

**UNIVERSITY OF
OSLO**
DENTAL FACULTY

Department of Endodontics

Postgraduate Program in
Endodontics

Case Book
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Table of contents:

Necrotic treatment:

<u>Case 1</u>	Chronic apical periodontitis	p. 4
<u>Case 2</u>	Necrotic maxillary right first premolar with presenting symptoms	p. 10

Non-surgical retreatment

<u>Case 3</u>	Retreatment due to possible contamination of a root filled tooth	p. 15
<u>Case 4</u>	Retreatment of the mesial root of the maxillary right second molar	p. 21

Surgical management

<u>Case 5</u>	Chronic apical periodontitis with a sinus tract, apicoectomy	p. 27
<u>Case 6</u>	Retreatment and apicoectomy of the mandibular left first central Possible cyst formation	p. 34
<u>Case 7</u>	Apicoectomy, submarginal incision	p. 42

Complications

<u>Case 8</u>	Fractured instrument in the mandibular left first premolar	p. 49
<u>Case 9</u>	Accidental perforation in the furcation	p. 56

Medically compromised patient

Case 10	Endodontic treatment of 6 teeth and crown lengthening on a medically compromised patient, a project of cooperation together with the prosthetic department	p. 66
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Resorption

- Case 11 Internal resorption in a maxillary left central p. 77
- Case 12 Cervical resorption after orthodontic treatment p. 86
- Case 13 Cervical resorption after a traumatic incident p. 96

Traumatic injury

- Case 14 Rotational and intentional replantation after traumatic injury p. 104
- Case 15 Horizontal root fracture after a traumatic incident p. 111

Hemisection/ root resection

- Case 16 Hemisection of the mesial root of a mandibular first molar p. 119

Pain management

- Case 17 Treatment of tooth with long-standing pain p. 125

Combined lesion

- Case 18 Endodontic-periodontal lesion p. 133

Other

- Case 19 Osteomyelitis in the right side of the mandible in conjunction with an apical periodontitis in the mandibular right second premolar p. 140
- Case 20 Treatment of a maxillary right first molar with irreversible pulpitis, taurodontic tooth p. 153

CASE 1

Chronic apical periodontitis



Figure 1

Patient: A 70 year old woman was referred to the postgraduate clinic from the student clinic because of chronic apical periodontitis in 26.

Medical history: Non-contributory.

Dental history and chief complaint:

The patient had felt something from the tooth for the last few weeks. No severe pain but more like a constant pressure around the tooth.

The examination at the student clinic revealed that the tooth had a chronic apical periodontitis and she was referred to the postgraduate clinic.

Clinical findings:



Figure 2



Figure 3

Extra and intra-oral: The oral mucosa and skin was normal. Only a discoloration on the gingiva around the 25 was seen. It resembled an amalgam-tattoo.

Dental: No caries could be detected in any of the teeth in the area. 24, 25 and 26 had metal ceramic crowns.

26 was slightly tender to percussion, but nothing could be felt on the other teeth. No tenderness to palpation was felt in the area.

Periodontal: Healthy marginal periodontal conditions.
26 had furcation involvement grade I measured from the buccal aspect and grade II measured from the distal. No deep pockets were found around 26.

Occlusal: Normal occlusal interferences.

Radiographic findings:

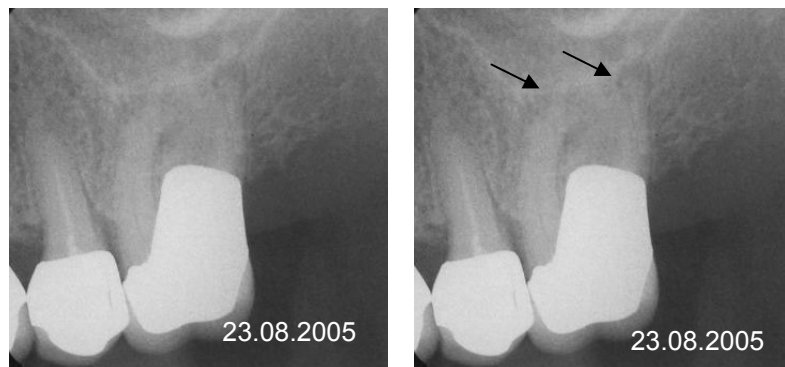


Figure 4

Figure 5

Periodontal: General bone-loss in the marginal area. A bit more marked on the distal aspect of 26.
25: The PDL was intact and could be followed around the whole root.
26: The mesial root had a radiolucent zone around the apex of about 4-5mm in diameter. The distal root had a radiolucent area of about 3-4mm in diameter around the apex.

Dental: 25: The tooth was root-filled. The root filling was incomplete. The tooth had a restoration resembling a metal ceramic crown.
26: The tooth had a metal ceramic crown. The mesial root was slightly curved towards the apex.

Diagnosis: Pulpal: Necrotic tooth 26, K04.11

Periodontal: Chronic apical periodontitis 26, K04.5

Problem list: Care had to be taken when drilling through the crown during access cavity preparation not to perforate to the periodontium.

Treatment plan: Cleaning, shaping and obturation of 26.

Treatment:

23.08.2005:

Consultation.
Access cavity preparation was done and three canals were found. The tooth was necrotic.
IRM was used as temporary top-filling.

14.09.2005:

Rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.
The canals, especially the palatal canal, were slightly obliterated.

A working length radiograph was taken:
MB: K15/18mm/dbc- correction to 19mm
DB: H15/19mm/dbc
P: K20/22mm/dbc- correction to 20.5mm

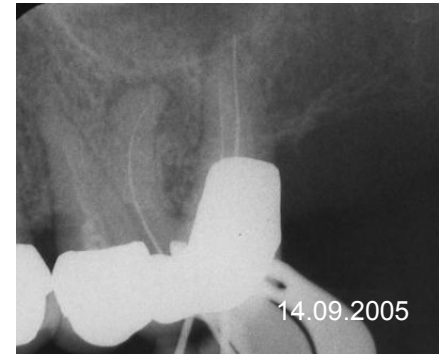


Figure 6

The MB was instrumented to size #35, the DB to size #45 and the P to size #55. NiTi hand-files were used.

Irrigation solutions used were 1% NaOCl and 16% EDTA.
Ca(OH)₂ was used as interappointment dressing.
IRM was used as temporary top-filling.

11.10.05:

Rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.
The tooth was scheduled for root-filling on this day but a MB2-canal was discovered.
A WLR was taken of the MB2: K15/19mm/dbc



Figure 7

The canals were instrumented and shaped with NiTi-handfiles.

MB: #40/19mm/dbc
MB2: #40/19mm/dbc
DB: #45/19mm/dbc
P: #55/20.5mm/dbc.

Irrigation solutions used were 1% NaOCl and 16% EDTA.
Ca(OH)₂ was used as interappointment dressing.

23.10.2005:

The patient had not had any symptoms since the last appointment and there was no tenderness to percussion or palpation.
Rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.

A master-cone radiograph was taken:

MB: #40/19mm/dbc
MB2: #40/19mm/dbc
DB: #45/19mm/dbc
P: #55/20.5mm/dbc

The tooth was root-filled with gutta-percha and AH⁺.



Figure 8

Prognosis:

The prognosis was considered to be good.

Follow-up examinations:

25.01.2007:

The tooth had been symptom-free and the patient had no complaints about it.

The radiographs showed that the lesion around the distal root had healed. A small radiolucent zone could perhaps be seen around the mesial root but it seemed to have decreased since the last appointment.



Figure 9



Figure 10

Discussion:

Apical periodontitis is defined as inflammation of the periodontium at the portals of entry of the root canal system. It is the host response following microbial infection of the pulp space (Takehashi 1965, Sundqvist 1976, Möller 1981). The most common pathways to the pulp are direct extensions from carious lesions and via cavity preparation, which frequently opens up extensive dentinal tubular access (Gomes 2004). 10% of vital teeth submitted to fixed prosthodontic treatment are expected to need endodontic treatment over a 10-year period (Karlsson 1986). Cheung et al. 2005 found somewhat lower survival rates for vital teeth undergoing fixed prosthodontic therapy; 15% of crowns and 30% of abutments in fixed bridges needed root canal treatment after ten years, after fifteen years 20% and 35%, respectively. The prime objective of endodontic treatment is to eliminate bacteria from the root canal space and to prevent re-infection. This is done by thorough debridement and disinfection of the whole root canal; completely obturate the space, so as to entomb any microbes that have escaped elimination (Trope & Debelian, Ess. Endo).

Sjögren et al. investigated what role a persisting infection had on the prognosis of endodontic therapy of teeth with apical periodontitis. The periapical healing was followed up for 5 years. They found that complete healing occurred in 94% of teeth that were bacteria-free at the time of filling, whereas teeth that had a positive culture only had a success rate of 68%.

This may put emphasis on the importance of use of chemo-mechanical debridement of the canal to eliminate the bacteria; up to 40-60% of the treated teeth have shown to become bacteria-free with the use of mechanical instrumentation together with an antibacterial irrigation (Byström & Sundqvist 1983) and studies have shown that teeth treated with Ca(OH)₂ can eliminate bacteria up to 100% (Sjögren 1991).

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2. Cheung GSP, Lai SCN, Ng RPY. Fate of vital pulps beneath a metal-ceramic crown or a bridge retainer. *IEJ* 2005;38:521-530
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4. Takehashi S, Stanley HR, Fitzgerald RJ. The effect of surgical exposures of dental pulps in germ-free and conventional laboratory rats. *OOO* 1965;20(3)
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6. Möller Å, Fabricius L, Dahlen G, Öhman A, Heyden G. Influence on periapical tissues of indigenous oral bacteria and necrotic pulp tissue in monkeys. *Scand Dent Res* 1981;89(6):475-84
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9. Sundqvist G. Bacteriological studies of necrotic pulps. Thesis. Umeå, Sweden 1976
10. Trope M, Debelian G. Endodontic treatment of apical periodontitis. In Ørstavik D, Pitt Ford TR, ed. *Essential Endodontology: Prevention and Treatment of Apical Periodontitis* 2008:347-380

CASE 2

Necrotic maxillary right first premolar with presenting symptoms



Figure 1

Patient: A 42 year old Norwegian woman came to the postgraduate clinic in endodontics because of severe pain in her maxillary right first premolar

Medical history: Non-contributory

Dental history and chief complaint:
The patient was scheduled for an emergency consultation at the postgraduate clinic in endodontics because of severe pain in the area around 14. The patient revealed that she had severe pain in the area for the last 3 to 4 weeks. She had not slept during night and had taken painkillers and self administered antibiotics for the symptoms. In the last few days the pain had eased but was still present.

Clinical findings:

Extra and intra-oral: The skin and oral mucosa was normal.



Figure 2



Figure 3

	EPT (0-80)	Cold	Percussion	Palpation	Restoration	Periodontal conditions
13	15	Yes	No	No	Non	WNL
14	No	No	Yes	No	DO-composite	WNL
15	-	Yes	No	No	Abutment	WNL
16	-	-	-	-	Pontic	-
17	-	Yes	No	No	Abutment	WNL

Dental and periodontal, clinical tests:

Figure 4

Radiographic findings:



Figure 5

Periodontal:

Normal marginal periodontal conditions on all teeth.

13: Normal PDL.

14: PDL was widened around the apex.

15: Normal PDL.

17: A root canal filling material was seen.

Dental:

No caries was seen on the radiograph on any of the teeth.

13: No fillings.

14: A DO - filling seemed to be close to the pulp.

15: Abutment in a bridge.

16: Pontic in a bridge.

17: Abutment in a bridge.

Diagnosis:

Pulpal: Necrotic tooth 14, K04.11

Periodontal: The periodontium was widened and could possibly be classified as a chronic apical periodontitis in an early stage, K04.50

Treatment plan:

Treatment of necrotic pulp/apical periodontitis 14.

Treatment:

25.08.2005:

An access cavity was made and two canals were exposed. There was no bleeding from the canals. This was a confirmation of the radiographic and clinical findings. The rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.



