Original Article

A Comparative Study of Apical Healing of Open Apices Using MTA and $Ca(OH)_2$ Apical Plugs in Cats

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Abstract:

Statement of problem: Endodontic treatment of necrotic teeth with open apices is a challenge. After ruling out surgery as a treatment scheme and introduction of the multivisit apexification which in turn had its disadvantages, apical plug seems to be a suitable substitute treatment plan for such cases. Apical plug makes the treatment through formation of a barrier against the obturating material in a single visit.

Purpose: The purpose of this study was to compare histologically the periapical healing using MTA and calcium hydroxide apical plugs after intervals of 4 and 12 weeks in cats.

Materials and Methods: In this clinical trial study 64 canines of 16 healthy and mature cats were divided into 3 groups after a periapical lesion formation by over instrumentation in the apical area with files up to no.120. The first group included 24 teeth on which MTA apical plug was applied. The second group included 24 teeth on which Ca (OH) 2 apical plug was applied. In both groups the canals were filled with gutta percha and sealer. The third group included 16 control teeth whose canals were left empty after instrumentation and debridement. The access cavities of all teeth were sealed with varnish and amalgam and the vital perfusion of cats was performed in 4 and 12 week intervals. Statistical analysis was established by χ^2 and independence test.

Results: After 4 weeks, periapical healing in the first group was 90%, in the second group 80% and in the third group, it was only 12.5 %. After 12 weeks, periapical healing occurred in 100% of the MTA group, while it was 57.1% in the second and 40% in the third group .Generally, in the study of histological parameters of healing, no statistical significant difference was observed between the 2 experimental groups, although the MTA group results were much better than the Ca (OH) 2 group especially at 12 weeks.

Conclusion: The use of MTA apical plug is more effective than Ca (OH) 2 in treatment of necrotic teeth with open apices.

Key words: MTA; $Ca(OH)_2$; Apical plug; Apical Healing

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INTRODUCTION

Treatment of necrotic teeth with open apices has so far been performed with the use of apexification method. Considering its various defects such as lack of a specific treatment time and long duration of treatment, uncertain apical closure, frequent instrumentation and weakness of cervical region of teeth, the use of

apical plug method seems to be more practical. In this method, a compact barrier is placed in the open area of the root-end to induce the formation a calcified barricade in the periapical region and after setting of this barrier for which different materials can be used; practitioner can obturate the canal with gutta percha.

Gerstein et al [1] made use of calcium hydroxide apical plug in teeth with open apices.

Dimashkieh [2] proposed the surgical apical plug. During a histological study on the tissue reaction to dentinal chips plug, Tronstad [3] concluded that this material is an appropriate barrier for canal filling and induces hard tissue formation. Ghoddusi and Sadr-E-Lahijani [4] observed osteogenesis in 100% of the cases after 6 months during Histologic and radiographic evaluation of $Ca(po_4)_3$ apical plug in cats In another study by Fallah Rastegar et al. [5] periapical healing following apical plug with hydroxi apatite in cats radiographically and histologically was observed to be 44.4% and 69.7% respectively. During a histological study on dogs, Shabahang and Torabinejad [6] found out that the amounts of induced inflammation with hard tissue formation following root-end induction by MTA compared to that of calcium hydroxide and osteogenic proteine-1 do not differ appreciably, but the ability of MTA to induce hard tissue formation is considerably higher than the other two.

The purpose of this study was the histological comparison between periapical healing with MTA and calcium hydroxide apical plugs after 4 and 12 weeks in cats.

MATERIALS AND METHODS

In this clinical trial study 64 canine teeth obtained from 16 healthy male Persian cats (18-24 months) under the supervision of a veterinarian were used and categorized into 3 groups: 24 teeth in the MTA group, 24 teeth in the $Ca(OH)_2$ group, and 16 teeth in a control group. A combination of $1^{mg}/_{kg}$ of xylazine (Rampan) and ketamine Hcl 10 $^{mg}/_{kg}$ via intramuscular injection was used for general anesthesia and a mixture of 1ml of 2% lidocaine and epinephrine concentration of 1/100.000 via infiltration for local anesthesia. After obtaining the primary radiography, tooth crowns' were dissected 1-2 mm above CEJ. The pulps were extirpated with barbed No 15 (VDW, Germany) and all teeth were exposed to oral environment in order to develop periapical lesions. After two weeks and under general anesthesia, canals were irrigated with normal saline and access cavities were sealed with amalgam. One of the 4 canine teeth of each cat was considered as the control and the other three treated as experimental groups.

