Maturogenesis of an Early Erupted Immature Permanent Tooth: A Case Report With 7-Year Follow-Up

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The main objective of treatment of an undeveloped tooth (immature) is to provide vital pulp therapy to allow continued development of root dentin. A case report is presented that demonstrates the use of calcium hydroxide ($CaOH_2$) as an indirect pulp-copping material for the purpose of continued maturogenesis of an early-erupted permanent tooth with severe mobility and almost-begun root formation. Seven-year radiographic and clinical follow-up demonstrated a vital pulp and physiologic root development without any endodontic failure clinically or radiographicaly.

Key words: *Maturogenesis, pulp-capping, early eruption*

INTRODUCTION

Maturogenesis has been defined as physiologic root development, not restricted to the apical segment. The continued deposition of dentin occurs throughout the length of the root, providing greater strength and resistance to fracture [1].

Root development begins when enamel and dentin formation has reached the future cementoenamel junction. At this stage the inner and outer enamel epithelium are no longer separated by the stratum intermedium and stellate reticulum, but develop as a two-layered epithelial wall to form Hertwig's epithelial root sheath. When the differentiation of radicular cells into odontoblasts has been induced and the first layer of dentin has been laid down, Hertwig's epithelial root sheath begins to disintegrate and lose its continuity and close relationship to the root surface. Its remnants persist as an epithelial network of strands or tubules near the external surface of the root. Hertwig's epithelial root sheath is responsible for determining the shape of the root or roots. The epithelial diaphragm surrounds the apical opening to the pulp and eventually becomes the apical foramen. An open apex is found in the developing roots of immature teeth until apical closure occurs approximately 3 years after eruption[2,3]. Because of the important role of Hertwig's epithelial root sheath in continued root development after pulpal injury, every effort should be made to maintain its viability. It is thought to provide a source of undifferentiated cells that could give rise to further hard tissue formation. It may also protect against the in-growth of periodontal ligament cells into the root canal, which would result in intracanal bone formation and arrest of root development [4].

Although vital pulp capping and pulpotomy procedures of cariously exposed pulps in mature teeth remain controversial, it is universally accepted that vital pulp therapy is the treatment of choice for immature teeth (incompletely developed apices) (5). Whenever a pulp exposure occurs in an immature tooth, it is appropriate to use a clinical technique that preserves as much vital pulp as possible. This step enables continued physiologic dentin deposition and complete root development (6).

A 7-year follow-up of a case report of an early erupted permanent tooth with severe mobility and almost-begun root formation is presented in which the vitality of the pulp was maintained utilizing calcium hydroxide ($CaOH_2$) as an indirect pulp capping material.

Case Report

A 6-year-old girl was referred to Gazi University, Faculty of Dentistry, Department of Pediatric Dentistry, with a complaint pain caused by cold and sweet foods and mobility at the left second mandibular premolar. The patient underwent an extraction of the left second primary mandibular molar due to caries 1 year ago (5 years old). Clinical examination revealed deep dentin caries with possible pulp exposure, extreme mobility, and hyperemic gingiva on her left second mandibular premolar. The radiographs revealed that root development of the mentioned tooth had almost begun (Fig. 1a-b).

Based on the results of clinical and radiographic findings, the pulpal status of the left second premolar was determined as vital. The initial treatment plan included the removal of the carious lesion and vital pulp therapy including either indirect or direct pulp capping depending on the pulp exposure. As the patient was a minor, informed consent was obtained from her parent.

