Endod Dent Traumatol 1993; 9: 238–242
Printed in Denmark . All rights reserved

Endodontics & Dental Traumatology
ISSN 0109-2502

Partial pulpotomy in young permanent teeth with deep carious lesions

Mejàre I, Cvek M. Partial pulpotomy in young permanent teeth with deep carious lesions. Endod Dent Traumatol 1993; 9: 238–242. © Munksgaard, 1993.

Abstract – The material comprised 37 young posterior teeth with deep carious lesions and exposed pulps, treated with partial pulpotomy and dressed with calcium hydroxide. The teeth were divided into two groups. Group 1 consisted of 31 teeth with no clinical or radiographic symptoms before treatment, Group 2 of 6 teeth with temporary pain, widened periodontal space periapically and/or productive osteitis, i.e. increased density of the surrounding alveolar bone. After an observation time of 24 to 140 months ($\bar{x}=56$ months), healing had occurred in 29 of 31 teeth in Group 1 (93.5%) and in 4 of 6 teeth in Group 2. It was concluded that the present, as well as previously reported results indicate that partial pulpotomy may be an adequate treatment for young permanent molars with a carious exposure, although more studies are needed before the treatment can be recommended for routine clinical use.

I. Mejàre, M. Cvek

Department of Pedodontics, Eastman Dental Institute, Stockholm, Sweden.

Key words: dental caries; pulp capping; partial pulpotomy.

Ingegerd Mejàre, Department of Pedodontics, Eastmaninstitutet, Dalagatan 11, S-113 24 Stockholm, Sweden

Accepted June 28, 1993

In mature teeth, a pulp exposed by caries is usually removed and the root canals are filled. In immature teeth the usual procedure involves treating exposed vital pulps with capping or pulpotomy and dressing with calcium hydroxide. However, neither of the latter two methods has given satisfactory results. Capping is considered to be so unpredictable that it should be avoided and pulpotomy, i.e. removal of the whole coronal pulp, is regarded as an intermediate treatment that should be followed by pulpectomy, when root development has been completed (1–4). Treatment of a pulp exposed by caries is clearly a problem in paediatric dentistry and new methods are needed to improve the prospects of pulpal healing, particularly in immature teeth. Any treatment of a pulp exposed by caries or accidentally, should aim to preserve it, vital and free of inflammation. To a very high degree this has been achieved by partial pulpotomy, i.e. removal of only a superficial layer of damaged and/or inflamed tissue in traumatically exposed pulps (5, 6). Partial pulpotomy has also been reported to be successful in treatment of pulps exposed by caries, in temporary and permanent molars, although the number of treated permanent teeth is rather limited (7–9). The aim of the present study was, therefore, further to evaluate the outcome of partial pulpotomy of pulps exposed by excavation in posterior permanent teeth with deep carious lesion.

Material and methods

Forty-four permanent teeth with pulps exposed during excavation of deep caries were treated with partial pulpotomy and dressed with calcium hydroxide. The treatments took place at the Department of Pedodontics, Eastmaninstitutet, Stockholm, between 1978 and 1990 and were performed by 16 dentists, who were specialists or post-graduate students. The minimum follow-up time was to be two years. Seven teeth did not meet this requirement, leaving 37 teeth, 2 premolars and 35 molars, for evaluation, in patients aged 6 to 15 years ($\bar{x}=9$ years).

The treatment included application of a rubber dam and excavation of all carious dentin, followed by ample flushing of the cavity and exposed pulp with sterile saline. The exposed pulp tissue and

surrounding dentin were then removed with a diamond instrument and a high-speed air-turbine to a depth of about 1.0–1.5 mm, during continuous flushing with a water spray from the turbine. Thereafter, the pulp wound was flushed with sterile saline until bleeding had ceased. When haemostasis had been achieved, the pulpal wound was dressed with calcium hydroxide (Calasept®, Scania Dental, Knivsta, Sweden), which was adapted and dried with sterile cotton pellets. Care was taken to avoid a blood clot between the wound surface and the dressing material. After the whole cavity floor had been covered with calcium hydroxide, the cavity was sealed with zinc oxide-eugenol cement. Permanent restoration with amalgam or composite was performed at a later appointment. After 3–6 months, the formation of a hard tissue barrier was clinically explored in 17 teeth, (Fig. 1, 2). The teeth were controlled after 3 and 6 months and thereafter annually. The observation period varied from 24 to 140 months ($\bar{x} = 56$ months).

