

REPARATION PROCESS AND CLOSING OF APICAL OPENING AFTER ENDODONTIC TREATMENT OF IMMATURE PULPLESS TEETH

Olivera Vojinovic, O. Piletic, E. Srnac (*)

INTRODUCTION

The closing process of the apical opening after the endodontic treatment of the pulpless immature teeth represents an interesting pathohistological problem in dental science. The knowledge of the histological structure of the subsequently formed tissue in the apex is also necessary for determining the adequate therapy and therefore the study of this problem is of a definite clinic importance. The former histological investigations of the human teeth showed various results. The wide apical opening of the immature teeth is closed by an unspecific cement-like tissue after a successful treatment according to a group of authors. (Binnie and Rowe, 1971, Vojinovic, 1966 i 1972) Heisthresay demonstrated that the apex could be subsequently formed by an irregular dentine tissue. The experimental research done in the animal teeth proved that the apical part of the root is closed by the tissue whose structure depends on a kind of applied endodontic treatment: the subsequent formation of the roots is done by the process of irregular odontogenesis and by the irregular dentin tissue after the vital amputation, while the apex is closed by an unspecific calcified cement and immature bonelike tissue in the complete absence of the pulp. (Vojinovic 1974, Dilewsky 1969)

The more detailed study of the histological structure of the tissue which after the endodontic treatment closes the apical opening is presented in this report. Besides, both the origin and the way of forming of this calcified tissue has been tried to be explained by means of the comparative histological analysis in various period of observation.

(*) Faculty of stomatology and Faculty of medicine, University of Belgrade, Yugoslavia

MATERIAL AND METHOD

The experimental material in this study consisted of 18 roots of permanent teeth in young dogs at the moment the apices were not formed completely. The total extirpation of the vital pulp was done under the general anesthesia (10 % thialbarbitone sodium, 5 ml/kg body weight intravenously), and under the aseptic condition. The canals of 16 roots were irrigated by saline solution, dried with a cotton pallet without any medicaments and filled with the Iodoform-Chlumsky paste (Iodoform powder and Chlumsky solution: phenol 30 gr, camphor 60g, absolute alcohol 10g.) at the same time. The canals in two roots were exposed to bacteria from the mouth cavity within the period of 10 days. After this period the canals were irrigated and filled by the above mentioned paste.

RESULTS

Radiological analysis

Radiological analysis proved that the apical part of all the roots closed within the observation period of 265 days by the calcified tissue which, judging by the radiograph was less mineralized than the regulary formed hard dental tissues. The subsequently formed apex was separated in all the cases from the surrounding bone by the irregular spacium. The closing of the apical opening was gradual and the first signs of the mineralisation were visible in the radiographs 2-3 month after the experiment had been done. (fig 1.)

Histological analysis

Histological analysis of the reparation tissue in the apical opening was done within the observation period of 45-60 (6 roots) of 105 days (2 roots) and of 265 days (10 roots)

Observation period from 45 to 60 days

Histological analysis of the apical region in the observation period from 45 to 60 days showed that the wide apical opening was filled with the new proliferous abundantly vascularised granulation tissue. This tissue represented a continuation of the periodontium as well as of the connective tissue of the near by bone cavities. (fig.2) There were a great number of undifferentiated cells in it, while lymphocytes, plasmocytes, rare mastocytes and macrophages formed a thick cellular protective barriere towards the filling paste (fig.3)

The more scarce the fibres elements of this granulation tissue were the deeper they were located in the lumen of the canal.

There was a blood clot to be frequently seen over the granulation tissue and much deeper in the lumen of the canal there was a reticular net. (fig. 3)

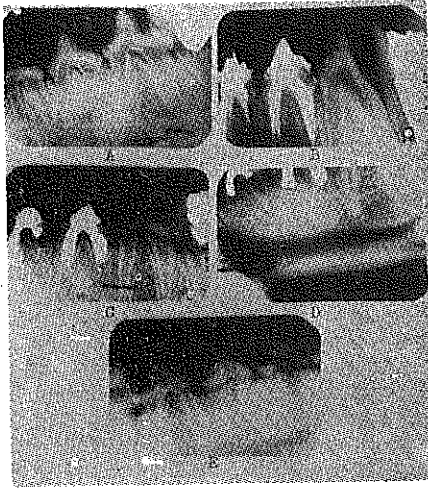


Fig. : 1 Radiograph of experimental dog's teeth before the vital extirpation. The development of the roots was not completed. B) The same teeth immediately after filling of the canals. C) The same teeth six month after the pulpectomy. D) The same teeth 265 after the plup ectormy. Apices are closed with the reparative hard tissue in both teeth despite bacteria present in one of them (the left one) E) Control teeth regularly developed.