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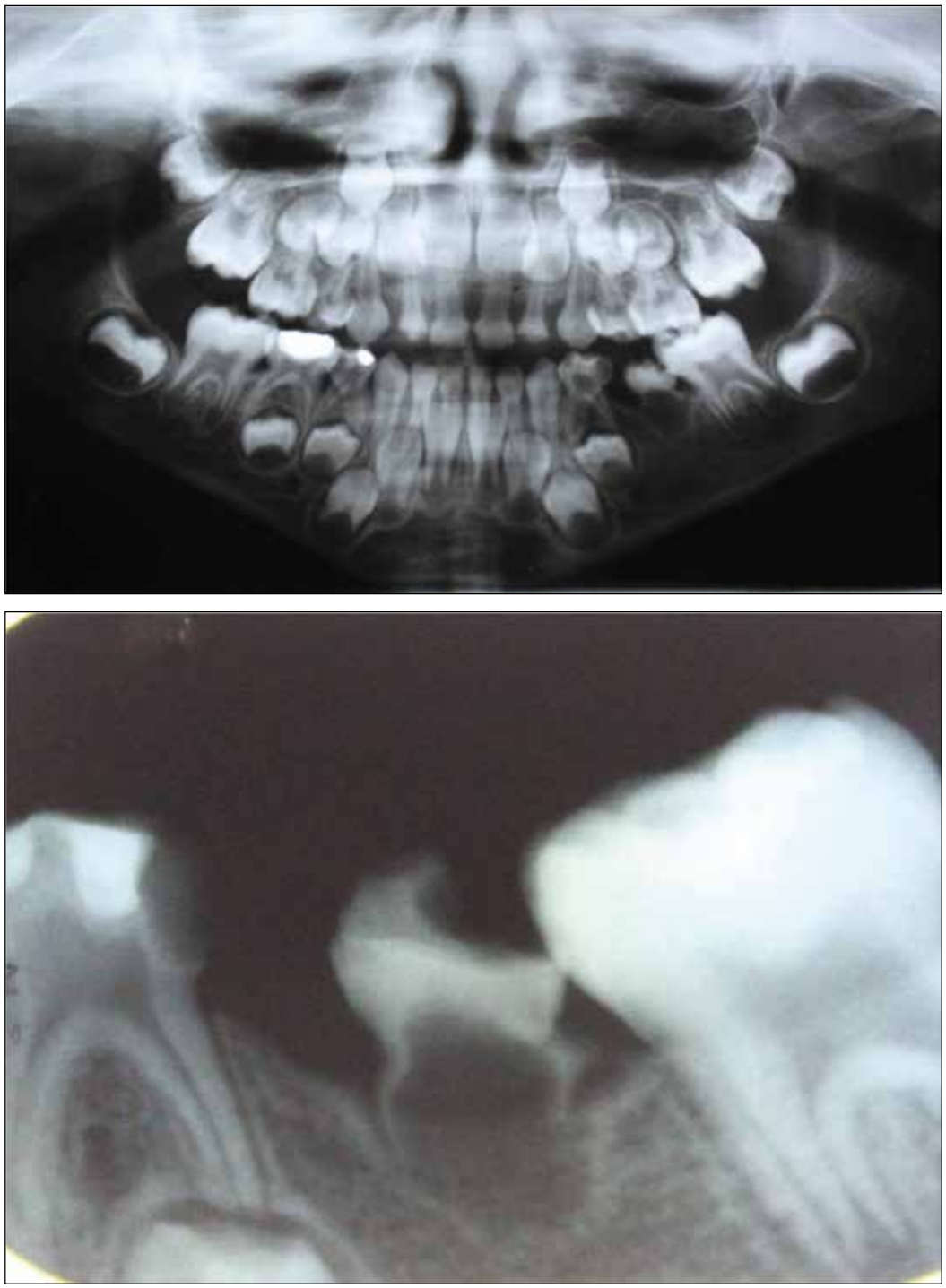
Fig 1a-b. The initial panaromic and periapical radiographs of the second mandibular premolar (2006).



After local anesthesia and carious removal using a number 4 sterile round bur on a low-speed handpiece, pulp exposure was not observed, and indirect vital pulp therapy was performed to maintain the viability of the radicular pulp and thereby permit continued root/dentin formation with the use of calcium $CaOH_2$ (Dycal, Dentsply Caulk, USA) and a glass ionomer cement (Ketac-molar, 3M ESPE, Seefeld, Germany) in two stages (Fig 2). To control the mobility, the left second mandibular premolar was splinted to the left first mandibular molar with use of an acid-etch resin splint. The patient was instructed to call the office if any pain, discomfort, or swelling developed. At the 1week follow-up appointment, the patient was asymptomatic but the splint was broken. The teeth were again splinted, and the patient was scheduled for a 1-month follow-up in order to monitor for mobility and evaluate root development.

In all the monthly recalls, although the patient was asymptomatic, the splint was broken and there was continued mobility, so splinting process was repeated until the sixth month. At the end of the sixth month, the mobility was within normal limits and the splint was removed. A periapical radiograph showed continued development and maturation of the root (Fig 3)

Fig 2. The radiograph of the teeth with glass ionomer cement at the end of second visit.