Figure 6

A working length radiograph taken was taken:
B: K20/20mm/B- adjusted to 19mm.
P: H20/20mm/P- adjusted to 19.5mm.
Both canals were instrumented to size #40 with NiTi-handfiles and irrigated with 1% NaOCl and 16% EDTA. Ca(OH)₂ was used as interappointment dressing. IRM was used as top-filling.

17.11.2005:

The patient had not had any symptoms since the previous appointment. The tooth had no tenderness to percussion or palpation. The rubberdam was applied and disinfected with a CHX-solution.

A master-cone radiograph was taken:
B:#40/19mm/B
P:#40/19.5mm/P
The tooth was root filled with gutta-percha and AH⁺. The canal entrances were sealed with 2-



Figure 7

3mm of IRM and IRM was used as temporary top filling.

Irrigation solutions used were 1% NaOCl and 16% EDTA.

A post-treatment radiograph was taken.



Figure 8

Prognosis: The prognosis seemed to be good.

Follow-up examinations:

30.01.2007: The patient was free of symptoms. The PDL was normal around the tooth. She had gotten a new composite restoration on the tooth but it was advised to make a crown on the tooth.



Figure 9



Figure 10

Discussion:

Clinically, apical periodontitis starts as an acute inflammation of the apical periodontal ligament followed by symptoms such as pain, tenderness to percussion and swelling (Nair 1997). The acute form of apical periodontitis (AP) may result from traumatic occlusion, AP with acute pulpitis or an acute exacerbation of chronic apical periodontitis and by definition there are minimal or no radiographic changes associated with this diagnostic term. (Sigurdsson Ess. Endo. 2008) This could explain the radiographic findings in this case. There was no defined radiolucent area, only a widened periodontium at the apex.

Whether different types and combinations of bacteria may be the cause of symptoms like swelling and/or tenderness to a larger extent than others are disputed. In his thesis from 1976 Sundqvist showed that teeth with necrotic pulps,

apical periodontitis and symptoms harbored a larger number of bacteria and more complex anaerobic bacterial flora than teeth without clinical symptoms. This was not supported by Haapasalo et al. 1986 who found no relationship between certain species and symptoms.

Newer studies have shown that several species of bacteria have been found in symptomatic infected root canals, with a predominance of obligate anaerobes, especially *Fusobacterium*, *Peptostreptococcus* and “black-pigmented bacteria” (Gomes 1994 and 1996).

Jacinto et al. 2003 was in line with these studies; they found that root canals from symptomatic teeth harbored more obligate anaerobes and larger numbers of bacterial species than asymptomatic teeth. Obligate anaerobes outnumbered facultative anaerobes in symptomatic teeth. More than 70% of the bacteria were strict anaerobes. Obligate anaerobes were statistically related to pain, tenderness to percussion and abscess, especially gram-negative bacteria

This patient had severe pain but no swelling. Whether the pain originated from specific bacteria and combinations could not be confirmed since no bacterial tests were taken.

References:

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2. Gomes BPFA, Drucker DB, Lilley JD. Association of specific bacteria with some endodontic signs and symptoms. *IEJ* 1994;27:291-298
3. Gomes BPFA, Lilley JD, Drucker DB. Associations of endodontic symptoms and signs with particular combinations of specific bacteria. *IEJ* 1996;29:69-75
4. Nair PNR. Apical periodontitis: a dynamic encounter between root canal infection and host response. *Periodontol 2000* 1997;24:157-148
5. Sigurdsson A. Clinical manifestations and diagnosis. In Ørstavik D, Pitt Ford T eds., *Essential Endodontology, Prevention and Treatment of Apical Periodontitis.* 2008
6. Sundqvist G. *Bacteriological studies of necrotic dental pulps.* Umeå, 1976.

CASE 3

Retreatment due to possible contamination of a root filled tooth



Figure 1

Patient: A 27 year old Norwegian female sought treatment at the Faculty of Dentistry in Oslo because she wanted to have a permanent filling in her mandibular left first molar.

Medical history: Non - contributory

Dental history and chief complaint:

The patient had received a root filling in 36 approximately one year before she came to the dental school and had not gone back to the dentist to get a permanent filling on the tooth. After a year she wanted a permanent restoration and came to the dental school. Here she was referred to the postgraduate clinic in endodontics for a retreatment because of the long time with a temporary filling. She had not had any symptoms since the root filling was finished.

Clinical findings:

Extra and intra-oral: The gingiva and soft tissues had a normal colour and texture. Normal skin.

Dental: 36 had an IRM temporary occlusal-distal filling, which was not adapted to the prepared margins of the tooth at all. Caries could be detected in the vicinity of the filling. The visible dentin around the temporary was discoloured. No tooth-substance above the gingival margin left at the distal aspect of the tooth.

Periodontal: The marginal periodontal conditions were within normal.

Occlusal: Normal occlusal interferences.

Other:

She had no pain either to percussion or palpation in the area.



Figure 2



Figure 3

Radiographic findings:



Figure 4

Periodontal:

The marginal bone-height was normal around 36. There were no signs of any changes in the periodontal ligament structure of 36 which seemed to be intact.

Dental:

36 had a restoration which had the same radiopaque similarity as IRM. The root canals were filled with a material that resembled gutta percha.

Other:

35 had a small OD-filling. 36 had no fillings. The periodontal conditions were normal on both teeth.

Diagnosis: Pulpal: Root filled tooth 36, K04.19

Periodontal: Normal periodontium

Treatment plan: Retreatment of the previous root filled tooth 36.

Treatment:

03.11.2004.

Examination of the patient. Clinical and radiographic photos were taken.

The gingiva was infiltrated with Septocaine®.

The distal aspect of the tooth was restored with a composite filling prior of treatment to secure aseptic conditions during the root canal treatment.

Rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.

Gutta-percha was removed with chloroform and NiTi- and SS-handfiles. A radiograph was taken to ensure that all the gutta-percha was removed from the canal.

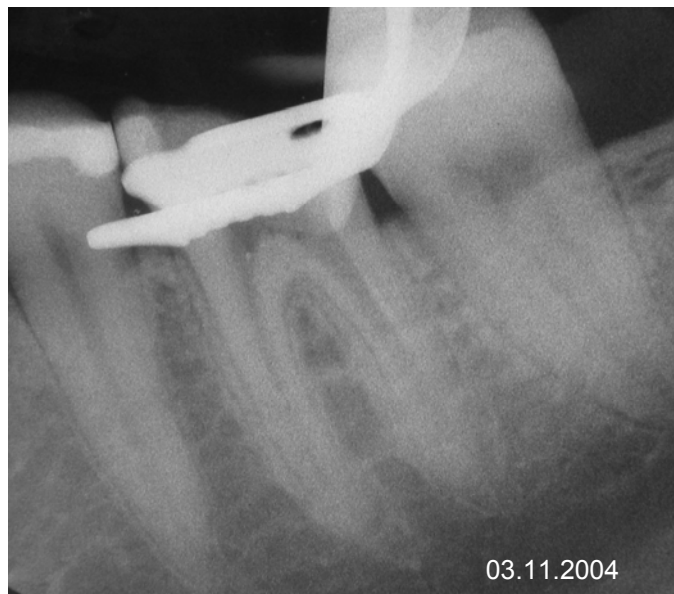


Figure 5

A working length radiograph was taken:

MB: K45/21mm/mbc

ML: H45/21mm/mlc

D: K60/21mm/mbc

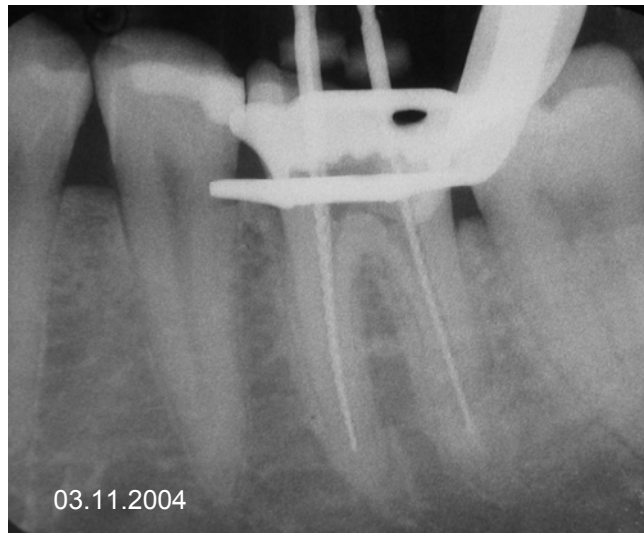


Figure 6

The canals were shaped with NiTi handfiles and the root-canals were irrigated with 1% NaOCl and 16% EDTA.

No further increase of the diameter of the canal was done.

An attempt was made to get 1-2mm further apical into the mesial canals, but it failed.

Ca(OH)₂ was used as interappointment medicament.
IRM was used as temporary filling.

23.11.2004.

Infiltration of the gingiva with Carbocaine[®] was done.
Rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.

A master-cone radiograph was taken:

MB: K45/21mm/mbc

ML: H45/21mm/mlc

D: K60/21mm/mbc



Figure 7

Irrigation with 1% NaOCl and 16% EDTA was done. The tooth was root filled with gutta-percha and AH⁺.

A post-treatment radiograph was taken.



Figure 8

The patient was referred to the student-clinic to receive a permanent restoration. A crown was recommended for the patient as soon as possible. She was scheduled for the treatment at the student clinic.

Prognosis: The prognosis seemed to be good.

Follow-up examination:

09.12.2005:



Figure 9

The patient had no symptoms. She had received a composite filling on the tooth and was satisfied with that for the time being. The radiograph showed that no pathology had risen after the treatment

Discussion:

Follow-up studies performed on endodontically treated teeth shows that the success rate of treatment is positively correlated with the criteria for good technical quality of the root filling (Kerekes & Tronstad 1979, Sjögren et al. 1990). Earlier it was therefore believed that a root filling of good technical quality provided an effective seal of the obturated root canal. Other studies have shown that leakage along the root filling will eventually take place and result in failure (Dow & Ingle 1955, Swanson & Madison 1987).

The time elapse before an open root filling to the oral environment will be contaminated may take according to Swanson and Madison only 3 days. They left the root canals open to artificial saliva and all teeth exposed to the saliva showed leakage along the root filling. These findings were confirmed by Torabinejad et al. who used bacterial penetration. The time before the canals showed penetration of bacteria ranged from 1 to 4 days and 80 to 90% of the canals exposed were infected.

Ray and Trope evaluated the relationship of the quality of the coronal restoration and of the root canal obturation on the radiographic periapical status of endodontically treated teeth. They found that the technical quality of the coronal restoration was significantly more important than the technical quality of the endodontic treatment for apical periodontal health.

Even though the reading is clear teeth with inadequate root fillings or coronal restorations but without clinical or radiographic signs of periapical inflammation represent a problem group. We know that a certain percentage of these teeth will fail and still many of these teeth are left untreated.

This case underwent a retreatment even though no pathological lesion was present in connection to the tooth and the root filling seemed to be of an adequate quality. The reason for this was that the tooth had been left with a temporary filling of IRM for more than a year. The IRM had eventually been worn down and cracked and there was caries under the filling. Either of the root canals had been sealed of and the root filling was exposed to the oral environment. It was reason to believe that there had been leakage along the root filling.

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1. Kerekes K, Tronstad L. Long-term results of endodontic treatment performed with standardized technique. JOE 1979;5(3):83-90
2. Sjögren U, Hägglund B, Sundqvist G, Wing K. Factors affecting the long-term results of endodontic treatment. JOE 1990;16(10)
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5. Torabinejad M, Ung B, Kettering JD. In vitro bacterial penetration of coronally unsealed endodontically treated teeth. JOE 1990;16(12):566-9
6. Ray HA, Trope M. Periapical status of endodontically treated teeth in relation to the technical quality of the root filling and the coronal restoration. IEJ 1995;28:12-18

CASE 4

Retreatment of the mesial root of the maxillary right second molar

Patient:

A 39 year old Norwegian man was at a 3-year follow-up control of 17. The periapical lesion on the MB-root was still persisting and had not been any signs of healing. Retreatment of the tooth was therefore decided.



Figure 1

Medical history:

Non-contributory.

Dental history and chief complaint:

The tooth was root-filled at the student-clinic in 2004 because of caries to the pulp and necrosis in the tooth. A small radiolucent zone around the mesial and palatal roots could be seen on the pre-operative radiograph.