The files of the patients were examined for the presence of clinical symptoms, such as spontaneous or provoked pain and sensitivity to percussion. Radiograhs, taken at the time of treatment, were examined separately by both authors with respect to root maturity and periapical conditions. Thereafter, the teeth were divided into two groups:

Group 1, consisting of 31 teeth which prior to treatment exhibited no clinical or radiographic symptoms. In 17 teeth pulpotomy was performed at the first appointment, after complete removal of carious dentin and exposure of the pulp. The remaining 14 teeth were primarily treated by stepwise excavation, i.e. the carious dentin was gradually excavated and covered with calcium hydroxide before the pulp was exposed (10–12). The stepwise excavation was done during 2–3 consecutive appointments at intervals of 2–3 weeks.

Group 2, consisting of 6 teeth which at the time of treatment showed clinical and/or radiographic symptoms. Three teeth exhibited a periapically widened and diffusely outlined periodontal space. Spontaneous pain was recorded for 2 of these teeth.

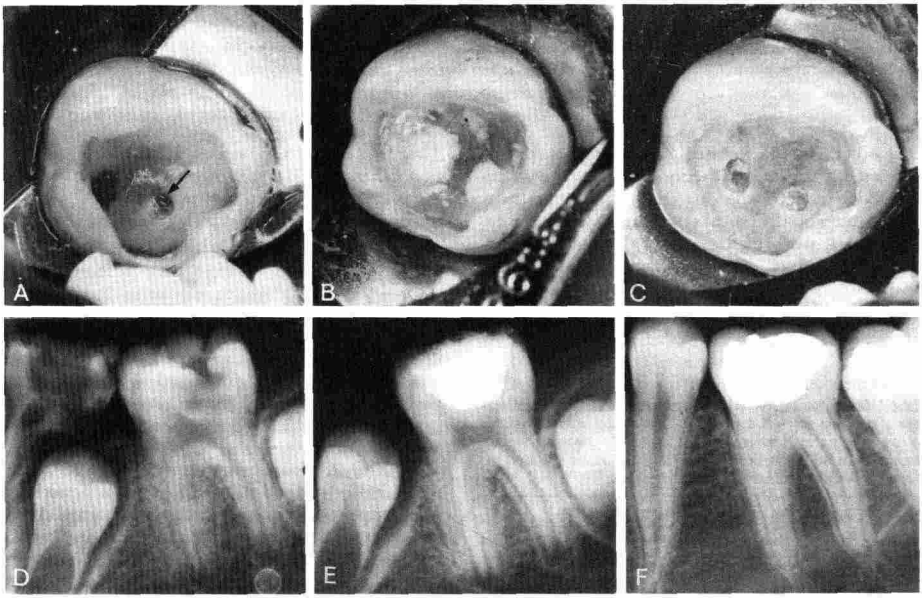

Fig. 1. A: 36; Two small pulp exposures after excavation of a deep carious lesion showing haemostasis in the mesial, first prepared amputation cavity (arrow) and ceased bleeding in the distal cavity. B. The pulp wounds dressed with calcium hydroxide. C: Appearance of hard tissue barriers three months after treatment. D: Radiograph taken before treatment showing a deep carious lesion and normal periapical conditions. E: Three months after treatment, before the clinical control of hard tissue barriers. F: Eight years after partial pulpotomy, showing normal periapical conditions and completed root development.

