

Apexification and periapical healing of immature teeth using Mineral Trioxide Aggregate

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ABSTRACT

Background: Apexification is a method to induce a calcified barrier in a root with an open apex or the continued apical development of an incomplete root in teeth with necrotic pulp. MTA apexification has several advantages such as it neither gets resorbed, nor weakens the root canal dentin, and also sets in the wet environment. The aim of this study is to evaluate the effectiveness of the use of MTA in apexification and periapical healing of teeth with incomplete root formation and periapical infection.

Materials and method: Apexification was carried out on fourteen permanent immature teeth of eleven children aged 7-12 years attended the teaching hospital of College of Dentistry, Baghdad University using mineral trioxide aggregate followed by obturation of the root canal using gutta percha. The teeth were monitored at 3, 6 and 12 months intervals by clinical examination and radiographical evaluation of root development and healing of periapical lesion.

Results: After a 12 months interval, all the teeth appeared to be asymptomatic so that the rate of clinical success in all of the cases was (100%). Radiographically, the success rate was 100% for thirteen teeth while that tooth which was started the treatment with large periapical lesion, showed regression of the periapical destruction suggestive of bone healing and regeneration of the root apex around the MTA material, end with small one so that it started unhealthy but finished with improved healing process.

Conclusion: Mineral trioxide aggregate showed both clinical and radiographical success as a material used to induce root-end closure in permanent teeth with immature root formation. This material had the primary advantage of reduction in the number of appointments, development of proper apical seal and healing of periapical lesions.

Key words: apexification, immature teeth, mineral trioxide aggregate. (J Bagh Coll Dentistry 2014; 26(3):108-112).

الخلاصة

خلفية: Apexification هو أسلوب للحث على تكوين حاجز كلسي في قمة الجذر غير مكتمل النمو أو هو تحفيز استمرار نمو قمة جذر الأسنان المنخورة اللب غير مكتملة نمو القمة الجذرية. MTA apexification له العديد من المزايا كونه لا يحصل له ذوبان أو تاكل، ولا يضعف عاج قناة الجذر، و يتصلب أيضا في بيئة رطبة. الهدف من هذه الدراسة هو تقييم فعالية استخدام MTA في apexification في تكوين القمة الجذرية للأسنان ودوره في تشكيل ونمو قمة الجذر للأسنان في حالة وجود التهاب مصاحب للقمة الجذرية. أجريت الدراسة على أربعة عشرة سن دائمية غير مكتملة نمو القمة الجذرية من أحد عشر طفلا تتراوح أعمارهم 7-12 سنة وفدوا الى المستشفى التعليمي لكلية طب الأسنان، جامعة بغداد باستخدام مادة ال MTA بلييه سد القناة الجذرية باستخدام مادة حشو الجذر gutta percah. وقد تم رصد ومتابعة حالة الأسنان على فترات 3 و 6 و 12 شهرا من خلال الفحص السريري والتقييم الشعاعي لحالة القمة الجذرية وملاحظة شفاء القمة الجذرية من اي التهاب مصاحب لها. كانت النتائج بعد مرور 12 شهرا، ان جميع الأسنان كانت بدون اي أعراض سريرية بحيث كان معدل النجاح السريري في جميع الحالات (100 %). وفيما يخص الأشعة السينية، كان معدل النجاح 100 % لثلاث عشرة سن في حين أن السن التي بدأت العلاج مع آفة ذروية كبيرة، أظهرت انحسارا كبيرا موحية بشفاء مصحوب بتكون عظمي و تجديد ذروة الجذر حول مادة ال MTA، اي ان السن انتهى بالتهاب صغير جدا مع أنها بدأت من منع الانتشاء من المتابعة لسو حظ التحسن الكبير في عملية الشفاء.

الاستنتاج: أظهرت الدراسة نجاح سريري وأشعاعي في استخدام مادة ال MTA على حد سواء كمادة تستخدم للحث على إغلاق الجذر في نهاية الأسنان الدائمة مع تشكيل قمة الجذر غير مكتملة النمو. كان لهذه المادة ميزة رئيسية في اختصار عدد زيارات المريض للمستشفى، ووضع ختم او حاجز قمي سليم وكذلك المساعدة على الشفاء من الآفات الذروية المصاحبة للقمة الجذرية غير مكتملة النمو.