Four weeks after lesion induction procedures, following the general anesthesia and obtaining the radiography for the approval of periapical lesion, rubber dam was placed and amalgam fillings were removed. Canal length measured and following the canal instrumentation and apical foramen enlargement to file No 120, $Ca(OH)_2$ (Densply, Latin America, Petrópolis, Brazil) was placed as intracanal dressing for 1 week and then the access cavities were sealed with Cavit (manufacturer). In the next step and under general anesthesia, the Cavite was removed and in order to remove the dressing the canals re-instrumented, irrigated and dried with paper points. Then, roots were obturated to 3-4 mm from the apical stop with MTA (ProRoot MTA, Dentsply, Tulsa Dental Tulsa, Ok, USA) and $Ca(OH)_2$ (Densply, Latin America, Petrópolis, Brazil) in group one and two respectively. Canals of group 2 were filled laterally during the same session by gutta percha and Tubli-Seal cement (Sybron Endo/Kerr; Orange,Calif, USA) and access cavities were filled with amalgam. Due to the prolonged setting time of MTA, the same filling procedures was performed in group 1 48 hours later.

Animals scarified by vital perfusion 4 and 12 weeks after apical placement of plug. Periapical sections of almost 6μ thickness were prepared and stained with Hematoxylin-Eosin (H&E) followed by histological studies using of a light microscope (X40 and X100).
Chronic inflammation with mild distribution to the surrounding bone marrow, granulation tissue formation, presence of fibrosis or a calcified barrier (partial or complete) alone or with each other indicated healing of the periapical lesion while acute inflammation with severe distribution (abscess), absence of granulation tissue, lack of fibrosis and calcified barrier indicated no healing.
The findings were analyzed with the use of χ^2 and independence test using SPSS software.

RESULT

Findings of this study were as follows:
1- There was no significant difference in the type of inflammation between the two experimental groups and the control group at both intervals.
2- There was a considerable decrease in severity of inflammation in MTA group as compared to the control group at the end of 4 weeks. Similar decrease in severity was also observed after 12 weeks, as compared to $Ca(OH)_2$ group ($P < 0.05$).
3- After 4 weeks, there was no significant difference in vasodilatation between experimental groups and control group. After 12 weeks, there was a noteworthy decrease in MTA group compared to Ca(OH)2 and control group ($P < 0.05$).
4- After 4 weeks, the distribution of inflammation into the surrounding bone marrow was less in MTA than control group ($P < 0.05$) but after 12 weeks, no significant difference was observed between experimental groups and control group.
5- There was no significant difference in bone resorption, cement resorption, granulation tissue formation and fibrosis between experimental groups and control group after 4 and 12 weeks (Fig. 1).
6- After 4 weeks, calcified barrier formation was appreciably more in experimental groups compared with control group ($P < 0.05$), but not after 12 weeks (Table 1 & Fig. 2, 3, 4).
7- At the end of 4 weeks, MTA group, Ca(OH)2 group and control group revealed 90%, 80%, and 12.5% periapical healing respectively. The difference between experimental groups and control was significant. ($P < 0.05$) (Fig. 5). These amounts were 100%, 57.1% and 40% after 12 weeks and the difference between MTA and control group was significant ($P < 0.05$) (Fig. 5).

Table I: Distribution of calcified barrier formation in open apex area.

Interval	Group	Calcified barrier formation		
		Partial	**Complete**	**Not formed**
4 weeks	MTA	50%	10%	40%
	$Ca(OH)_2$	50%	10%	40%
	Control	0%	0%	100%
12 weeks	MTA	75%	0%	25%
	$Ca(OH)_2$	57.1%	0%	42.9%
	Control	20%	0%	80%

DISCUSSION

Since histological studies, are virtually impossible on human models, experimental animals are used as substitutes. Vital perfusion is practicable in experimental animals in which microscopic samples with high resolutions are maintained. In this study, vital perfusion was done according to Asgari's method [7]. Asgari suggested the use of cats as appropriate animals due to the availability, low expense, easy anesthesia and the canine tooth canal which is similar to the human teeth.
The results revealed periapical healing following MTA and $Ca(OH)_2$ apical plugs,