The patient was scheduled for a 3-year control of 17 in January 2007. The control revealed that the apical lesion on the mesial root was persisting. He had not had any problems with the tooth since he finished the root canal filling in 2004.



Figure 2

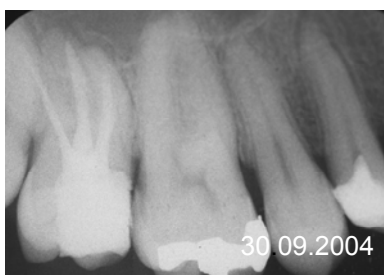


Figure 3



Figure 4

Clinical findings:

Extra and intra-oral:

The oral mucosa and skin had normal texture and colour.

Dental:

15 had a small composite filling on the distal aspect.
16 had an onlay of gold.
17 had a composite restoration.

No caries could be detected. No tenderness to percussion or palpation.

Periodontal: Normal marginal periodontal conditions.

Occlusal: No occlusal interferences.

Radiographic findings:

Periodontal: A general bone-loss of 1-2 mm could be seen, but not more than expected for the age.
15: The PDL seemed to be intact around the whole root.
16: The PDL seemed to be intact around the whole root.
17: The PDL seemed to be intact around the palatal and the disto-buccal roots. Around the apex of the mesio-buccal root a radiolucent area of about 3-4mm in diameter was seen.



Figure 5

Dental: 15: The tooth had a small filling on the distal aspect, resembling composite in radiopacity.
16: The tooth had a mesio-occlusal-onlay, possibly also stretching towards the palatal or buccal aspect of the tooth. It had the same opacity as gold.
17: A large mesio-occlusal filling resembling composite was lying in the cavum. The tooth was root-canal filled with a material which had the same opacity as gutta-percha. The root-filling did not follow the curvature of the root in the MB-root and stopped approximately 3-4mm from the apex.

Diagnosis: Pulpal: Previously root-filled tooth 17, K04.19

Periodontal: Chronic apical periodontitis, mesial root, K04.50

Treatment plan: 1. Retreatment of only the mesial root of 17
or
2. Retreatment of the whole tooth

Problem list:

Whether only the mesial root or the whole tooth should be retreated was discussed. It was dependent on if there were any communication between the root canals and contamination between them had occurred. If no communication was obvious it could be assumed that it would be safe to do retreatment of the mesial root only.

Treatment:

21.03.2007:

An access cavity was made. The canals were not connected to each other. There was IRM covering all three canal entrances and the pulp chamber was clean and dry. The decision to only do retreatment of the mesial root was done.

An infracture line was seen stretching from the occlusal aspect of the buccal wall towards the palatal, but not through the whole tooth.

Rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.

Only the IRM over the mesial canal-entrances was removed. Two canals were located.

Gutta-percha was removed with hand-files of the types K/NiTi/Hedström together with Chloroform. The MB2 canal had not been shaped and cleaned properly during the earlier treatments. I managed to get to the proper working-length in the MB2-canal.

After removal of the gutta-percha a working length radiograph was taken:
MB1: K45/17.5mm/mbc
MB2: K20/18mm/mbc
The MB1 was instrumented to size #50 and the MB2 to size #45.



Figure 6

Irrigation used was 1% NaOCl, 16% EDTA and 2% Chlorhexidine-di-gluconate.

Interappointment dressing used was Ca(OH)₂.

17.04.2007:

The patient had not had any kind of symptoms during the month with antibacterial dressing.

Rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.

The canals were dry and clean.

A master-cone radiograph was taken.



Figure 7

Irrigation used was 1% NaOCl, 16% EDTA and 2% CHX-di-gluconate.

The mesial canals were filled with gutta-percha and AH⁺. A small plug of IRM was condensed into the canal entrances and took some minutes to set.

Top-filling: acid-etch, scotchbond, composite Z-250.

A post-treatment radiograph was taken.



Figure 8

Because of the infracture-line seen a crown or an onlay with proper cusp-coverage was recommended.

Prognosis:

The prognosis was considered to be good.

Follow-up examination:

16.04.2008: The patient had no symptoms from the tooth.



Figure 9
Preoperative
radiograph



Figure 10
First follow-up after
initial treatment
Failure was noted
and retreatment
done



Figure 11
First follow-up
after retreatment

The apical radiolucency around the apex of 17 had disappeared comparing to the radiograph from April 2007. The PDL was now intact and could be followed around the apex.

Discussion:

A decision to do retreatment of the mesial root only was taken together with the supervisor.

It was the only root with apical pathology and all the root canals were covered with a plug of IRM and no communication between the canals were observed. We therefore assumed that there had been no contamination between the canals and it was safe to go forward with the planned treatment.

Several studies show that the prognosis for vital pulp therapy and treatment of teeth with no radiographic signs of apical periodontitis is good (Sjögren 1990, Kerekes & Tronstad 1979). The challenge of endodontic treatment lies therefore within the cases that have established apical periodontitis and studies have demonstrated that the success rate in endodontic therapy is significantly influenced by the presence or

absence of a pretherapeutic radiographic lesion (Grahnèn & Hansson 1961, Molven & Halse 1988).

In addition; in this case the technical quality of the mesio-buccal root filling was poor. The MB2-canal had been negotiated but not cleaned and shaped to a satisfying length and width, neither had the main MB-canal been to a certain extent. Chugal et al. 2003 looked at some biologic and treatment factors that could affect the treatment outcome. And one of the factors they looked into was working length and obturation level. They found that teeth/roots with apical periodontitis had a more unsuccessful outcome if the canal was instrumented and obturated further from the radiographic apex than those obturated closer to the radiographic apex. The findings were statistically significant .

As known, retreatment cases of apical periodontitis inhabit a different type of microbial flora and *Enterococcus faecalis* is often connected to such cases (Molander 1998, Peciuliene 2000).

2% chlorhexidine-di-gluconate as an irrigant was therefore used as a precaution simply because it seems to be effective in reducing or completely eliminating *E. faecalis* from the root canal and dentinal tubules (Vahdaty 1993, Gomes 2003, Basrani 2002).

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CASE 5

Chronic apical periodontitis with a sinus tract, apicoectomy

Patient:

A 49 years old Norwegian woman was referred to the postgraduate clinic after a follow-up exam on the maxillary left first premolar which showed a non-healing apical periodontitis.



Figure 1

Medical history:

Non-contributory

Dental history and chief complaint:

The patient had received a root-canal filling in 24 several years ago by her private dental practitioner. The tooth underwent a retreatment at the clinic for undergraduates in the Faculty of dentistry in April/May 2005 because of a sinus tract and a persisting apical periodontitis in the tooth. During the retreatment a second root-canal was discovered. The root-canals were cleaned and shaped and thereafter root filled with gutta-percha and AH⁺. The tooth was dismissed as “under healing”, but at the 6 months follow-up (fig. 4) in October 2005 the sinus tract was still persisting. It was then decided to do a referral to the postgraduate clinic in endodontics for an apicoectomy of the tooth.



Figure 2



Figure 3



Figure 4

Clinical findings:

Extra oral: Normal skin

Intra oral: A sinus tract could be seen on the oral mucosa on the buccal side of 24/25, close to the lateral fraenum.

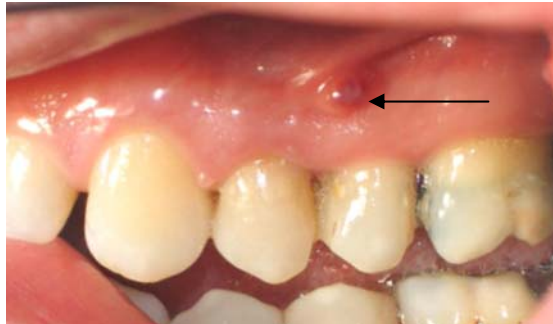


Figure 5

Dental: No caries was detected on any of the teeth in the area.

21, 22, 23 had no restorations.

24 had a distal-occlusal composite filling. On the mesial aspect, close to the gingival margin an amalgam-filling could be seen. The tooth was slightly tender to percussion and palpation. An infractions-line was seen in connection with the composite-filling.

25 had a composite filling covering the mesial, distal and occlusal aspects.

26 had a large mesial-distal-occlusal amalgam filling.



Figure 6

Periodontal: Healthy marginal periodontal conditions, pocket depths within normal limits.

Radiographic findings:

Periodontal: 22, 23, 25 and 26 had normal periodontal conditions. The PDL was intact and could be followed around all teeth.

24 had a circumscribed lucency of about 5-6mm in diameter around the apex. A sinus tract tracing was done with gutta-percha and the GP could be followed towards the apical of the root of 24; into the lesion.



Figure 7

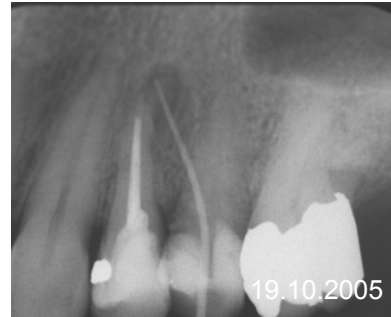


Figure 8

Dental:

23: no fillings, completely intact tooth.
 24: OD resembling composite, a filling resembling amalgam on the mesial side. The root canal contained a root filling.
 25: MOD filling resembling composite.
 26: MOD filling resembling amalgam.

Other:

On the radiograph the maxillary sinus appeared to be a bit of a distance away from the apical part of the tooth and was expected not to give any problems.

Diagnosis:

Pulpal: Root-filled tooth 24, K04.19

Periodontal: Chronic apical periodontitis 24 with sinus tract to the oral cavity, K04.62

Problem list:

Possible close proximity to the maxillary sinus, but the radiographs could almost certify that this was not the case.

Treatment plan:

Apicoectomy of 24.
 Since the tooth had been retreated at the dental school only one year earlier the decision to do an apicoectomy instead of a retreatment was done.

Treatment:

19.10.2005:

Consultation, clinical and radiographic photos and treatment-planning.

01.11.2005:

Apicoectomy:
 Anaesthetic was given and the patient rinsed the mouth with an anti-septic mouthwash (corsodyl/chlorhexidine) for 1 minute.

A marginal incision was made from the distal of 22 to the distal of 26 with one mesial releasing incision. The flap was elevated and a fenestration of the bone on about

0.5mm appeared (figure 9, arrow 1). This lesion was lying approximately at the same height as the sinus tract (figure 9, arrow 2).

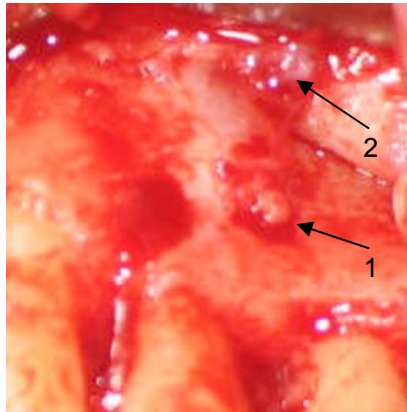


Figure 9

The granulation tissue surrounding the root was removed with a curette and a round bur with slow speed. The bone-lesion was extended with a round bur.

Apical surgery; about 2mm of the apical part was removed; the angulation on the root was oblique. The gutta-percha was removed from the retrograde aspect with an ultrasonic device. Retrograde filling with white MTA was done. Stryphonon-gas was used to stop bleeding.

A control radiograph of the MTA was taken.



Figure 10

No fenestration to the maxillary sinus was seen. The flap was replaced and 6 sutures were set.



Figure 11

Post operative information was given and a week's cure of penicillin was administered together with painkillers.

08.11.2005.

Control and removal of the sutures was done. The patient did not complain of any heavy pain or swelling in the p.o. period. The healing of the wound was good, and the sinus tract seemed to be closed. There was some redness around the area where the sinus tract had been and there was still trace of the opening (figure 12, arrow). Because of that a new control in a few months was given to see if the oral mucosa had healed nicely.



Figure 12



Figure 13

Prognosis:

The prognosis was good.

Follow-up examinations:

11.01.2006.