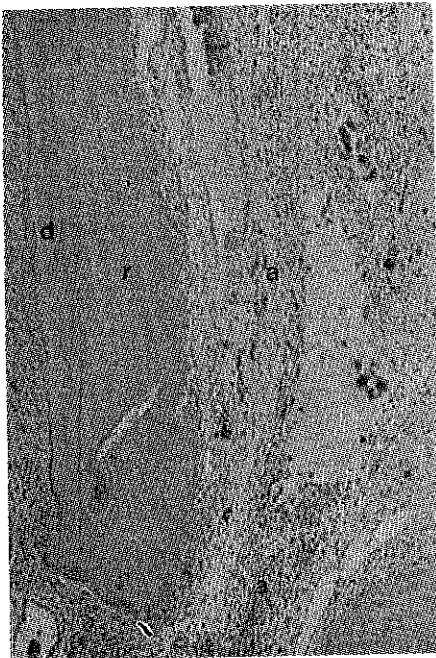


Fig. 2 The apical opening 60 days after vital extirpation of the pulp a) Granulation tissue which filled the apical opening d) Dentine. r) Reparation calcified tissue (Formol 4 %, Ac. Formici 17 %, H&E 85x)

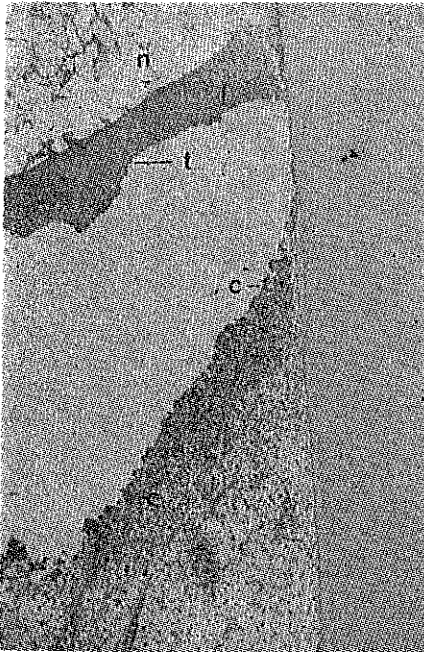


Fig. : 3 The granulation tissue which filled the apical opening 60 days after the vital extirpation. c) Cellular barrier t) Blood clot n) Reticular net towards the filling paste (formol 4 %, Ac. Formici 17 %, H&E 85 x)

There were dentine fragments of various sizes, shapes and locations inside the granulation tissue. Some of them were surrounded by the cells similar to odontoblasts and some of them served as the tissue bases for the apposition of the cement-like and immature bone-like masses, which coated them completely. (fig 4) The fragments of the cement-like tissue also surrounded by the cells were seen beside the dentin-like fragments.

Observation period of 105 days

The apical opening in this period was partly closed only by the cement-like tissue. In some cases this tissue was formed next to the wall of the canal as a separately formed product, but in some other cases it represented the continuation of the normal cement.

In the central part of the calcified tissue there were some empty spaces and some with the cells in them. The calcified tissue was surrounded by the formative cells. Some cells were coated with the mineralized mass secreted by themselves. (fig 5)

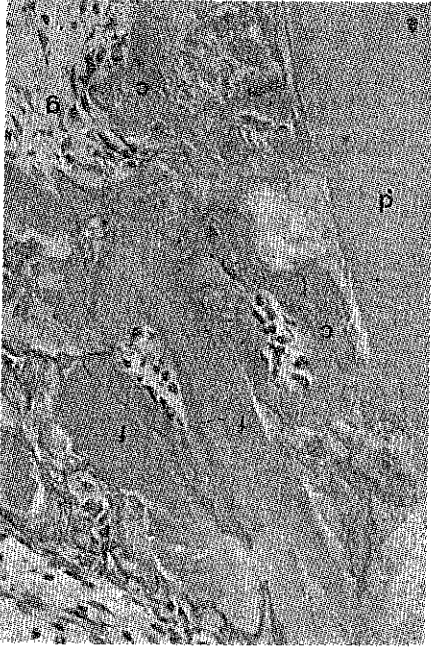


Fig. : 4 Dentone fragments incorporated in the cement - like tissue. d) Dentine. g) Granulation tissue which filled the apical opening 60 days after the experimental pulpectomy. f) dentin fragments. c) Cement - like tissue

(Formol 4 %, Ac. Formici 17 %, 175 x)



Fig. : 5 Apical opening after 105 days after the vital extirpation of the pulp. r) Regular dentine. b) bone tissue. p) periodontium. c) Connective capsule. f) Reparation calcified tissue.