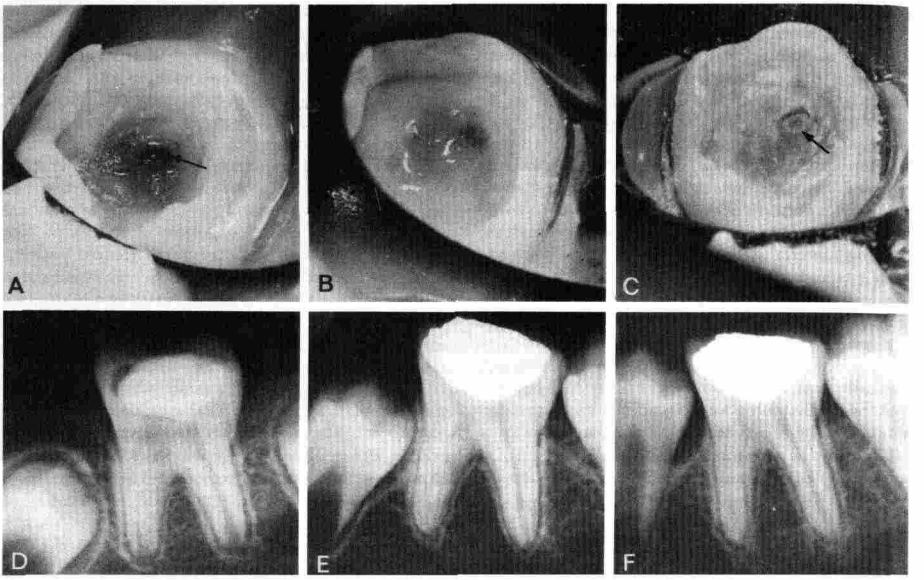

Fig. 2. A: 36; pulp exposed by caries (arrow). B. Haemostasis after complete removal of carious dentin and partial pulpotomy. C. Appearance of hard tissue barrier 3 months later (arrow). D: Radiograph taken before treatment, showing a temporary filling in the occlusal cavity, normal periapical conditions. E and F: Two and four years after partial pulpotomy.

The other 3 teeth exhibited a productive periapical osteitis, i.e. a widened periodontal space with increased density of the surrounding alveolar bone, but with no other clinical symptoms. Stepwise excavations was performed in one of these teeth.

At the end of the observation period, healing was recorded if there were no clinical symptoms or demonstrable radiographic changes other than a completed root development in immature teeth.

Table 1. Distribution of posterior permanent teeth, treated with partial pulpotomy after pulp exposure due to caries, with respect to the observation period, maturity of roots and occurrence of a failure: (*) denotes one separate case of failure. Group 1: teeth without clinical or radiographic symptoms and Group 2: teeth with such symptoms before treatment.

	Observation period (months)				
	24	25–36	37–48	49–60	61–140
Group 1: no of teeth	31	29	23	15	7
immature	14	14	9	7	2
mature	17(*)	15	14(*)	8	5
Group 2: no of teeth	6	4	4	1	
immature	1(*)				
mature	5(*)	4	4	1	

The tooth should also be sensible to electric stimulation. The distribution of the teeth within the two groups, with respect to root maturity and length of the observation time, is shown in Table 1.

Results

The results are presented in Table 1.

In *Group 1*, healing was found in 29 of 31 teeth, i.e. in 93.5%, (Figs. 1, 2). Failure occurred in two teeth; in one, pulpitis developed after 10 days; in the other, the occlusal filling was missing and a periapical radiolucency was observed 48 months after treatment.

In *Group 2*, clinical symptoms ceased after treatment and at the end of the observation period the radiographs showed periapically a normal periodontal space bordered by lamina dura in 4 teeth, including 3 which before treatment had shown a productive periapical osteitis (Fig. 3). In the remaining 2 teeth, the widened and diffusely outlined periapical space developed into a periapical radiolucency, 10 or 24 months after treatment.

In the material as a whole, all clinically inspected hard tissue barriers, 15 in Groups 1 and 2 in Group

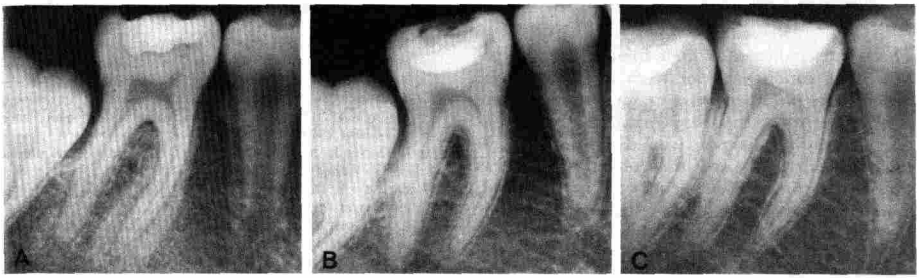

Fig. 3. A: 46; Radiograph taken before partial pulpotomy with a temporary filling in the occlusal cavity, periapically widened periodontal space and increased density of the alveolar bone. B: Eight months after treatment, showing normal periodontal conditions periapically. C: Six years later.

2, were found to be continuous. These teeth also showed healing at the end of observation. All failures occurred in teeth in which the pulp was exposed and pulpotomy performed during the first appointment, i.e. the teeth had not been previously treated with stepwise excavation.