The 2-3 months control showed total healing clinically. No tenderness to percussion or palpation was felt and there was no trace of the sinus tract. The patient was dismissed and scheduled for a recall in approximately 6 months. No radiograph was taken at this appointment.



Figure 14

08.05.2006:

For some reason the patient was scheduled for a recall in the beginning of May the same year only 6-7 months after the surgery. The patient had no problems with the tooth and the radiograph revealed that healing had taken place.

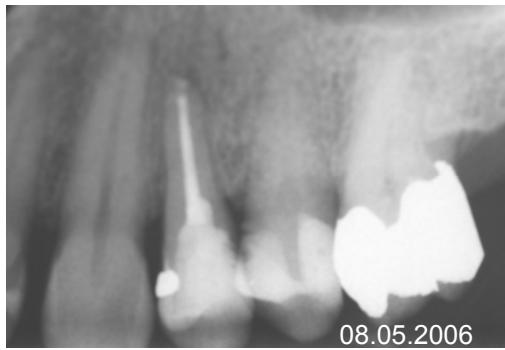


Figure15

06.06.2007:

The patient had another control 1½ years after the surgery. There was no trace of the sinus tract and the patient had not had any symptoms from the tooth. No tenderness to palpation or percussion could be felt. The radiographs showed that the lesion had healed, but a slight widening of the PDL was seen around the apex. The patient was scheduled for further follow-up in another two years.



j

Figure 16



Figure 17



Figure 18

Discussion:

A sinus tract is a direct pathway from the source of the infection to a surface. It is a state where dead and dying microbes and polymorphonuclear cells follow the path of least resistance. The reason that a sinus tract develops is not fully understood. It may be the mechanism with which the body controls the infection, or it may indicate a specific infection of some volume/ number/ virulence of the bacteria (Trope & Sigurdsson 2002). When longstanding, the tract might become epithelialized

(Baumgartner 1984). With adequate disinfection of the root canal and resolution of the periapical inflammation, the sinus tract will heal without further treatment and the epithelium, if present, will in most cases disintegrate (Trope & Sigurdsson 2002).

In this case the sinus tract persisted even after retreatment of the tooth. It was a indication of retreatment failure and a surgical approach had to be done.

Endodontic surgery is performed to resolve inflammatory processes that cannot successfully be treated by conventional techniques; which may be due to complex canal and/or anatomy and external inflammatory processes. (Lin 1984, Wada 1998, Tronstad 1987).

Bacteria may establish themselves and live in the periapical area and hence be the cause of persisting apical periodontitis (Tronstad 1987, Sunde 2000a). Sunde et al. have done several studies to prove the existence of bacteria in periapical lesions. Amongst others: a "checkerboard DNA-DNA hybridization technique was used to identify bacteria in periapical lesions of root filled teeth with apical periodontitis. Bacterial DNA was identified in all samples taken from the apical area (Sunde 2000b). And a method of using fluorescence in situ hybridization (FISH) in combination with epifluorescence and confocal laser scanning microscopy, they were able to see bacteria alive in periapical endodontic lesions. (Sunde 2003).

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CASE 6

Retreatment and apicoectomy of the mandibular left first central Possible cyst formation

Patient:

A 64 years old woman was referred to the postgraduate clinic in endodontics from the clinic for undergraduates due to a non-healing 31 with a chronic apical periodontitis.



Figure 1

Medical history:

Non-contributory.

Dental history and chief complaint:

The patient had not had any problems with 31. An apical radiolucency had been discovered by a routine radiographic examination at the student clinic and the tooth was referred to the postgraduate clinic for a retreatment of the root-filling.

Clinical findings:

Extra and intra-oral:

The oral mucosa and skin was normal.

Dental:

No tenderness to percussion or palpation on any of the teeth in the area



Figure 2

Periodontal:

The marginal periodontium was of normal height.

Occlusal:

Normal occlusal interferences.



Figure 3

Radiographic findings:

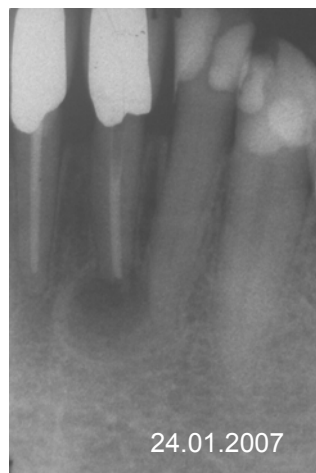


Figure 4

Periodontal:

No marginal bone-loss was seen on the radiographs.

Dental:

41- the tooth had a restoration resembling a metal-ceramic crown, the tooth was root filled. The periodontal ligament could be followed continuously around the whole root.

31- the tooth had a restoration resembling a metal-ceramic crown, the tooth was root filled. Some of the coronal part of the root filling was removed or possibly left unfilled. There was a round, well-defined radiolucent area around the apex of the tooth. The diameter of the radiolucency was about 5-6mm. The apex seemed to be slightly resorbed.

32 and 33- both teeth were restored with fillings resembling composite in radiopacity. The PDL could be followed around both teeth.

Diagnosis: Pulpal: Root filled tooth 31, K04.19
 Periodontal: Chronic apical periodontitis 31, K04.50
 Tentative: Possible cyst formation, K04.80

Treatment plan: 1. Conservative retreatment of 31
 2. If necessary an apicoectomy of the tooth would be performed.

Problem-list: Access cavity preparation had to be done with care due to the risk of perforating into the periapical tissues. It was believed that it was a possible cyst-formation around the root so healing was uncertain.

Treatment:

24.01.2007: An access cavity was drilled in the tooth and the canal-entrance was found. The access cavity had to be stretched against the buccal aspect of the tooth to get a straight line access. This might weaken the crown slightly. Rubberdam was applied and disinfected with a 5% chlorhexidine in 70% ethanol solution.

The gutta-percha was removed with chloroform and K-/NiTi- handfiles and ProTaper rotary- files. Temporary used was IRM.

07.02.2007: Rubberdam was applied and disinfected with a 5% chlorhexidine in 70% ethanol solution. The removal of the gutta-percha continued. A working length radiograph was taken: K45/19.5mm/l. An apex-locator was also used in determining the working length. The canal was rinsed to size #50 and disinfected with irrigants. Ca(OH)₂ mixed with 2 % CHX-digluconate was used as interappointment dressing.

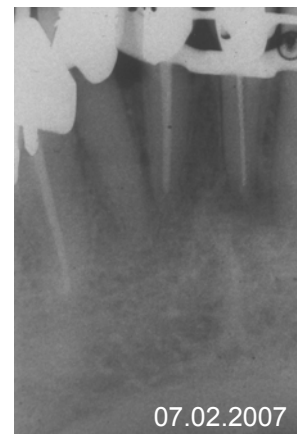


Figure 5

28.02.2007: The tooth was free of symptoms and root filling was planned today. Rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol. A master-cone radiograph was



Figure 6

taken; #50/19,5mm/l.
The canal was constantly filling up with a yellow-brownish fluid and it was difficult to get the canal totally dry. The paper-points were covered with a yellowish fluid, see fig. 7.

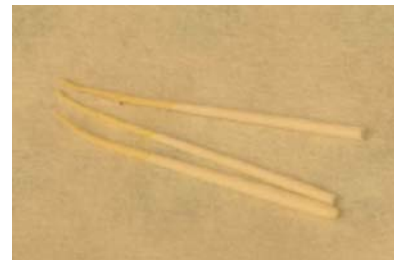


Figure 7

It was decided to do an apicoectomy of the tooth and the tooth could therefore be root-filled in this session.

The tooth was root-canal filled with gutta-percha and AH⁺.

A post-treatment radiograph was taken.

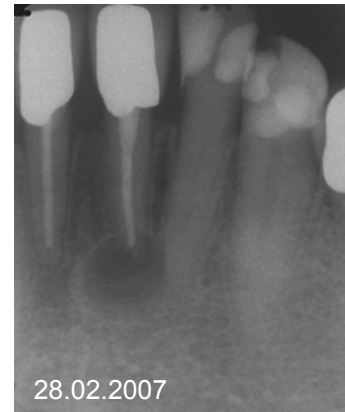


Figure 8

During all sessions the tooth was irrigated with 1% NaOCl, 16% EDTA and 2% Chlorhexidine-di-gluconate.

11.04.2007:

A marginal incision from 41M to 34M with a mesial releasing incision was done. The flap was reflected and the lesion was exposed.

An osteotomy around the lesion area was done and a lot of granulation-tissue became visible. The granulation-tissue was removed with a round bur and a curette.

Apical surgery was done and about 2-3mm of the root-tip was removed. Root-filling material was removed with an ultrasonic device and a retrograde filling with MTA was placed. The flap was replaced and 5 sutures were placed. A radiograph was taken to look at the placement of the MTA.

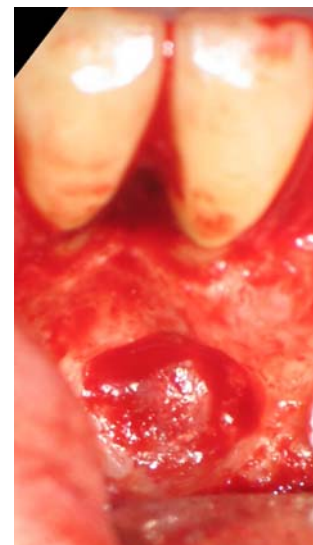


Figure 9

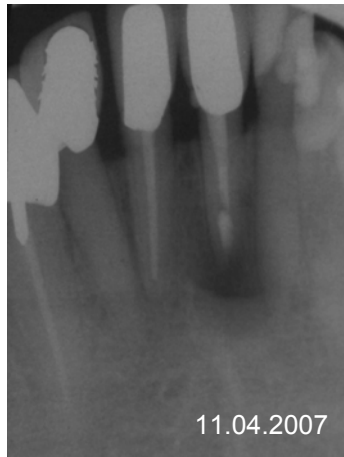


Figure 10

13.04.2007: The patient called and said that she had got a flare up. There was severe pain and swelling in the area according to the patient. Antibiotics were prescribed over the phone.

18.04.2007: When she came for suture-removal the conditions were better and the patient had no symptoms. Only a small irregularity was seen in the buccal mucosa where the realising incision had been.



Figure 11

Prognosis: The prognosis was assumed to be good.

Follow-up examinations:

03.05.2007: The patients had no complaints; there were no symptoms from the area. No radiographs or clinical photos were taken at this appointment.

15.04.2008:



Figure 12

The patient had no symptoms in the area.

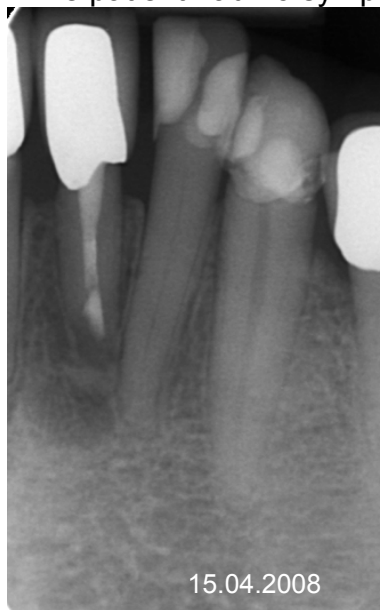


Figure 13

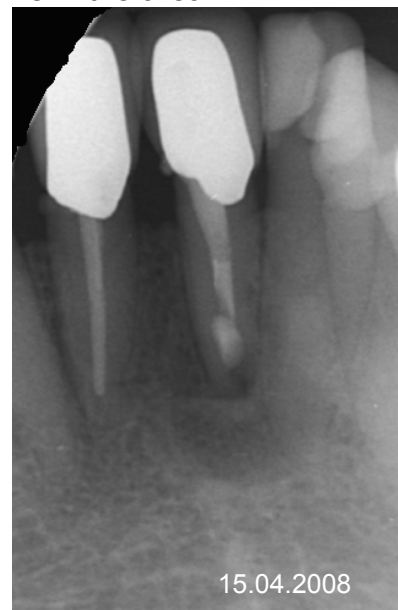


Figure 14

The radiographs showed that there had been healing in the area. The PDL could be followed around the apex. There were still some irregularities in the bone so the patient was scheduled for a new follow-up session in two years.