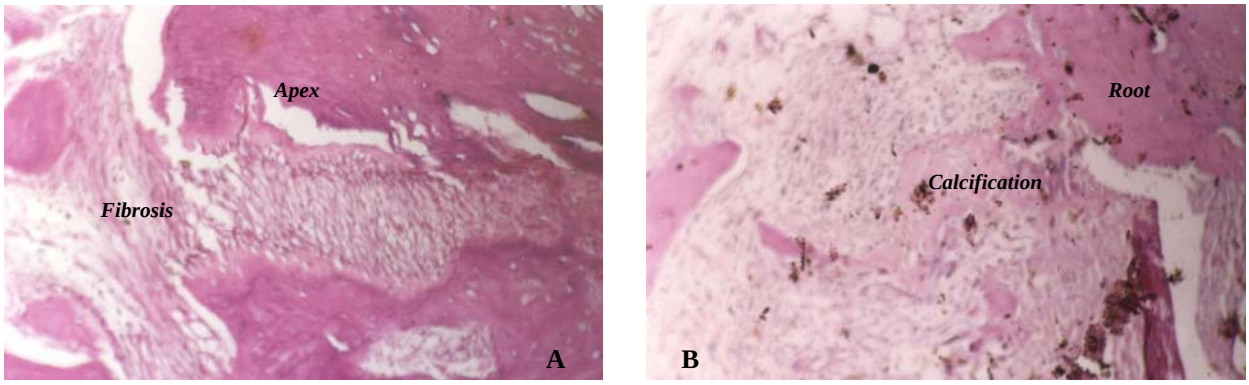

Fig 1: MTA after 4 weeks (X100); A: Formation of fibrotic tissue in apex area, B: Amorphous calcification in apex area.

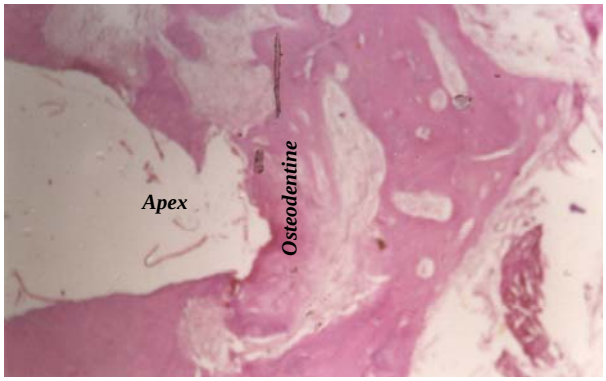

Fig 2: $Ca(OH)_2$ after 4 weeks(X40); the calcified barrier formation.

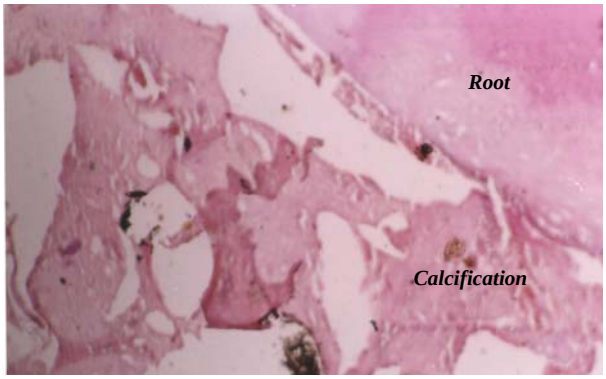

Fig 4: MTA after 12 weeks (X100); amorphous calcification in apex area.

although the difference was not statistical significant. This finding advocates the use of apical plug as treatment of necrotic teeth with open apices.

In the study by Shabahang and Torabinejad [6], hard tissue formation was significantly more in MTA group than $Ca(OH)_2$ and osteogenic proteine-1 groups which is different from our finding.

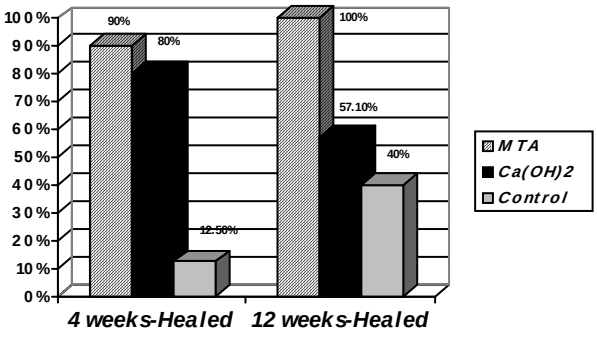

Fig. 5: Diagram of periapical healing in experimental groups and the control group in 4 & 12 week intervals

In their study, the canals were sealed with experimental materials without actually obturating the canals with gutta and sealer, so healing and calcified barrier formation may have been imperfect because of periapical leakage due to high solubility of $Ca(OH)_2$ in tissue fluids after one month. But in the present study since the canals were obturated with gutta and sealer and the access cavities were sealed with amalgam, coronal and apical leakage which could interfere with periapical healing and calcified barrier formation would not be suspected in any of the experimental groups (especially in the 4 week interval group).

However periapical healing in $Ca(OH)_2$ group after 12 weeks (57.1%) was less than 4 weeks group (80%) which could be due to the gradual solubility of $Ca(OH)_2$ in tissue fluids after one month.

Type and severity of inflammation and infiltration to the surrounding bone marrow was less in MTA group after 4 weeks. After 12 weeks, severity of inflammation and vasodilatation was less in MTA group. These findings could explain the better bio-compatibility and sealing of MTA compared to $Ca(OH)_2$.

Our study is in accordance with the study carried out by Chegin et al [8] which revealed a 93.7% clinical and radiographic success rate for MTA plug after 6 months.