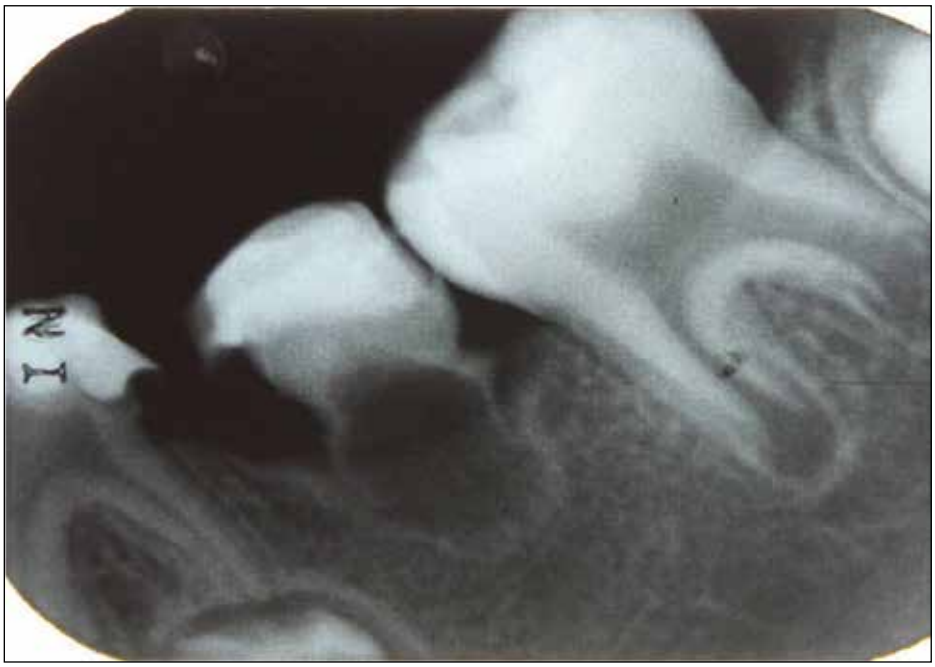
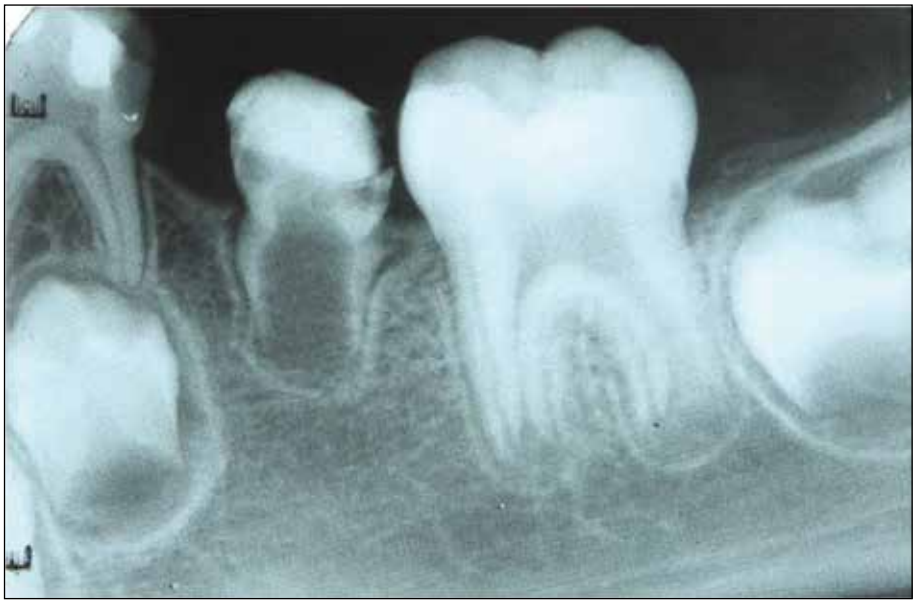


Fig 3. The radiograph of the teeth at the end of the six months.



At the 12-month follow-up, the patient reported no episodes of pain or swelling. On clinical evaluation, the restoration was intact, and the tooth responded within normal limits during electric vitality test. The periapical radiograph showed development of half of the root. The left second mandibular premolar was restored with composite resin and a strip crown, so it achieved physiological occlusal contacts (Fig 4). Again at the 2-year and 3-year follow-ups, continued development and the maturation of the root was observed (Fig 5-6).

Four years after the first visit, the patient was asymptomatic. The pulp electric vitality test was fine and the radiograph showed complete root development and apical closure (Fig. 7a-b). Root maturation (maturogenesis) occurred with no evidence of internal root resorption or pulp calcification during the 4-year follow-up.