(Formol 10 %, Ac. Formici 17 %, H&E 30 x)

The apical part of the canal was in this period filled by the same granulation tissue as in the former one, but with a greater number of connective fibres and a bigger calcified trabecular substance (fig 6). The formerly described protective barrier could be seen towards the filling paste in this observation period.

A visible tendency of the complete closing of the apex and its separation from the surrounding bone tissue by the connective capsule could be clearly perceived in all the sections (fig 5)

Observation period of 265 days

The histological analysis showed in this period of time that the apical opening in all the cases was closed by the calcified tissue of the extremely irregular structure. Several types of the hard tissue could be recognized in it. The greatest part of this calcified conglomerate consisted of the irregular and immature bone and cementlike tissues. Fragments of dentine were fitted into this irregular calcified mass. Visible cavities occurred here and there filled with the tissue of an indefinite structure (fig. 7)

The calcified conglomerate closing the apical opening was clearly separated both from the regularly formed dentine and from the surrounding bone. It was separated from dentine by the surface on which dentine tubules interrupted and by the connective capsule from the surrounding bone. (fig. 7)

A thinner or a thicker layer of the uncalcified connective capsule with blood vessels and cells was recognized in all the cases towards the root canal (fig. 8). The blood clot was there over it and reticular net towards the filling paste. The formerly described layers of the newly formed tissue (fig 9) which closed the apical opening after the therapy were found out after 265 days in all the experimental roots of the teeth both in those where the complete extirpation of the pulp was done and in those which were treated as apical periodontitis.

DISCUSSION

Our experimental investigations, described in this paper proved that the further forming of the root does not continue by the process of the regular odontogenesis in the pulpless teeth. The presence of odontoblasts was not seen in any of the histological sections except around small separated dentine fragments inside the granulation tissue which in the early observation period filled the apical opening. The newly formed part of the apex was clearly separated in all the sections both from dentine and the surrounding bone which means that it formed itself as an independent calcified product. (fig.7)

The structure of the reparation calcified tissue in the apical opening was of the same character in all the roots no matter how



Fig. : 6 Apical opening 105 days after the vital pulpectomy. t) The calcified tissue of trabecular structure inside the granulation tissue (g) which filled the apical opening. d) Regular dentine. s) Surrounding bone tissue.

(Formol 10 %, Ac. Formici 17 %, H&E 30 x)



Fig. : 7 The apical opening 265 days after the extirpation of the pulp. d) Regular dentine. r) The reparation calcified callous, which completely closed the apical opening. i) Cavities inside the calcified tissue c) Connective capsule. s) Surrounding bone tissue.

(Formol 10 %, Ac. Nitrici 5 %, H&E 30 x)

they were treated: as apical periodontitis or by the method of vital extirpation. The identical arrangement of each layer of the reparati-on tissue in various teeth was also noticed (fig. 7,8,9) This proves that the reparation process in the apical region of the immature teeth has also its own and determined course in the absence of the radi-cular pulp.

The conclusion can be brought that regarding to the presence and the arrangement of the blood vessels and cells, the innervation and vascularisation of the newly formed callous in the apical opening are achieved through the labyrinth of the empty spaces inside the calcified tissue. The calcified callous, which in the later observation period closes the apical opening is formed, judging by the results of our experiments, by means of the formative activity of the cells of the granulation tissue which fills the apical part of the canal immediately after the experiment was performed. (fig. 2,3) Since this gra-nulation tissue always represents an extension of periodontium it can be assumed that it derived from the periodontium itself. The young cells with the potention for forming structurally different calcified tis-sue (dentine, cementlike and bone-like) under the influence of the moderate irritative factors.

The calcified tissue becomes gradually bigger in its volume at the expense of the granulation tissue which in the later observation period remains only towards the filling paste. (fig. 8)

The appearance of dentin fragments in this reparation tissue could be explained in this way: a part of them is formed as a product of the mechanical manipulation in the canal of the root and the others as a product of the formative activity of the odontoblast-like cells. Odontoblasts in the granulation tissue represent an interesting feno-menon. They may be supposed to have developed from undifferen-tiated cells which possessed a high potention of differentiation into various kinds of formatively active cells. The probability that the re-gular odontoblasts separated from the pulp tissue remained in the apical part of the canal after the extirpation of the radicular pulp is very small.