INTRODUCTION

Devitalization of the pulp is one of the sequelae of traumatic injuries to the young permanent teeth. It leads to concomitant arrest in the future development of the immature roots of the involved tooth. In such cases blunderbuss canals are viewed radiographically. The canals make obturation and obtaining hermetic seal of the root canal system not possible ⁽¹⁾. Therefore, different materials have been tried to create a physical barrier that enables obturation of the root canal ⁽²⁾.

The traditional radicular-closure procedure employs calcium hydroxide (Ca(OH)₂). This technique was followed for the management of immature apices for over half a decade and has shown to give excellent results regardless of the periapical pathology. Root development or apical calcification in addition to apical healing was ob-

erved within three months postoperatively and may continue for more than a year ^(3,4). The hydroxyl group is considered the most important component of calcium hydroxide because of the alkaline environment it provides which is required for encouraging repair and active calcification. The disadvantage of calcium hydroxide is time consuming and may require up to 7-8 months or even a year for the apical barrier to form ⁽⁴⁾.

Apexification using mineral trioxide aggregate (MTA) provides an alternative treatment modality in immature pulpless teeth. MTA did not have calcium hydroxide in its composition but it had calcium oxide that could react with tissue fluid to form calcium hydroxide ⁽⁵⁾. Both MTA and calcium hydroxide led to the formation of calcite crystals, these crystals which were originating from reaction of calcium ions from MTA and calcium hydroxide with carbon dioxide from the tissue had a role as an initiating step in the formation of hard tissue barrier except MTA requires significantly less time ⁽⁶⁾. The

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treatment time between the patient's first appointment and the final restoration is lessened in addition to the regeneration achieved by this material⁽⁵⁻⁷⁾.

MTA in apexification has become a popular material due to its superior biocompatibility, excellent marginal adaptability and good sealing ability. Satisfactory compaction of obturating material is achievable as MTA on setting provides a sound and hard apical barrier⁽⁸⁾. The aim of this study is to evaluate the effectiveness of the use of MTA in apexification and periapical healing of teeth with incomplete root formation and periapical infection.

MATERIALS AND METHODS

The sample included in this study was obtained from the children attending the teaching hospital of the College of Dentistry, Baghdad University. The collection of the sample, treatment and follow-up started in October 2010 and ended in May 2013 (each tooth was monitored for up to one year). Twenty traumatized partially developed permanent maxillary incisors of seventeen (10 males and 7 females) patients were included. Patients that did not return for follow up on call were excluded from the study. The number of the treated teeth with their follow up was therefore reduced to 14 teeth of eleven patients.

Full detailed treatment plans were explained to the children's parents and written consents for treatment were obtained prior to the clinical procedures. An information record for each child was filled with information concerning the general health of the child including the medical history in addition to the chief complain and reason for attending the hospital. Information about the history of the traumatized tooth/teeth and clinical oral findings were also recorded during an intraoral examination to determine the condition of the teeth and soft tissues. The amount of coronal fracture (according to Ellis classification of tooth fracture⁽⁹⁾), discoloration, mobility, tenderness to percussion and pulp vitality were recorded also. Vitality of the tooth was tested with ethyl chloride. A diagnostic periapical radiograph was taken to examine the presence of root fractures, the amount of root development and the condition of the periapical region. All the teeth selected for this study had coronal fracture with pulp exposure or necrotic pulp with a history of trauma ranging from ten days to two years and a previous swelling or recurrent swellings.

Following the administration of local anesthesia (when treating tender teeth) and after isolation of the traumatized tooth, establishment of proper unrestricted access was done to ensure complete

access to the canal walls in order to acquire adequate debridement. The length of the root canal was estimated shorter than the apex 2-3 mm. After complete removal of the necrotic pulp tissue, irrigation of the canal was performed using copious amounts of 5% sodium hypochloride. The canal was then dried with premeasured absorbent paper points to the working length followed by application of root canal medicament (CMCP) and the tooth was closed with a temporary filling. Irrigation of the root canal was repeated at a week interval until a completely clean and dry canal was reached. Instrumentation of the canal was carried out to debride and shape the root canal walls⁽⁸⁾. At this time MTA (Pro Root MTA, Dentsply Tulsa Dental, U.S.A) was applied apically. MTA powder was mixed with distilled water in a ratio 3:1 for about 30 seconds until it became homogenous and its consistency became thick similar to wet sand^(10,11). Then it was immediately carried into the root canal by the use of an endodontic messing gun (figure 1) and by hand condensation^(4,11-13).