At the 7-year follow-up, radiographic evaluation showed increased root length, complete apical closure, and thickening dentinal walls (Fig 8). Consequently, the tooth with new developing root structure and advanced mobility is under follow-up of 7 years without any endodontic failure clinically or radiographically.

DISCUSSION

Immature teeth can be affected by caries or by trauma, which can influence the development and maturation of the root [7-9]. Vital pulp therapy of pulps is an alternative conservative treatment option for young permanent teeth with immature roots. The aim of vital pulp therapy is to preserve and protect the reversibly inflamed pulp tissue from additional injury and to facilitate its healing and repair

Fig 4. One year follow-up radiograph.

Fig 5. Two year follow-up radiograph.

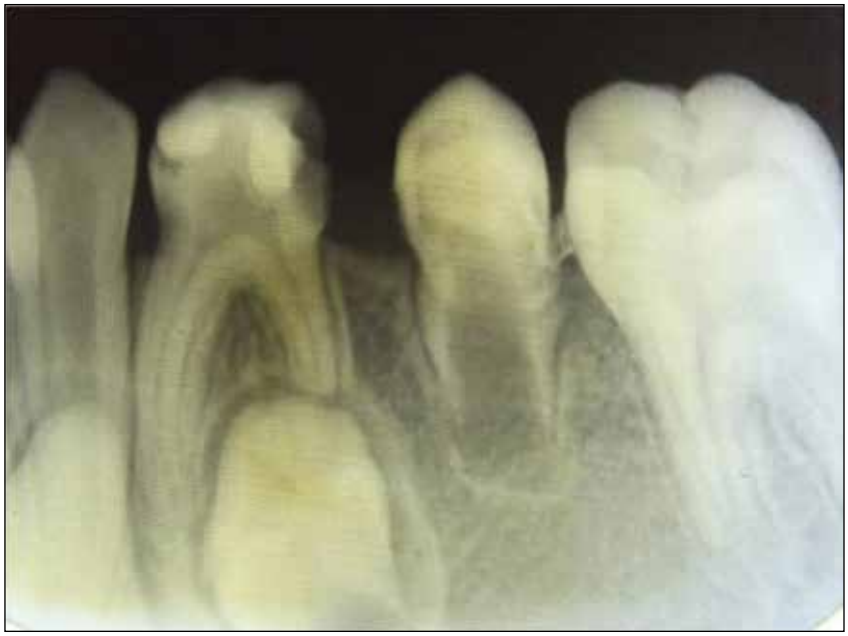


Fig 6. Three year follow-up radiograph.

while maintaining vitality [10]. Although many materials and drugs have been used as pulp-capping agents, the application of calcium hydroxide to stimulate dentin formation after a carious exposure of immature permanent teeth continues to be the treatment of choice [11].