The fenomenon that the apex obtained the form similar to re-gular root can be explained by the presence of the connective capsule which was found around each newly formed root and probably conditioned its shape. (fig. 5,7)



Fig. : 8 The apical opening 265 days after the vital extirpation of radicular pulp. r) Regular dentine. t) Calcified reparation tissue which filled the apical opening. u) Uncalcified tissue layer towards the filling paste (Formol 10 %, Ac. Nitric 5 %, H&E 30 x)

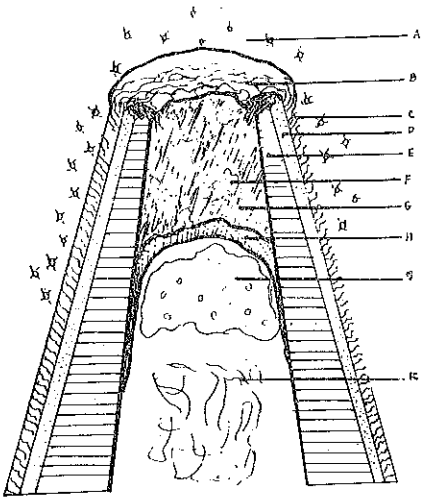


Fig. : 9 The different layers of the tissue which closed the apical opening 265 days after the vital extirpation.

A) Alveolar bone tissue. B) Connective capsule. C) Periodontium D) Cementum. E) Dentine. F) Cavities inside the reparation calcified tissue G) Cement-like reparation tissue which filled up the apical opening. H) Uncalcified layer towards the filling paste. J) Blood clot. K) Reticular net

It could be concluded according to the pathohistological analysis of the reparative process in the apical region presented in this paper, that the endodontic treatment of the immature teeth should be directed in the first place towards the removal of all irritative factors out of the tooth canal which could prevent the formation of the reparation granulation tissue in the apical opening.

The presence of the blood clot above the granulation tissue (fig. 3) in the early observation period points to the fact that special care should be dedicated to it, as being a protective barrier during the therapy.

Our clinical experience proved that the formation of blood clot as well as its further protection from the irritative factors in the canal of the root were the fundamental prerequisite of the closing of the apical opening by the calcified tissue (Voinoviç 1971)

Special attention should be paid to the choice of the filling paste which has a direct potential effect upon the formation of the calcified callous. Iodoform —Chlumsky paste as this experiments proved, has somewhat stronger irritative effect than required which is confirmed by the presence of thick layer of the protective cells towards the paste itself. (fig 3) The recent experiments proved, has somewhat stronger irritative effect than required which is confirmed by the presence of thick layer of the protective cells towards the paste itself. (fig. 3) The recent experiments positively indicated that the paste with calcium hydroxide ise more convenient in the treatment of the immature teeth. (Vojinovic in press)

It can be concluded on the basis of what has been stated so far, that the endodontic treatment of the immature pulpless teeth is to be specific and adjusted to the reparation process in the periapical region. This is the only way to reach the final aim in the endodontic therapy of immature pulpless teeth, that is the closing of the wide apical opening.

NORMAL OLGUNLUĞUNA ERİŞMEMİŞ VE PULPASI ALINMIŞ DİŞLERİN KANAL TEDAVİLERİNDEN SONRA APEKSLERİNİN KAPANMASI VE TAMİR PROÇESI

Dişhekimliğinde normal olgunluğuna erişmeden pulpası alınmış olan dişlerde yapılan kanal tedavilerinden sonra apekslerinin kapanma proçesi histopatolojik bir sorun teşkil eder. Kanal tedavisini müteakip apekte teşekkül eden dokunun yapısı hakkında bilgi sahibi olmak, aynı zamanda kullanılacak tedavi yönteminin saptanması bakımından da önemlidir. Bu nedenle bu sorun üzerindeki araştırmaların kesin olarak klinik önemleri de söz konusudur.

Materyel ve metot:

Bu araştırma apeksleri henüz kapanmamış olan 18 genç köpeğin sürekli dişleri üzerinde yapılmıştır. Genel anestezi ve aseptik koşullar

altında dişlerin pulpalari çıkarılmıştır. 16 tane kök kanalı tuzlu su eriyiği ile yıkanıp herhangi bir ilâç kullanılmadan kurutulmuş ve loodform-Chlumsky macunu ile doldurulmuştur. İki kökün kanallarına 10 günlük bir süre içinde ağız ortamından bakteri bulaşmıştır. Bu süreden sonra kanallar yıkanmış ve yukarıda sözü geçen macun ile doldurulmuştur.

