	42	12	5	0	0
25	90	90	89	89	89
26	4	0	0	0	0
27	6	4	0	0	0

Mean +(-) s.e (n=27)	34.53 +(-) 4.85	24.43 +(-) 4.31	16.40 +(-) 3.65	10.47 +(-) 2.94	5.73 +(-) 2.17
Anova					
	D.F.	*Sum of Squares*	*Mean Sum of Squares*	*F*	*p*
Between Month	4	15720.91	3930.23	9.51	<0.05
Within Month	145	59919.36	413.23		
Total	149	75640.28			
Critical Difference					
	Mean Difference	*Significance*			
0 & 4th	10.1	p>0.05			
0 & 8th	18.13	p>0.05			
0 & 12th	24.06	p<0.05*			
0 & 18th	28.8	p<0.01*			
4th& 8th	8.03	p>0.05			
4th& 12th	13.96	p>0.05			
4th& 18th	18.7	p>0.05			
8th& 12th	5.93	p>0.05			

Table 2

8th& 18th	10.67	p>0.05			
12th& 18th	4.74	p>0.05			





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