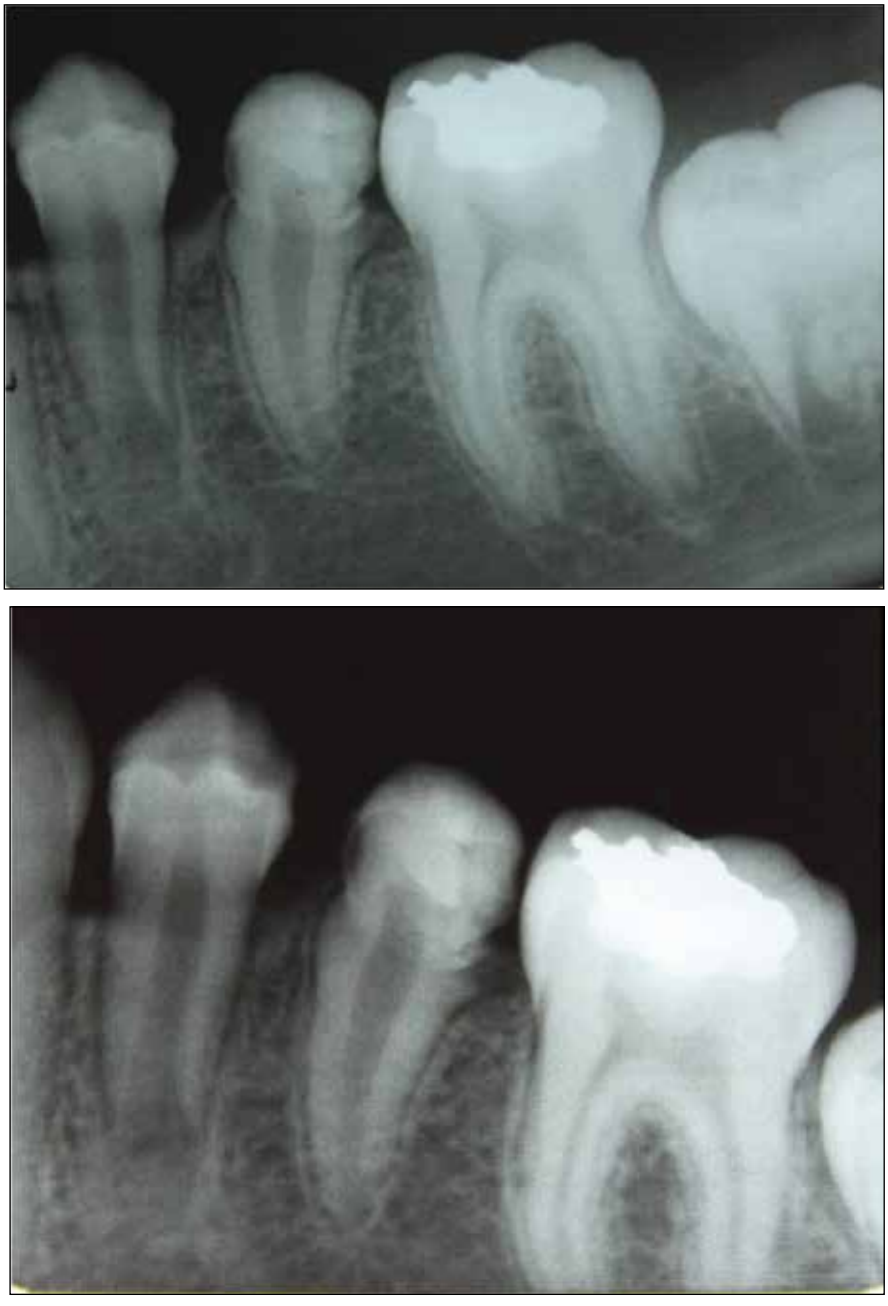
Cvek [12] has reported that immature teeth with traumatically exposed pulps and treated with a partial pulpotomy and pulp capping ($CaOH_2$) had a success rate of 96%. The treatment was successful based on the following criteria: no clinical symptoms, no radiographically observed intraradicular or periradicular pathologic changes, continued development of an immature root, radiographically observed and clinically verified hard-tissue barrier, and sensitivity to electrical stimulation.

After pulp capping or pulpotomy, the patient should be recalled periodically for 2 to 4 years to determine success. Although histologic success cannot be determined, clinical success is judged by the absence of any clinical or radiographic signs of pathosis and the verification of continued dentin deposition both radiographically and clinically [8,12,13].

Recently, the term maturogenesis has gained new attention and has been defined as the physiological root development, not restricted to the apical segment[11]. The continued deposition of dentin occurs throughout the length of the root, providing greater strength and resistance to fracture [14].

In this case, the early eruption (6 years old) of the left second mandibular premolar with insufficient root development was in accordance with the early extraction of the left second primary mandibular molar tooth. Rodríguez *et al* [15] reported that the degree of mineralization of enamel is one of the mediating factors in its

Fig 7a-b. Four year follow-up radiographs.



resistance to acid attacks. At the stage of teething, if the enamel is immature, a higher susceptibility to dental caries is occurring[15]. This finding and the high incidence of caries in the patient's primary dentition can be the explanation of the early dentin caries of the left second mandibular premolar.

In the light of clinical and radiographic findings, the treatment plan was vital pulp therapy depending on the pulp exposure (direct or indirect pulp capping).It is generally accepted that an attempt must be made to preserve pulp vitality in immature teeth, and in this context root maturogenesis of the left second mandibular premolar appeared normal, with no evidence of internal resorption or pulp calcification at the 7-year follow-up with clinical success criteria reported by Cvek [12] and by the other previous studies [8,13].The 7-year follow-up of the case demonstrated that maturogenesis treatment protocol continued root maturation without any endodontic failure clinically or radiographically, although the case was an early-erupted permanent tooth with severe mobility and almost-begun root formation.

CONCLUSION

It should be mentioned that due to the early loss of deciduous teeth, vitality of immature permanent teeth, which are more susceptible to acid attack in the early stages, is compromised. Based on the follow-ups (7-year) and the clinical results of the case, we find that maturogenesis is an acceptable term to use when dealing with the treatment of immature teeth with vital pulps, even though there was severe mobility clinically and almost begun root formation radiographically.