Discussion:

A yellowish fluid was constantly filling up the canal and making it difficult to dry with paper-points it was therefore decided not to fill another round with $\text{Ca}(\text{OH})_2$, but go forward directly with an apicoectomy of the tooth. And with the radiographic appearance of the lesion it was perhaps reasonable to think that it was a cyst. Whether cyst-formation was present could not be verified because the lesion could not be removed in one piece during the surgery, so it was not sent for any histologic examination.

A periapical lesion is believed to continue until there is a balance between the host protective function and the virulence of the infecting organism. A granuloma is formed in this process, which in turn may develop into a cyst (Bhaskar 1966). Cystification of the granuloma occurs as epithelial elements proliferate and ultimately form a lining (Regezi & Sciubba 1998). The granuloma may develop into a pocket cyst or a true cyst; where a true cyst has a complete lumen and an apical pocket cyst has a cavity open to the root canal (Nair 2008).

The radiographic features of a radicular cyst are that they appear as round or pear-shaped, unilocular, lucent lesions in the periapical region (Scholl et al. 1999). They are usually less than 1 cm in diameter and are bordered by a thin rim of cortical bone (Weber 1993). In a study by Nair et al. (1996) the frequency of the incidence of abscess, granuloma, and radicular cyst among human periapical lesions was obtained. They found that out of 256 specimens 35% were periapical abscesses, 50% granulomas and 15% were cysts, either true or pocket cysts.

The patient got severe pain and swelling the day after the surgery. The patient could not attend for an appointment at the dental school so painkillers and antibiotics were prescribed over the phone. Whether this was the right treatment can be discussed since the actual clinical features had not been looked at. Surgical procedures will mostly give some discomfort to the patient, how they are interpreted by the patient is quite individual.

Post surgical infections following surgical endodontic procedures are very rare, so the administration of antibiotics is seldom required and cannot be justified as part of the routine post-surgical regimen (Powell et al. 2005). Most post-surgical infections are caused by normal oral flora (Khemaleelakul 2002). However, infection may be a result of inadequate aseptic surgical techniques or from bacteria penetration of the surgical site because of poor re-approximation and stabilization of elevated and reflected tissues. Signs and symptoms of infection are usually present 36-48 hours after the procedure and include increased and progressive swelling and pain. These symptoms may or may not be associated with suppuration, fever, and lymphadenopathy (Powell et al. 2005). If this happens antibiotic therapy is initiated and an antibiotic suitable for the situation is chosen. The drug of choice is penicillin VK or clindamycin or a cephalosporin if the patient is allergic to penicillin (Baumgartner 2004).

In this patient a penicillin V, phenoxymethylpenicillin, was used. She said that already the next morning the symptoms were gone and when she came for her control and suture removal everything had healed fine.

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CASE 7

Apicoectomy, submarginal incision



Figure 1

Patient: The patient, a 46 years old woman, was referred to the postgraduate clinic in endodontics because of problems after a previous endodontic treatment of her maxillary, right central.

Medical history: Non-contributory

Dental history and chief complaint:



Figure 2

The patient sought the dental school in March 2006 for conservative treatment and crown therapy. Retreatment of 11 and 21 was planned.

In October 2006 the retreatment of 11 started at the student clinic.

During the retreatment session gutta-percha was extruded 2mm into the periapical area. After this treatment-session the patient got pain. $\text{Ca}(\text{OH})_2$ was placed and one week later the tooth was root filled with

gutta-percha and AH⁺. The tooth was free of symptoms at the day of filling.

A few months after the finishing of the root-filling the patient got pain. She was then referred to the postgraduate clinic in endodontics to an apicoectomy on the tooth.

Clinical findings:

Extra and intra-oral:

A compact, well-defined swelling could be palpated in the oral mucosa on the buccal aspect of the tooth.

Dental:

The patient had pain at the day of consultation. The tooth 11 was tender to percussion and palpation.

No caries could be detected on any of her teeth. 11 and 21 were considerably shorter than the other teeth and they probably had enamel disturbances. There were also discolorations on both incisal edges of the teeth.

11 had a temporary IRM and 21 had an old amalgam filling, both on the palatal aspect of the tooth. Stains on the palatal aspect of both teeth could possibly be after amalgam- fillings.



Figure 3

Periodontal:

The periodontal conditions were normal. Pocket depths were within normal limits.

Occlusal:

No occlusal interference, there were not any signs of attrition, abrasion or erosions on her teeth.

Radiographic findings:



Figure 4

The radiographic examination revealed normal marginal periodontal conditions.

11: Widened PDL, the tooth was root-filled with a material that resembled gutta-percha.

12: Normal PDL, no fillings.

21: Normal PDL, the tooth had a root-filling that resembled gutta-percha in opacity, the filling seemed uneven in quality. In the tooth had a filling that resembled amalgam in opacity in the coronal aspect.

Diagnosis:

Pulpal: Root-filled tooth 11, K04.19

Periodontal: Chronic apical periodontitis 11, K04.50

Treatment plan:

Apicoectomy with retrograde filling of 11

Treatment:

08.03.2007:

Chlorhexidine mouthwash for 1 minute before the treatment. The conditions for a submarginal incision were optimal.



Figure 5

A submarginal incision was made from 21D to 23M with realising incisions on both sides. The flap was gently elevated and the lesion appeared.

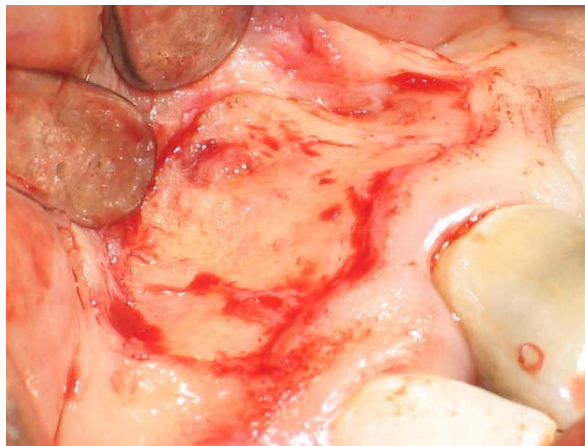


Figure 6

Osteotomy was done and granulation tissue was removed. Apical surgery was done. The apical preparation was done with an ultrasonic device. Stryphonon-gas was used to stop bleeding and was put into the wound-cavity. A retrograde filling with white MTA was done.



Figure 7

The flap was replaced and 7 sutures were set to keep the flap steady. Post operative information was given and pinex forte was prescribed against possible p.o. pain. Mouthwash with corsodyl was recommended for 1 week. The patient was set up for suture-removal and control the week after the surgical intervention.



Figure 8



Figure 9

14.03.2007:

The patient came back for removal of the sutures. She had only had slight pain, but nothing of significance. The healing of the gingiva was fine. The sutures were removed.



Figure 10



Figure 11

Prognosis:

The prognosis seemed to be good.

Follow-up examination:

23.11.2007:



Figure 12

7 months control. The patient has no problems with the tooth. She also had received permanent restorations on both her centrals.

The PDL can be followed around the whole root on 11.

Discussion:

The flap design is important for the healing of the wound after apical surgery and many factors play an important role when the choice of design is considered. Amongst them are marginal gingival recession, necrosis of the gingival papilla, ease of access, maintenance of an adequate blood supply, trauma to the wound margins, and scarring (Kramper 1984).

The submarginal flap design may also be referred to as an Ochsenbein-Luebke flap (Luebke 1974) is similar to the rectangular flap, with the difference that the horizontal incision is placed within the attached gingiva. It is used when aesthetics is important, and where it is important that the marginal gingiva is left untouched. It is crucial that the submarginal incision is used only when there is a broad zone of attached gingiva with a minimum of 2mm (Lang 1972). This is because a sufficient amount of marginal attached gingiva in place is important to avoid deprivation of blood supply to this unreflected tissue and risk its necrosis. Such tissue breakdown will lead to a major recession with a compromised aesthetic result (Velvart 2005).

Kramper et al. (1984) looked at three different flap designs used in apical surgery where the purpose was to evaluate the clinical and histological features of healing of three types; the semi lunar incision of the alveolar mucosa, the submarginal incision in attached gingiva and the intrasulcular incision of the attachment apparatus and papillae of the teeth.

In the results they concluded that the semi lunar flap should be avoided in apical surgery because of the friable nature of the tissue of the alveolar mucosa which makes it difficult to gain complete closure and healing by primary intention. The

intrasulcular incision showed some level of alveolar bone loss and gingival recession which could be avoided using the submarginal incision.

Scar formation was the biggest problem with the submarginal flap and there would be less scar-formation if the two vertical releasing incisions are parallel instead of divergent as in a Luebke-Ochsenbein design (Kim 2002).

In this case a full thickness flap could have been used as well as the submarginal flap.

Since a submarginal flap is mostly used when aesthetics has to be maintained and in this case this was not the main priority because the teeth were going to be crowned on a later stage, although maintenance of the gingival height might be important in any situation and especially in this area.

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CASE 8

Fractured instrument in the mandibular left first premolar



Figure 1

Patient:

34 years old female of Arabic origin was referred to the postgraduate clinic in endodontics due to a fracture of an spiral filler in her mandibular left, first premolar.

Medical history:

Non- contributory

Dental history and chief complaint:

The patient sought help at the emergency clinic at the dental school in November 2007 because of diffuse pain in 34. The tooth had been restored with an old IRM temporary filling and a eugenol-pellet at some point before that session and was waiting for endodontic treatment of the tooth.

A student excavated caries and started emergency treatment of the tooth. The tooth was instrumented up to size #50.

During the filling with $\text{Ca}(\text{OH})_2$ a lentulo file fractured in the canal.

The journal from that day does not mention any use of a rubberdam or the preoperative diagnosis. The tooth was then referred to the postgraduate clinic for removal of the fractured instrument.

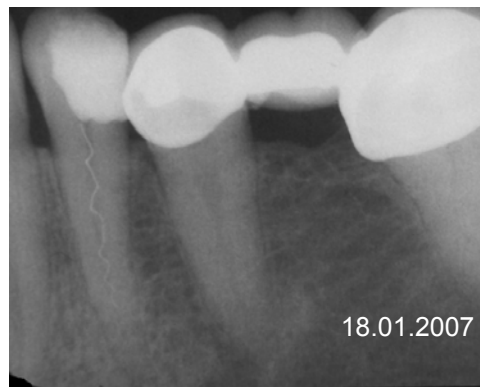


Figure 2

Clinical findings:

Extra and intra-oral: No special findings.

Dental: No caries is detected. An IRM temporary filling is seen on tooth 34. The patient has a metal-ceramic bridge from 35 to 36.

Periodontal: The marginal periodontal conditions were within normal.

Occlusal: Normal occlusal interferences.



Figure 3



Figure 4

18.01.2007 Clinical tests.

	33	34	35
Cold	+	+	+
Palpation	-	-	-
Percussion	-	-	-

Radiographic findings:

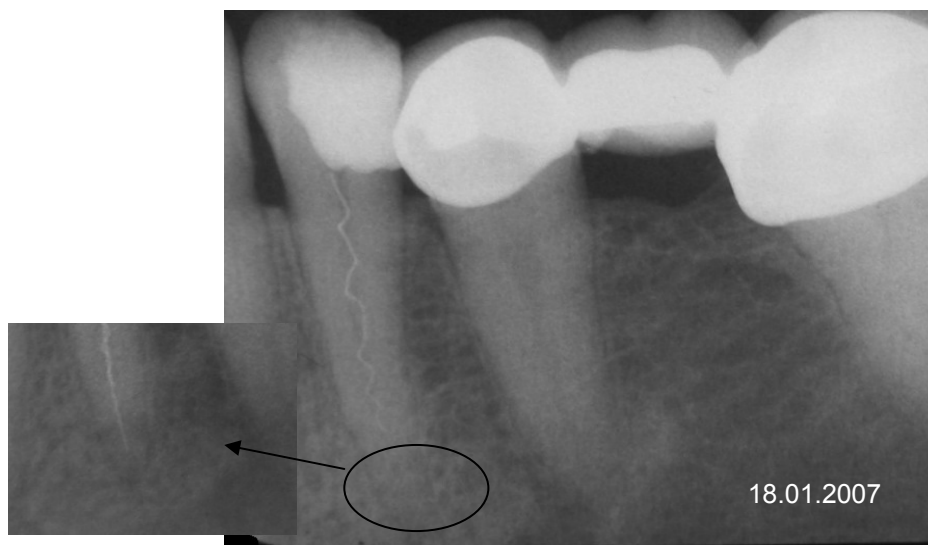


Figure 5

There were some difficulties in interpreting the preoperative radiograph because the apex was very blurry on this particular radiograph. The apex from the working length radiograph was therefore inserted to get a clear view of the apical conditions. This radiograph was taken the same day.