Bulgular:

Radiografik incelemelere göre 265 günlük bir gözlem süresi içinde apeksler/kapanmış ve oluşan apeks çevredeki kemik dokusundan düzgün olmayan boşluklarla ayrılmıştır. (Şekil 1)

Histolojik incelemeler:

45 - 60 günlük gözlemler: Bu süre içinde geniş apeks açıklığı kan damarlarından zengin prolifer olmuş bir granülasyon dokusu ile dolmuştur. Burada periodonsiyum ve bağ dokusu devamlılık göstermektedir (Şekil 2). Değişikliğe uğramamış hücreler fazla sayıda vardır. Lenfosit, plasmosit ve az miktarda mastosit ve makrofaj'lar da dolgu maddesine doğru kalın, koruyucu bir hücresel tabaka oluşturmuşlardır. (Şekil 3)

Granülasyon dokusu içindeki fibrilli elementler kanalda daha derinde yer almışlardır.

Granülasyon dokusu üzerinde ekseriya bir kan pıhtısı görülmektedir ve kanal içersinde çok daha derinde yer almış olan retiküler bir ağ vardır. (Şekil 3)

Granülasyon dokusu içersinde ayrıca çeşitli şekillerde ve büyüklükte dentin parçacıkları vardır. Bunların bazıları odontoblast'lara benzer hücrelerle çevrilmiştir ve bazıları olgunlaşmamış kemik veya semente benzer kitlelerin birikimi için dokusal bir zemin görevi yaparlar. (Şekil 4)

15 günlük gözlemler:

Bu süre içinde apeksler semente benzer bir doku ile kısmen kapanmış durumdadır. Bazı hallerde bu doku ayrı olarak, bazı hallerde de normal sementin bir devamı imiş gibi gözükmektedir.

Kalsifiye dokunun orta kısmında bazı boşluklar vardır. Bazı durumlarda bu boşlukların içi hücrelerle doludur. Kalsifiye doku şekillenmiş hücrelerle sarılmıştır. Bu hücrelerden bazıları kendi ifraz ettikleri mineralize bir kitle ile kaplıdır. (Şekil 5)

Bu süre içinde kanalın kök kesimi, önceki sürede olduğu gibi, aynı tip granülasyon dokusu ile dolmuştur. Fakat içinde bağ dokusu lifleri fazladır ve kalsifiye olmuş trabeküler madde daha büyüktür. (Şekil 6) Önceden tanımlanan koruyucu tabaka yine dolgu maddesine doğru görülebilir.

265 günlük süre içindeki gözlemler:

Bu süre içinde kötü vak'alarda apeks açıklığı aşırı derecede düzgün olmayan bir kalsifiye doku ile kapanmıştır. Bu kalsifiye doku içinde çeşitli sert dokular tanımlanabilir. Bunların büyük çoğunluğu düzgün olmayan olgunlaşmamış kemik ve sementa benzer dokulardır. Aradaki boşluklara dentin parçacıkları yerleşmiştir. Orada burada görülen boşluklar da yapısı kesin olmayan bir doku ile doludur (Şekil 7)

Bu kalsifiye olmuş karmakarışık doku gerek düzgün oluşan dentin dokusundan ve gerekse çevredeki kemikten belirgin bir şekilde ayrılabilir.

Her vak'ada kök kanalına doğru içinde kan damarları bulunan ince veya kalın kalsifiye olmamış bir bağ dokusu kapsülü vardır. (Şekil 8). unun üzerinde kan pıhtısı ve dolgu maddesine doğru da retiküler ağ bulunur. Tedaviden sonra apeks açıklığını kapatabilmek için, daha önceden de tanımlanan ve yeni oluşan doku tabakaları, 265 günlük bir gözlem süresinden sonra gerek pulpaları tamamen alınmış dişlerde ve gerekse apikal periodontitis'li dişlerin tedavilerinden sonra daima mevcuttur.

Sonuç:

Olgunlaşmamış dişlerde yapılan kanal tedavilerinin kendine özel bir anlamı vardır ve tedavi planı, periapikal bölgede tamir prosesine uygun olarak düşünülmelidir. Bu tip vak'alarda endodontik tedavinin amacına erişebilmesi için tutulacak yegane yol budur.

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