REFERENCES

1. Anthony DR, Senia SE. The use of calcium hydroxide as a temporary paste fill. Tex Dent J; 6,10-14. 1981.
2. Rafter M. Apexification: a review. Dent Traumatol.;21(1):1-8. 2005
3. Bhasker SN. Orban's oral histology and embryology, 11th ed. St. Louis: Mosby-Year Book; 1991.
4. Andreasen JO, Borum MK, Andreasen FM. Replantation of 400 avulsed permanent incisors. Endod Dent Traumatol; 8:45–55. 1992.
5. Fong Cheng D, Davis Martin J. Partial pulpotomy for immature permanent teeth, its present and future. Pediatr Dent; 24:29–32. 2002.
6. Camp JH. Pedodontic-endodontic treatment. In: Pathways of the pulp. 4th ed. Cohen S, Burns RC, eds. St. Louis: Mosby:685–98. 1987.
7. Langeland K, et al. Human pulp changes of iatrogenic origin. Oral Surg;32:943. 1971.
8. Klein H, Fuks A, Eidelman E, Chosack A. Partial pulpotomy following complicated crown fracture in permanent incisors: a clinical and radiographic study. J Pedodontics; 9:142. 1985.
9. Krakow AA, Berk H, Gron P. Therapeutic induction of root formation in the incompletely formed tooth with a vital pulp. Oral Surg;32:943. 1971.
10. Tziafas D, Smith AJ, Lesot H. Designing new treatment strategies in vital pulp therapy. J Dent; 28:77–92. 2000.
11. Weisleder R, Benitez CR. Maturogenesis: is it a new concept? J Endod. Nov;29(11):776-8. 2003.
12. Cvek M. A clinical report on partial pulpotomy and capping with calcium hydroxide in permanent incisors with complicated crown fractures. J Endod;4:232. 1978.
13. Ravn, JJ. Follow-up study of permanent incisors with complicated crown fracture after acute trauma. Scand J Dent Rest;90:363.1982.
14. Fuks AB. Current concepts in vital primary pulp therapy. Eur J Paediatr Dent;3:115–20. 2002
15. Rodríguez Miro MJ, Elías Avila L, Gispert Abreu E. Effect of a mineralizing solution (Minersol) on acid solubility resistance of enamel. Rev Cubana Estomatol. Sep-Dec;25(3):11-21. 1988.

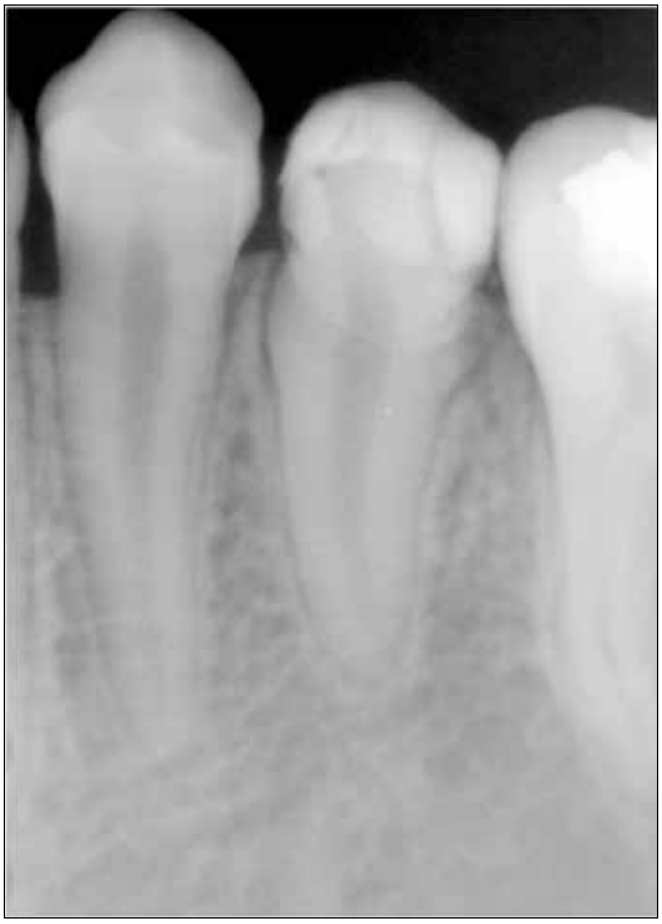


Fig 8. Seven year follow-up radiograph.