Figure 1: The endodontic messing gun

The working length of the messing gun was adjusted 3-4 mm shorter than the estimated working length so that a 4-5mm plug was formed. The plug was checked radiographically. If creation of an ideal plug failed from the first attempt, it was rinsed with sterile water and the procedure was repeated. A sterile cotton pellet moistened with sterile water was placed over the canal and the access cavity was sealed with a temporary filling. The moistened cotton pellet allowed the MTA plug to completely set. The time required for its setting is 4 hours after which the root canal could be obturated with gutta percha. In this study the pellet was left until the next day (24 hours)^(14, 15). Lateral compaction technique was used to obturate the canal with gutta-percha and zinc oxide eugenol sealer^(2,12). Periapical radiographs were taken after applying the plug and after obturating the root canal to be sure a proper seal was obtained. The patient was recalled at monthly intervals for radiographic evaluation of the apical barrier formation and periapical healing. When this was

achieved the final restoration of the fractured crown was done to restore esthetic (figures 2, 3).

All the patients were recalled after 3 months, 6 months and 12 months respectively and evaluated clinically and radiographically.

The success or failure was determined according to the following criteria:-

1. Clinical evaluation: the presence of any signs such as swelling, pain, tenderness to percussion or palpation and pathological mobility was definitely indicative of clinical failure.
2. Radiographical evaluation: The radiographs were examined carefully and compared with the preoperative radiographs. Observation of any partial loss of the lamina dura, widening of the periodontal ligament, any sign of pathological

external or internal root resorption as well as periapical or inter-radicular radiolucency was considered as radiographic failure.

In case that the tooth already present with periapical radiolucency, the following calculations were made depending on periapical index (PAI)⁽¹⁶⁾:(1) tooth that started unhealthy (PAI 3–5) and finished healthy (PAI 1, 2); (2) tooth started unhealthy (PAI 3–5) and finished improved but still unhealthy (healing process) (PAI 3–5); (3) the tooth that started unhealthy (PAI 3–5) and ended the same or worse⁽¹⁷⁾.

The clinical and radiographic examination of the teeth treated, throughout the study period, was carried out by the three authors. The data was described in numbers and percentage values.



Figure 2: Case 1: Periapical radiographs of two teeth treated with MTA.

a-working length estimation b-MTA apexification for two incisors c-obturation of one root canal d-obturation of the other root canal e-follow-up at 3 month interval f- follow-up at 6 month interval g- follow-up at 12 month interval.

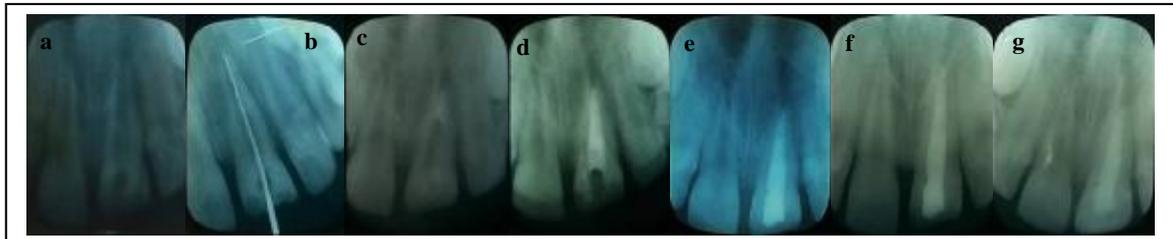


Figure 3: Case 2: Periapical radiographs tooth treated with MTA.

a- diagnostic radiograph, b-working length estimation c-MTA applied at the apex d-obturation of root canal e-follow-up at 3 month interval f- follow-up at 6 month interval g- follow-up at 12 month interval.

RESULTS

The number of patients was 11 (7 males, females). The number of the teeth treated was 14.

Table (1) describes the sample according to age, gender, number of traumatized teeth and classification of the coronal fracture. Fractures of the teeth were mostly of type III (n= 9) followed by type IV (n= 5).

Table 1: Distribution of sample and type of fracture

Age (Years)	No. of patients		No. of teeth	Classification of coronal tooth fracture*				
	Male	Female		I	II	III	IV	V
7	1	1	3	-	-	-	3	-
8	-	2	3	-	-	2	1	-
9	2	-	2	-	-	2	-	-
10	2	-	3	-	-	3	-	-
11	1	1	2	-	-	2	-	-
12	1	-	1	-	-	-	1	-
Total	7	4	14	-	-	9	5	-

* Classification of tooth fracture was according to Eliss.