Our findings about Ca(OH)2 plug confirms Weisenseel et al [9] who noted that $Ca(OH)_2$ plug leakage was less than customized gutta-percha. Schumacher and Rutledge [10] observed perfect clinical periapical healing following 2 years of $Ca(OH)_2$ plug placement.

In a histological study by Pitts et al [11], $Ca(OH)_2$ was prone to solubility. Considering this finding and our findings after 12 weeks, it can be concluded that in case of $Ca(OH)_2$ solving into tissue fluids prior to periapical healing and calcified barrier formation, the apical seal may be jeopardized.

One of the important points in our study was periapical healing in 12.5% of 4 week control group cases and 40% of 12 week control cases. This confirms Tornek & Smith [12], who believed that canal debridement and instrumentation of infected dentinal tubules and coronal sealing leaving the canal empty, could initiate apical barrier formation. In the present study, the following different types of partial calcified barriers were observed: osteodentin similar to the study of Dylewski [13], bone similar to study of Nevins et al [14], cellular cement like Pitt et al [11] Steiner and Van Hassel [15] and dentin & amorphous calcification similar to Smith et al [16].

CONCLUSION

In a comparison between apical plug and the contemporary multivisit apexification in treatment of necrotic teeth with open apices, it is evident that the former takes less time and does not need repeated canal instrumentation consequently leading to lower frequency of CEJ weakness and cervical fracture. Less frequent follow up problems, calcified barrier formation in 60% to 75% and periapical healing in 80% to 100% of the cases are other positive points.

Considering the mentioned advantages, the use of MTA apical plug is better than $Ca(OH)_2$ in treatment of necrotic teeth with open apices.

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مقایسه اثر پلاگ اپیکالی از جنس MTA و کلسیم هیدروکساید بر بهبود ناحیه اپیکال دندانهای گربه با آپکس باز

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چکیده

بیان مسأله: درمان کانال‌های نکروتیک با آپکس باز، یکی از مشکلات درمانی ریشه دندان است. صرف نظر از درمانهای جراحی و درمان چندجلسه‌ای اپکسیفیکیشن که به نوبه خود دارای مضراتی است، استفاده از پلاگ‌های اپیکال، می‌تواند جایگزین مناسب‌تری برای درمان این موارد باشد؛ زیرا مواد مذکور با ایجاد یک سدّ در مقابل مواد پرکننده کانال در ناحیه اپیکال، امکان درمان ریشه چنین دندانهایی را در یک جلسه فراهم می‌نمایند.

هدف: مطالعه حاضر با هدف مقایسه بافت‌شناختی اثر پلاگ‌های اپیکال MTA و کلسیم هیدروکساید بر بهبود ناحیه اپیکال پس از ۴ و ۱۲ هفته در دندانهای گربه انجام شد.

روش تحقیق: تعداد ۶۴ دندان کانین ۱۶ گربه سالم و بالغ پس از ایجاد ضایعه اپیکال در اثر over instrumentation تا فایل شماره ۱۲۰ به صورت تصادفی به سه گروه تقسیم شدند. گروه اول شامل ۲۴ دندان بود که با MTA درمان شدند؛ در گروه دوم نیز ۲۴ دندان با کلسیم هیدروکساید مورد درمان قرار گرفتند. در هر دو گروه، کانال‌ها با استفاده از گوتاپرکا پر شدند. در گروه شاهد ۱۶ دندان پس از آماده‌سازی و دبریدمان بدون پرکردن رها شدند. حفره دسترسی تمام دندانها با وارنیش و آمالگام ترمیم شد. گربه‌ها پس از ۴ و ۱۲ هفته کشته شدند. داده‌ها با استفاده از آزمونهای Chi-Square و نمونه‌های مستقل تحلیل شدند.

یافته‌ها: پس از چهار هفته در ۹۰٪ از نمونه‌های MTA، ۸۰٪ از نمونه‌های کلسیم هیدروکساید و فقط ۱۲/۵٪ از نمونه‌های گروه شاهد بهبودی مشاهده شد و پس از دوازده هفته در تمام نمونه‌های MTA و ۵۷/۲٪ از نمونه‌های کلسیم هیدروکساید و ۴۰٪ از نمونه‌های شاهد، بهبودی دیده شد. به طور کلی با مطالعه شاخصهای بافت‌شناختی مربوط به بهبودی ناحیه اپیکال، نتایج اختلاف معنی‌داری را در دو گروه نشان نداد؛ اما بخصوص در فاصله دوازده هفته، اثر MTA کمی بهتر از کلسیم هیدروکساید بود.

نتیجه‌گیری: جهت درمان دندانهای نکروتیک با آپکس باز، استفاده از پلاگ‌های MTA مؤثرتر از کلسیم هیدروکساید می‌باشد.

واژه‌های کلیدی: MTA؛ کلسیم هیدروکساید؛ پلاگ اپیکال؛ بهبود ناحیه اپیکال

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