Periodontal:

Normal marginal periodontal conditions.
No apical radiolucencies on any of the teeth in the area.

Dental:

No caries was seen. An OD temporary filling resembling IRM in density was placed in the 34. A metal ceramic bridge is stretching from 35 to 37.

Other :

A foreign object that resembled an endodontic file was seen within the root canal of 34.

Diagnosis:

Pulpal: Necrotic pulp 34, K04.11

Periodontal: Normal periodontium 34

Problem list:

- 1.It could be difficulties of removing the endodontic file.
- 2.There was a possibility that the canal was contaminated because of lack of careful aseptic conditions.

Treatment plan:

1. Removal of the endodontic file
2. Endodontic treatment of 34

Treatment:

18.01.2007:

Clinical photos were taken and clinical assessments were done.

A preoperative radiograph was taken.

A mandibular block with 1 carp xylocaine® with adrenalin was given.

An access cavity preparation was done.

Rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.



The lentulo file was well visible in the canal after removal of the temporary filling.

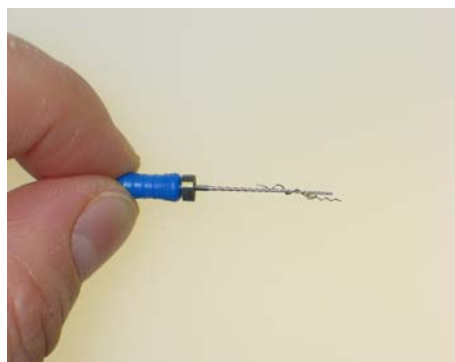
Figure 6



By using a K-file no 10 it was possible to pass the lentulo file and negotiate the remaining canal apical of the instrument.

A working length radiograph was taken: K15/23.5mm/B

Figure 7



An endo-lift was used to make some more space on both sides of the file. This was done with K-files from 10 to 20. By using a Hedström file size #30 the lentulo file was twirled around it and it came out together with the Hedström file.

Figure 8

Canal-preparation was done with ProTaper rotary files (S₁, S₂, F₁) and NiTi handfiles and up to #45.

Irrigation-solutions used were NaOCl 1% and EDTA 16%.

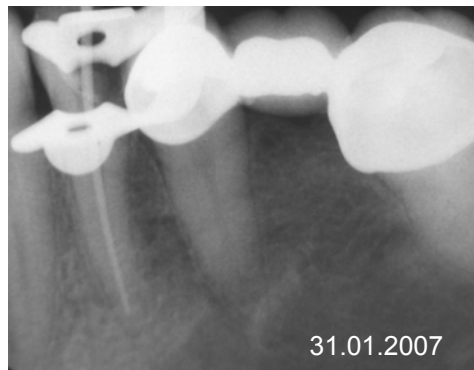
Ca(OH)₂ was used as intracanal medicament.

The tooth was sealed with a temporary IRM filling.

31.01.2007

The patient had no symptoms.

Rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.



Master-cone radiograph:
#45/23.5mm/B

Figure 9

The tooth was root filled with Gutta percha and AH⁺. An IRM-plug was pushed into the 3-4mm coronal part of the root canal to prevent contamination of the root canal filling. Temporary filling was IRM.

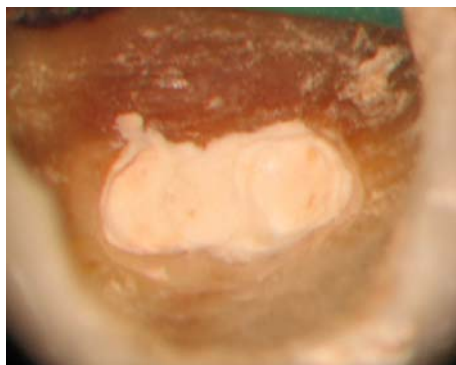


Figure 10



Figure 11

Prognosis:

The prognosis was good.

Managed to get past the broken instrument and rinse the canal. Even though it would have been stuck and left in the canal, the prognosis had been good independently of that.

Follow-up examinations:

21.02.2008:

The patient had no symptoms from the tooth and she received a composite filling on the tooth only 14 days after the endodontic treatment was done.

A control radiograph was taken. No pathological changes were seen in the periodontium and the tooth was dismissed as healed.



Figure 12

Discussion:

In most circumstances fracture of instruments is a result of incorrect use or overuse of an endodontic instrument, and occurs most commonly in the apical third of the root canal (Parashos 2004).



This was probably the case here where one could see the spiral filler being stretched and stuck in the apical area. This may indicate that the instrument had been used at a very high speed and when it got stuck an attempt was done to drag it out in a coronal direction.

Fractured instruments may include endodontic files, lateral or finger spreaders, spiral fillers, or Gates Glidden burs and they can be nickel-titanium (NiTi), stainless steel (SS), or carbon steel.

The prevalence of retained fractured endodontic hand instruments (mostly SS files) has been reported to range from 1 to 6% (Bergenholtz G 1979, Strindberg LZ. 1956, Kerekes & Tronstad 1979, Sjögren 1990, Pettiette 2002).

The fracture of rotary NiTi files range from 0.4-5% (Pettiette 2002, Al-Fouzan 2003, Schäfer 2004).

Management of a case with a broken instrument may involve an orthograde or a surgical approach. The three orthograde approaches are:

- 1) attempt to remove the instrument
- 2) attempt to bypass the instrument
- 3) prepare and obturate to the fractured segment

When these instruments can be removed, successful treatment or retreatment generally occurs. If an instrument can be removed or bypassed and the canal can be properly cleaned and filled, non-surgical endodontics is the most conservative approach. If the entire segment of the broken instrument is apical to the curvature and safe access with visualization is not possible, then non surgical removal usually cannot be accomplished (Ruddle, Pathways of the Pulp 8th ed. 2002).

The prognosis of a tooth with fractured instrument will therefore depend on what stage of instrumentation the separation occurs, the preoperative status of the pulp, the periradicular tissues, and whether the file can be removed or bypassed (Roda, Pathways of the Pulp 9th ed. 2006). If the preoperative pulp was vital and non-infected and there was no periapical periodontitis the separated instrument will not affect the prognosis of the tooth (Crump & Natkin 1970). Also the prognosis of necrotic teeth with no evident periapical periodontitis is overall good (Sjögren 1990). The prognosis for this case was therefore assumed to be good since there were no evident signs of periapical pathology and we were able to remove the instrument and root fill the tooth to a satisfying length.

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CASE 9

Accidental perforation in the furcation



Figure 1

Patient: A 26 year old Norwegian, white female was referred to the postgraduate clinic from the student clinic because of an accidental perforation through the furcation area in the maxillary left first molar.

Medical history: Non-contributory

Dental history and chief complaint:

The patient had started treatment at the student clinic in August 2005. There she had undergone conservative treatment with composite fillings in small carious lesions amongst other in 26.

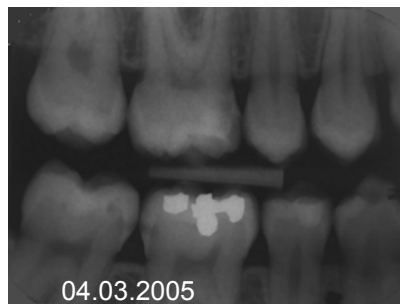


Figure 2

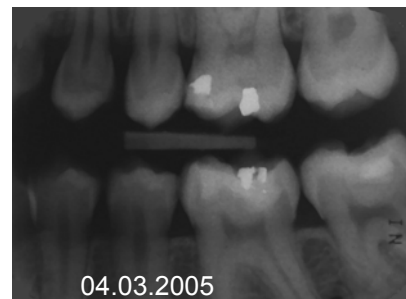


Figure 3

The maxillary left first molar was restored with a deep composite filling. Later on it developed a symptomatic pulpitis in 26 according to the student's records. Access cavity preparation was then started at the student clinic. During access cavity preparation there was an accidental perforation to the furcation area of the tooth and it was filled with a eugenol-pellet and IRM. The student consulted an instructor at the endodontic department which advised him to seal the perforation with $\text{Ca}(\text{OH})_2$ and thereafter eugenol-pellet and IRM, but the patient was already sent home before the instructor could have a look at her.

The patient was then referred to the postgraduate clinic for finishing the root canal treatment.

Clinical findings:

Extra and intra-oral: The skin and oral mucosa was normal.

Dental: No carious lesions in any teeth could be detected. 26 was tender to percussion but not to palpation. It also showed a strong sensitivity to cold air. No other tests were done on any other teeth in the area.

Periodontal: Normal marginal periodontal conditions.

Occlusal: No abnormal occlusal interferences.



Figure 4



Figure 5

Radiographic findings:



Figure 6

Periodontal: 26: The lamina dura seemed to be intact around the roots. A diffuse radiopacity was seen in the furcation area.
24, 25, 27: No periodontal pathology or bone lesions were noted in connection to those teeth. Lamina dura could be traced around all teeth.

Dental: 24: No caries or fillings were detected.
25: No caries or fillings were detected.
26: Temporary MO IRM-filling. A large radiolucent area was observed in the cervical area of the tooth. It started slightly below the cavum and stretched down in the furcation area and into the palatal and distal roots.

Diagnosis: Pulpal: Chronic pulpitis 26, K04.03

Periodontal: Normal periodontium

Dental: Perforation in the furcation area

Problem list: The extent of the perforation was unknown so it was difficult to foresee whether it was possible to treat it.

Treatment plan:

1. Sealing of the furcal perforation with MTA in 26
2. Endodontic treatment of 26
3. If the perforation was too large an extraction of the tooth would be the alternative option

Treatment:

01.12.1005: Temporary filling was removed and rubberdam applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.

An extensive perforation through the furcation area a few mm down into the underlying alveolar bone was located (fig. 10). The width of the perforation was as large as the vicinity of the pulp chamber walls. Small perforations were also seen around on the wall.

Three root canal entrances were located (fig. 7, 8, 9). The mesio-buccal and palatal canal-entrances were found hidden quite high up on the tooth walls. The disto-buccal canal-entrance was found deep down 3-4mm in the floor of the cavity into a part of the disto-buccal root.

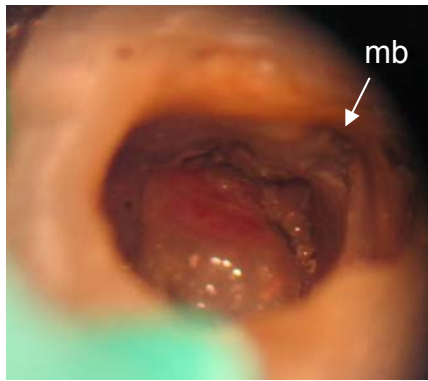


Figure 7

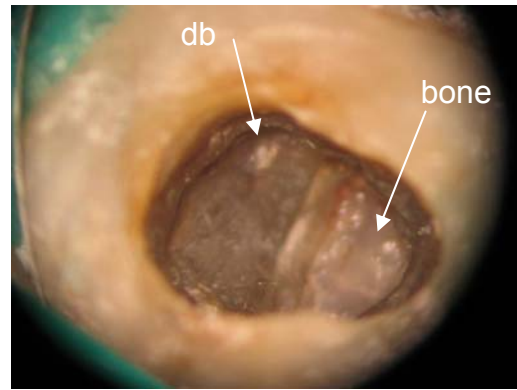


Figure 8



Figure 9

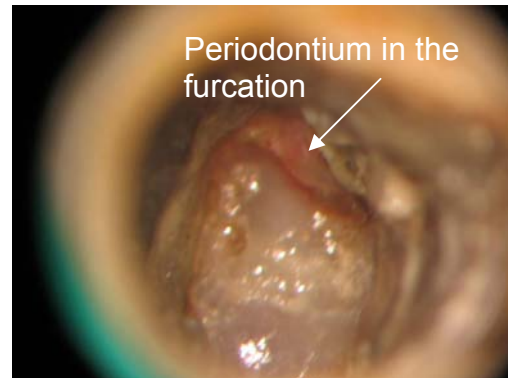


Figure 10

The first treatment sessions were concentrated on sealing the large perforation.