The clinical findings of the treated teeth were recorded at 3, 6 and 12 months (Table 2). At the three post treatment intervals there was no sign or symptom of clinical failure (clinical success was 100%).

The radiographic findings of the treated teeth are shown in Table (3). The periodontal ligaments were normal for all of the cases and external

resorption was not found in any of them. However one case had a periapical lesion that did not heal completely even after 12 months, but it seemed to be improved progressively from the 3rd month (Fig. 4), so that the findings of PAI analysis revealed that this case started unhealthy and finished improved but still unhealthy (healing process).

Table 2: Clinical findings of the treated teeth

Pre treatment findings		Clinical findings						Clinical success	
		Pain	Swelling	TP*	ST**	PM***	Discoloration of tooth		
		2	7	2	3	0	1	No.	%
Post treatment Intervals	3months	0	0	0	0	0	0	14	100
	6 months	0	0	0	0	0	0	14	100
	12months	0	0	0	0	0	0	14	100

*Tenderness to percussion **Sinus tract ***Pathological mobility

Table 3: Radiographical findings of the treated teeth

Post Treatment Interval	Radiographical Findings			Radiographical Success	
	Normal PDL	Periapical Radiolucency	External Resorption	No.	%
3 Months	14	1	0	13	92.9
6 Months	14	1	0	13	92.9
12 Months	14	1	0	13	92.9

DISCUSSION

Traumatic dental injury is a common accident during childhood. The age group included in this study lied in between 7 and 12 years which is characterized by vigorous playing. Although immediate treatment of a traumatized tooth raises its prognosis, most of treatments were delayed because parents can't ascertain the seriousness of the injury or are unsure where to seek treatment. This lead to the high frequency of pulp necrosis especially evident in delayed treatment of type III and IV fractures^(1,2,14). Fractures involving enamel and dentin with pulp exposure allowed the entry of bacteria into the pulp as well as chemical and thermal irritation of the pulp canal which eventually, with delay of treatment, lead to pulp necrosis⁽¹⁷⁾.

Apexification treatment is supposed to create an environment to permit deposition of cementum, bone and periodontal ligament to continue its function of root development. The goal of this treatment was to obtain an apical barrier to prevent the passage of toxins and bacteria into periapical tissues from the root canal. Technically this barrier is necessary to allow compaction of root filling material⁽¹⁹⁾.

Mineral trioxide aggregate as an apexification material represents a primary monoblock⁽⁸⁾. Appetite like interfacial deposits formed during the maturation of MTA result in filling the gap induced during material shrinkage phase and improves the

frictional resistance of MTA to root canal walls. The formation of nonbonding and gap filling appetite crystals also accounts for seal of MTA⁽²⁰⁾.

The novel approach of apexification using MTA lessens the patient's treatment time between first appointment and final restoration. During a long apexification period, the root canal is susceptible to reinfection if the coronal seal fails, and to root fracture (as seen with calcium hydroxide apexification). With the use of MTA there is less chance of root fracture in immature teeth with thin roots because the material immediately bonds with the roots and strengthens it^(1,21,22).

Radiographically the healing of the periapical radiolucencies was gained in all but one case (figure 4). Although the size of the lesion decreased with time and there were no clinical symptoms of failure in this case, it was still there after a year recall. The unresolved periapical radiolucency may be due to the lesion healing with fibrous tissue, and not necessarily a sign of endodontic failure⁽²³⁾. Periapical scar tissue originates from connective tissue-forming cells that colonize the periapical area before the cells responsible for generating the different periodontal components do so⁽²⁴⁾.

As conclusion; Mineral trioxide aggregate showed both clinical and radiographical success as a material used to induce root-end closure in permanent teeth with immature roots. This material had the primary advantage of reduction in the

number of appointments, development of proper

apical seal and healing of periapical lesions.



Figure 4: Case 3: periapical radiographs of tooth treated with MTA showing periapical radiolucency. a-diagnostic radiograph b-working length estimation c-MTA applied at the apex d-obturation of root canal e-follow-up at 3 month interval f- follow-up at 6 month interval g- follow-up at 12 month interval.

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