Discussion

In the present material, the treatment was made empirically and the technique was adopted from partial pulpotomy of crown-fractured incisors. The material comprised relatively few teeth and the results should be judged thereafter. However, the results in Group 1, containing symptomless teeth, corroborated the high frequency of healing found in a similar material reported by Zilberman et al. in 1989 (9). Our results, together with those from studies on temporary teeth (7, 8), seem to provide solid ground for further research.

Knowledge about the relationships between various clinical symptoms and pulpal changes, as well as about the extent of pulpal reactions at different stages of caries progression, is limited and conflicting views have been expressed (13–19). Judging from recent studies, however, it appears that in advanced stages of a caries lesion, just prior to or soon after pulp exposure, bacterial components cause only local irreversible changes, abscesses or necrosis beneath the exposure, while the remaining pulp may be infiltrated with inflammatory cells to a varying degree or even free from inflammatory changes. The bacteria seem to be able to gain access to the pulp lumen only after some part of the pulp has become necrotic (19-25). These views appeared to be confirmed by the present results, since partial pulpotomy, i.e. removal of only superficial layers of pulp tissue together with the surrounding and potentially contaminated dentin, sufficed to ensure healing in most of the treated teeth. There is no telling whether or not the remaining pulp in these teeth was inflamed before the treatment. However, it has recently been shown that even a severely inflamed pulp may heal, provided the cause of inflammation is removed and the tooth restored in a way that prevents microleakage (26–29), i.e. by requirements that were met with the present treatment. The use of a gentle surgical method and the absence of an intermediate blood clot may also have contributed to pulp healing (30, 31).

The number of teeth in Group 2 is too small to warrant conclusions and any discussion of these results would be purely academic. These teeth were included in the study partly because the results might lend some support to the findings in Group 1. The primary intent was, however, to exemplify the ability of the pulp and the periodontal tissues to heal, after the irritants have been removed. Similar observations on healing of periapical lesions have been reported, for example, after indirect capping of teeth with deep carious lesions (32, 33).

In the material as a whole, no failures occurred in the teeth which were treated by stepwise excavation prior to the pulpotomy. This therapy seems to be widely practised in paediatric dentistry, although little is known about its success. It is thought that, through the antibacterial effect of calcium hydroxide on carious dentin, the pulp is given a chance to recover and eventually demarcate itself, with formation of secondary dentin (12, 34). The present results make it tempting to speculate that the pulps of the teeth treated with stepwise excavation may have been in a better condition at the time of pulpotomy than the pulps exposed by immediate excavation. These aspects will be further discussed in a following paper.

Conclusions

The results indicated a high frequency of pulpal healing in young posterior teeth when superficial layers of the pulp beneath a carious exposure were removed, provided that all surrounding carious dentin was removed, the pulp wound was dressed with calcium hydroxide, and the coronal cavity was sealed with zinc oxide-eugenol cement. However, more comprehensive studies are needed before this treatment can be recommended for routine clinical use.

Acknowledgement – The authors wish to express their sincere gratitude to Mrs Catrine Rohdin, Senior Dental Assistant, for invaluable help with collecting and compiling the material for this study.