There was not any especial bleeding from the perforation only a constant seepage of tissue fluid that was filling up the cavity-floor.

It was therefore decided to fill the cavity with $\text{Ca}(\text{OH})_2$ and wait until the next appointment to start filling the perforation.

Irrigation with 2% chlorhexidine-di-gluconate solution and sterile water.

IRM was placed as temporary top-filling.

15.12.2005 and
17.12.2005:

The patient had felt some tenderness towards cold, but no severe pain in the tooth.

Rubberdam applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.

It was decided to fill MTA in the perforation. The filling was done over two treatments because there were difficulties in the setting of the MTA due to too much seepage of fluid from the periodontium in the furcation and the underlying bone. There was also some bleeding in between the appointments that affected the setting.

Another issue was the thickness of the MTA. It would probably be too difficult to get enough moistness to get the whole MTA block to set in one session.



Figure 11

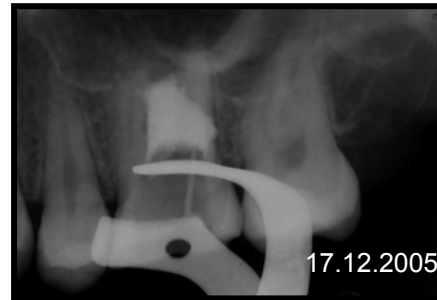


Figure 12

A gutta-percha point was placed into the DB-canal so that the passage wouldn't be blocked during placing of the MTA. A moist cotton-pellet was placed over the MTA. IRM was used as top-filling. Irrigation was done with 2% chlorhexidine-di-gluconate.

01.02.2006:

The patient had not had any severe pain in the area since last time.

Rubberdam applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.

The MTA had set properly this time.

A working-length radiograph was taken:

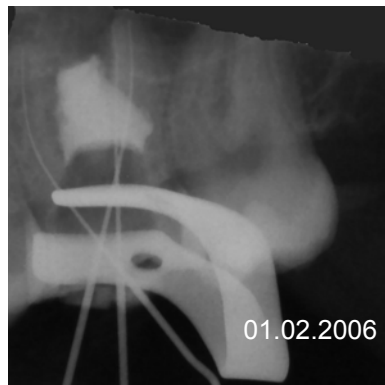


Figure 13

MB: K15/19mm/mpc - 18mm
DB: H15/18mm/dbc - 17mm
P : K20/19mm/mpc - 18mm

An apex-locator was used to help finding the canal lengths.

The buccal canals were instrumented to size #45. The palatal was instrumented to size #60.

Ca(OH)₂ was placed as interappointment medicament and Cavit was placed over the canal entrances.

More MTA was laid in the buccal part of the cavum because there were small perforations in the cavity wall

on the buccal aspect. A moist cotton-pellet was placed over the MTA.

Irrigation was done with 2% chlorhexidine-di-gluconate. IRM was used as temporary filling.

23.02.2006:

The patient had felt some sensitivity towards temperature changes. When cold air was blown towards the tooth a severe, shooting pain was setting in a few seconds delayed. The pain lasted some minutes before it disappeared. There was no tenderness to palpation. Tenderness towards percussion was uncertain since she felt something on all teeth that were tested.

Despite that the patient had felt some discomfort it was decided to root fill the tooth this session

A master-cone radiograph was taken. The canals were filled with gutta-percha and AH⁺ and the canal entrances were sealed with IRM. IRM was used as top-filling.

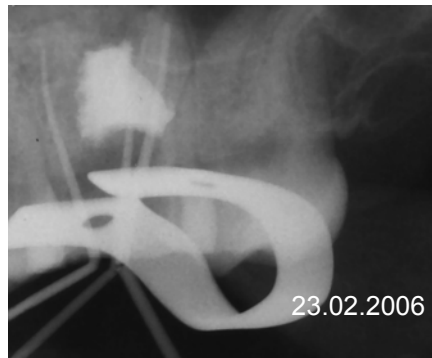


Figure 14



Figure 15



Figure 16

09.03.2006:

Tenderness towards cold was still present. The tooth also felt different to the other teeth according to the patient. No especial tenderness to palpation or percussion, but a strong delayed pain was felt when endo-ice was tested on the tooth. It lasted a few minutes before it disappeared.

Prognosis:

Periodontal: The prognosis seemed to be good.

Dental: The prognosis seemed to be poor. The tooth was very weak since so much tooth substance was lost. There were small perforations almost all the way around in the wall of the access cavity. One might say that there was only a shell of the tooth left.

Follow-up examinations:

13.06.2006:

The pain towards changes in temperature was still present. Sometimes the pain could be severe. The radiographs showed no pathology, apical or in the furcation area.



Figure 17



Figure 18

25.01.2007:

The pain towards cold was still there but not as often as before. No tenderness to percussion or palpation. No apical changes could be seen on the radiographs. Lamina dura seemed to be intact around the roots.



Figure 19



Figure 20

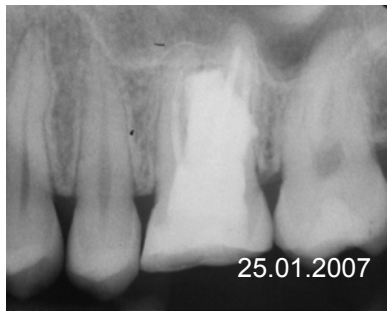


Figure 21



Figure 22

04.10.2007:

The tooth showed no tenderness to palpation or percussion, but the sensation was different in this tooth. The patient said that she could feel the pain from cold at least once a week. It was a sharp pain that lingered. No apical changes were seen on the radiographs.



Figure 23



Figure 24

15.04.2008:

The patient said that the pain was more seldom now. She tended to forget about the tooth most of the time. She could feel pain once in a while but it was not as painful as before. No tenderness to palpation or percussion was present. The PDL could be followed all the way around the tooth.



Figure 25



Figure 26

Discussion:

Pulp chamber floor perforations caused by resorptive defects, caries or iatrogenic events during endodontic procedures are undesirable damages. It creates an

artificial communication between the root canal system to the supporting tissue of the teeth and the oral cavity (Fuss & Trope 1996).

Factors that affect the prognosis of perforation repair include time delay before the repair, location of perforation, ability to seal the defect and previous contamination with microorganisms (Roda & Gettleman 2006).

It is important to seal the perforation as soon as possible. Seltzer S and associates (1970) made artificial perforations in the pulp chamber floor in monkeys' teeth. Some of the perforated teeth were sealed immediately, some left open for a while before sealed and some not sealed at all. The monkeys were killed at intervals from one week to 18 months and the periodontal effects of the root perforations were evaluated. The reaction ranged from mild to severe, where the most severe reactions occurred when the perforated regions were not sealed immediately.

MTA was introduced to endodontics in the early 90ties as a root-end filling and lateral perforation repair material (Lee et al. 1993). The material has shown to have good sealing ability (Torabinejad 1995a, Fischer 1998), as well as being biocompatible (Torabinejad 1995b, Masuda 2005).

Torabinejad et al. (1997) found the presence of cementum growing on the surface of MTA and regeneration of the periradicular periodontium has been seen when used as a root-end filling material on non-infected teeth (Regan et al 2002), and also the presence of organizing connective tissue with only occasional signs of inflammation onto the MTA has been observed (Economides et al. 2003).

Overfilling of MTA, as here; may be prevented by the modified matrix concept where a resorbable collagen matrix is placed in the area of granulation tissue extraradicularly (Bargholz 2005). The MTA is subsequently placed against the matrix.

There have been no signs of pathology around the MTA or roots of the tooth on the follow-up radiographs. Even though the patient has had some symptoms from the tooth the healing according to the radiographs and clinical tests with percussion and palpation has been uneventful.

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CASE 10

Endodontic treatment of 6 teeth and crown lengthening on a medically compromised patient; a project of cooperation together with the prosthetic department



Figure 1

Patient:

A 41 year old Norwegian man was referred to the postgraduate clinic in endodontics from the postgraduate clinic in prosthetics because they wanted endodontic treatment of 11, 12, 13, 16, 21, 23, and 26 done for prosthetic purposes.

Medical history:

The patient had a muscular disease called Myotonia congenita, type Becker (G71.1). The disease affects the muscular system and belongs under the category of rare medical conditions. This kind of disease falls under the category Dystrofia myotonia.

The disease had intervened in his personal life and he was dysfunctional in most of the daily situations and lived for the time being at the house of a relative.

The patient was a smoker.

He was not on any regular medication for his illness, but received physiotherapy at the time.

Dental history and chief complaint:

There were several problems with his teeth. Probably because of his illness combined with poor hygienic conditions all his teeth were abraded in line with the gingiva and they all had carious lesions. Excavation of caries and temporary fillings/composite had been done by the prosthodontist. The teeth were going to be restored with a posts and crowns and small bridges so root canal filling was necessary in almost all the teeth in the upper jaw, and not only because of the prosthetic treatment but

also because he pulp was exposed and he had apical periodontitis in several of them.