References

1. Seltzer R, Bender IB. The dental pulp. Philadelphia: Lippincott 1984; Ch 14.
2. Tobin DF. Pulpotomy in primary and young permanent teeth. *J Dent Child* 1954; *21:* 252–4.
3. Hallet GE, Porteous JR. Fractured incisors treated by vital pulpotomy. A report on 100 consecutive cases. *Br Dent J* 1963; *115:* 414–26.
4. Langeland K, Dowden WE, Tronstad L, Langeland LK. Human pulp changes of iatrogenic origin. *Oral Surg Oral Med Oral Pathol* 1971; *32:* 943–80.
5. Cvek M. A clinical report on partial pulpotomy and capping with calcium hydroxide in permanent incisors with complicated crown fracture. *J Endod* 1978; *4:* 232–7.
6. Fuks A, Chosak A, Eidelman E. Partial pulpotomy as an alternative treatment for exposed pulps in crown-fractured permanent incisors. *Endod Dent Traumatol* 1987; *3:* 100–2.
7. Jeppesen K. Direct pulp capping on primary teeth – a long term investigation. *J Int Assoc Dent Child* 1971; *12:* 10–9.
8. Schröder U, Szpringer-Nodzak M, Janicha J, Waginska M, Budny J, Losek K. A one-year follow-up of partial pulpotomy and calcium hydroxide capping in primary molars. *Endod Dent Traumatol* 1987; *3:* 304–6.
9. Zilberman U, Eliyahu M, Sarnat H. Partial pulpotomy in carious permanent molars. *Am J Dent* 1989; *2:* 147–50.
10. Law DB, Lewis TM. The effect of calcium hydroxide on deep carious lesions. *Oral Surg Oral Med Oral Pathol* 1961; *14:* 1130–7.
11. Sowden JR. A preliminary report on the recalcification of carious dentin. *ASDC J Dent Child* 1956; *23:* 187–8.
12. Magnusson BO, Sundell SO. Stepwise excavation of deep carious lesions in primary molars. *J Int Assoc Dent Child* 1977; *8:* 36–40.
13. Seltzer S, Bender IB, Zionz M. The dynamics of pulp inflammation: correlations between diagnostic data and actual histologic findings in the pulp. *Oral Surg Oral Med Oral Pathol* 1963; *16:* 846–71.
14. Koch G, Nyborg H. Correlation between clinical and histological indications for pulpotomy of deciduous teeth. *J Int Assoc Dent Child* 1970; *1:* 3–10.
15. Schröder U. Agreement between clinical and histologic findings in chronic coronal pulpitis in primary teeth. *Scand J Dent Res* 1977; *85:* 583–7.
16. Brännström M, Lind PO. Pulpal response to early dental caries. *J Dent Res* 1965; *44:* 1045–50.
17. Baume LJ. Dental pulp conditions in relation to carious lesions. *Int Dent J* 1970; *20:* 309–37.
18. Langeland K, Langeland LK. Indirect capping and the treatment of deep carious lesions. *Int Dent J* 1968; *18:* 326–80.
19. Reeves R, Stanley HR. The relationship of bacterial penetration and pulpal pathosis in carious teeth. *Oral Surg Oral Med Oral Pathol* 1966; *22:* 59–71.
20. Langeland K. Management of the inflamed pulp associated with deep carious lesion. *J Endod* 1981; *7:* 169–81.
21. Trowbridge HO. 2. Pathogenesis of pulpitis resulting from dental caries. *J Endod* 1981; *7:* 52–60.
22. Lin L, Langeland K. Light and electron microscopic study of teeth with carious pulp exposures. *Oral Surg Oral Med Oral Pathol* 1981; *51:* 292–316.
23. Torneck CD. 1. A report of studies into changes in the fine structure of the dental pulp in human caries pulpitis. *J Endod* 1981; *7:* 8–16.
24. Langeland K. Tissue response to dental caries. *Endod Dent Traumatol* 1987; *3:* 149–71.
25. Eidelman E, Ulmansky M, Michaeli Y. Histopathology of the pulp in primary incisors with deep dentinal caries. *Pediatr Dent* 1992; *14:* 372–5.
26. Mjör IA, Tronstad L. Healing of experimentally induced pulpitis. *Oral Surg Oral Med Oral Pathol* 1974; *38:* 115–21.
27. Cox CF, Bergenholtz G, Heys DR, Syed SA, Fitzgerald M, Heys RJ. Pulp capping of dental pulp mechanically exposed to oral microflora: a 1–2 year observation of wound healing in the monkey. *J Oral Pathol* 1985; *14:* 156–68.
28. Warfinge J, Bergenholtz G. Healing capacity of human and monkey dental pulps following experimentally-induced pulpitis. *Endod Dent Traumatol* 1986; *2:* 256–62.
29. Bergenholtz G, Cox CF, Loesche WJ, Syed SA. Bacterial leakage around dental restorations: its effect on the dental pulp. *J Oral Pathol* 1982; *11:* 439–50.
30. Granath L-E, Hagman G. Experimental pulpotomy in human bicuspids with reference to cutting technique. *Acta Odontol Scand* 1971; *29:* 155–63.
31. Schröder U. Effect of extra-pulpal blood clot on healing following experimental pulpotomy and capping with calcium hydroxide. *Odont Revy* 1973; *24:* 257–68.
32. Jordan RE, Suzuki M, Skinner DH. Indirect pulp-capping of carious teeth with periapical lesions. *J Am Dent Assoc* 1978; *97:* 37–43.
33. Cotton W, Langeland K, Burmeister JA, Farell PE. Evaluation of carious teeth with apical radiolucencies for indirect pulp capping. *J Dent Res* Abstr 1983; *62:* 216, abstr 424.
34. Fisher FJ. The effect of a calcium hydroxide/water paste on micro-organisms in carious dentine. *Br Dent J* 1972; *133:* 19–21.