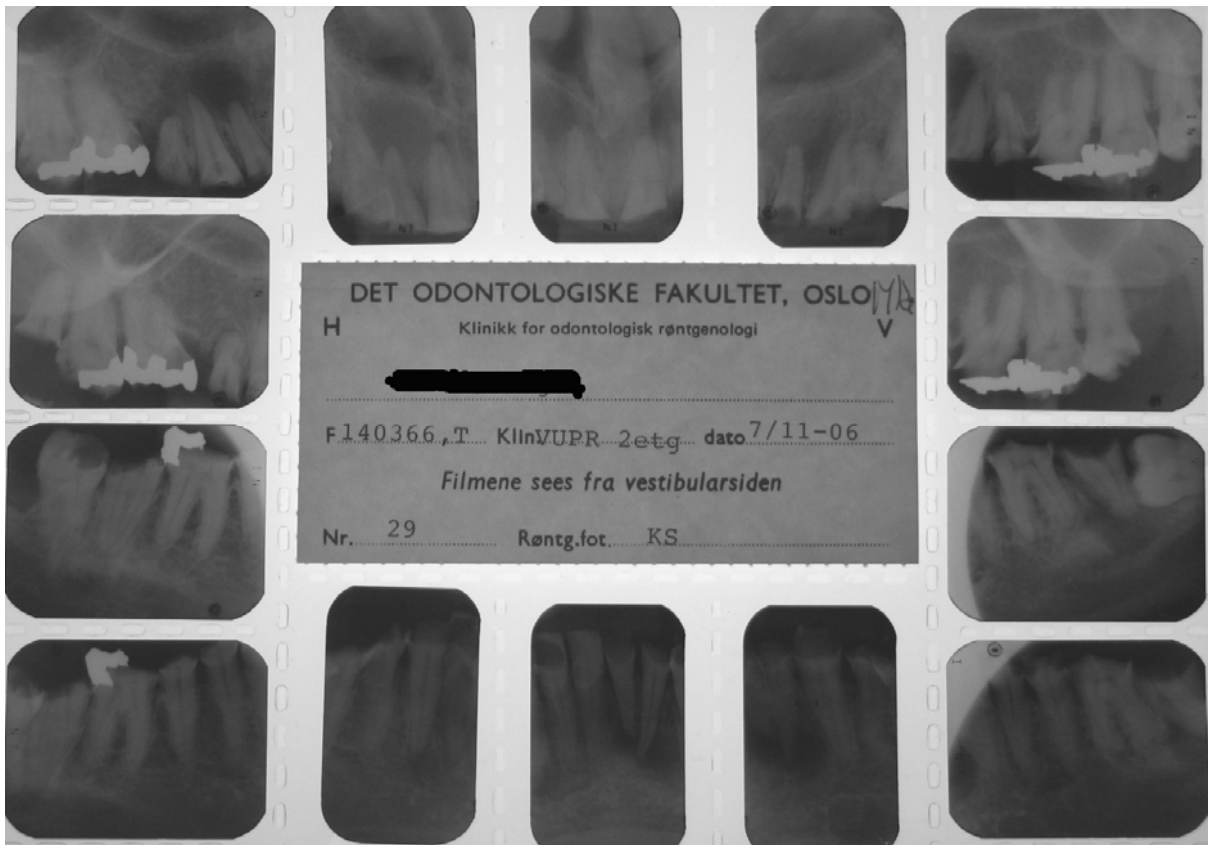


Figure 2, full mouth status taken 07.11.2006

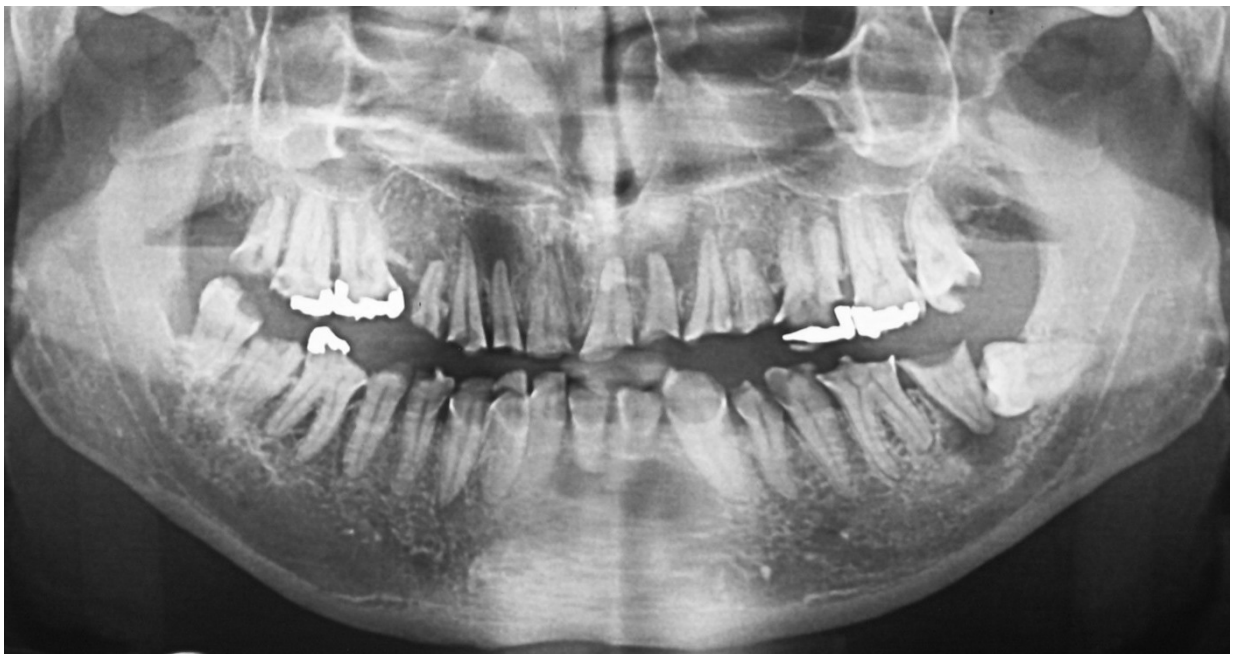


Figure 3 OPG taken 07.11.200

Clinical findings:



Figure 4



Figure 5



Figure 6

Extra and intra-oral: The skin and oral mucosa was normal.

Dental: All front teeth in the upper jaw were abraded and there were nothing left of the crowns of the teeth. Either composite or IRM fillings were covering the occlusal aspect of the teeth. The molars were also all covered with composite. The specialist in prosthodontist could not recall that the pulp had been exposed in 13 or 26 during excavation of caries.

Periodontal: Normal marginal periodontal conditions.

Occlusal: The patient had grinded down all teeth, especially in the upper jaw; probably induced by caries and poor hygienic conditions.

Clinical tests 07.06.2007:

	16	13	12	11	21	23	26
Cold	+	Yes	No	No	No	No	+
Percussion	No	No	No	No	Yes, vertical	No	No
Palpation	No	No	Yes	Yes	No	No	No
Caries	no	No	No	No	No	No	No
PPD	WNL	WNL	WNL	WNL	WNL	WNL	WNL

Figure 7

Radiographic findings:

07.06.2007



Figure 8. Older radiograph of 16



Figure 9
Teeth 13, 12



Figure 10
Teeth 12, 11, 21



Figure 11
Teeth 12, 13



Figure 12
Tooth 26

Periodontal:

- 11: A well-defined radiolucent area of about 5mm in diameter was seen around the apex.
- 12: A large well-defined radiolucent area of about 12mm in diameter was seen around the apex.
- 13: Normal periapical conditions. The PDL could be followed uninterruptedly around the whole root.
- 16: Normal periapical conditions. The PDL could be followed uninterruptedly around all roots.
- 21: A diffuse radiolucent zone of about 4 to 5mm in diameter was seen at the apex.
- 23: A radiolucent area of about 3mm was seen at the apex.
- 26: Normal periapical conditions. The PDL could be followed uninterruptedly around all roots.

Dental: No caries was seen on any of the teeth. All the teeth had composite fillings, IRM or no fillings at all to cover the canal.

Special remarks: Since the radiograph of 16 was impossible to retrieve for this purpose, an older radiograph was used instead (fig. 8). The radiograph did not reflect the clinical situation at the date when he had the consultation, only the periapical situation was authentic. The clinical situation of 16 was as the other teeth, caries had been excavated and a composite filling was filled in as temporary (fig. 4).

18, 14, 22 and 24 were going to be extracted so no description on those teeth was done.

Diagnosis:

Pulpal: 11: Necrotic pulp, K04.11
12: Necrotic pulp, K04.11
13: Healthy pulp
16: Healthy pulp
21: Necrotic pulp, K04.11
23: Necrotic pulp, K04.11
26: Healthy pulp

Periodontal 11: Chronic apical periodontitis, K04.50
12: Chronic apical periodontitis, K04.50
13: Normal periapical periodontium
16: Normal periapical periodontium
21: Chronic apical periodontitis, K04.50
23: Chronic apical periodontitis, K04.50
26: Normal periapical periodontium

Treatment plan: 11: Treatment of necrotic pulp/apical periodontitis
12: Treatment of necrotic pulp/apical periodontitis
13: Pulpectomy. Treatment due to prosthetic reasons
16: No treatment
21: Treatment of necrotic pulp/apical periodontitis
23: Treatment of necrotic pulp/apical periodontitis
26: Pulpectomy. Treatment due to prosthetic reasons

No treatment was done on 16 since tooth was vital and there was enough tooth structure left, so a prefabricated post was not needed in this tooth.

Crown lengthening was planned around 11, 12, 13, 16, 21, 23, 26.

Problem-list:

The endodontic treatment seemed to be straight forward treatments on all teeth. The biggest problem was the patients' ability to hold his mouth open for the length of an endodontic treatment.

There were also a few discussions with the prosthodontist what kind of treatment the patient needed.

The prosthodontist' opinion:

16 needed a root canal treatment because a post was necessary to retain a crown on this tooth.

12 had to be extracted because the apical radiolucency was too large to heal.

All teeth needed posts to retain the crowns and bridges in spite of that a crown lengthening had been planned to gain 2-3mm of space for the crown preparation.

The endodontist' opinion:

16 had no need for a post. It seemed to be more than enough tooth substance left to build a retain a crown onto it. And since the caries did not influence the pulp the tooth should be spared from a root treatment.

12; the lucensy was large, but the size of the lucensy does not decide whether the tooth will heal or not.

Since all teeth were going to have crown lengthening the need for posts would most likely disappear. So posts should only be placed if outmost necessary.

Treatment:

I will not go into the treatment of each tooth in detail, an ordinary protocol was followed when shaping and cleaning and obturation the teeth were done.

The teeth with vital pulps were treated after the concept of pulpectomy, one-session treatment if possible.

The teeth with necrotic pulps were treated over two or more sessions with an interappointment dressing of Ca(OH)_2 .

Rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol in each treatment session.

Irrigation solutions used every time were NaOCl 1% and EDTA 16%.

The canals were mechanically shaped with K-handfiles, NiTi-handfiles, ProTaper rotary instruments and Hedström files.

All teeth were obturated with gutta-percha and AH⁺ except for 13 which was filled with gutta-flow.

Since all teeth were going to have prefabricated posts, gutta percha was removed 5 to 6mm down into the canal to facilitate post preparation. It would make it easier for the specialist in prosthetics to do preparation of the posts.

07.06.2007 – 11.12.2007

Working length radiograph = WRL
Master cone radiograph = MCR
Post operative radiograph = POR

11:



Figure 13
WRL: K15/15mm/P



Figure 14
MCR: #70/15mm/P



Figure 15
POR

12:



Figure 16
WRL: K15/13.5mm/B
- 12.5mm



Figure 17
MCR: #55/12.5mm/B

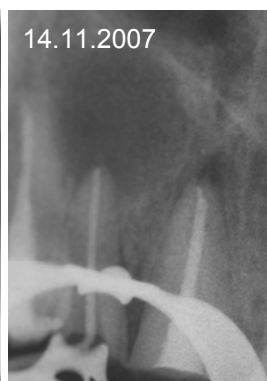


Figure 18
POR



Figure 19
The patient felt pain from the area. An alternative could have been an apicoectomy, but the prosthodontist wanted the tooth extracted

13:



Figure 20
WRL: K15/18.5mm/P
-17.5mm



Figure 21
MCR: #55/17.5mm/P



Figure 22
POR

21:



Figure 23
WRL: K15/18.5mm/P
- 15mm



Figure 24
MCR: #70/18mm/P



Figure 25
POR

23:



Figure 26
WRL: K15/14.5mmP



Figure 27
MCR: #50/14.5mm/P



Figure 28
POR

26:

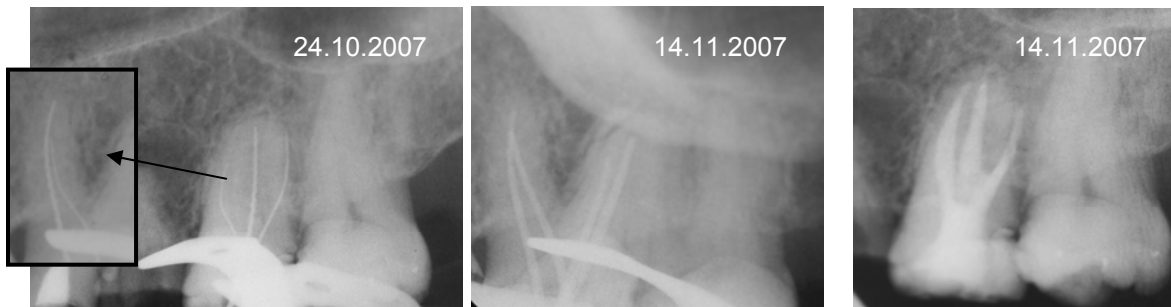


Figure 29
WRL: MB1:K15/17mm/B
MB2:H15/14mm/D
- 17mm
DB:K15/15mm/B
-14mm
P:K20/15mm/B

Figure 30
MCR: MB1: #40/17mm/B
MB2: #40/17mm/D
DB: #45/14mm/B
P:#55/15mm/B

Figure 31
POR

(fig. 29; part of a radiograph inserted of the MB root with files in MB1 and MB2)

Crown lengthening

31.01.2008



Figure 32



Figure 33



Figure 34

The prosthodontist had made a guiding mouth guard that showed how much to remove from the gingiva to get enough space for the crowns (fig. 32, 33).

Crown lengthening was done on 11, 13, 21 and 23.

Extraction of 12, 22 and 24 were planned in the same session.

Local anaesthesia was given; 6 carpules of xylocaine® with adrenalin was given.

A marginal incision was made where the guard ended from the distal of 13 to the distal of 23. Approximately 2mm lower than the existing gingival margin.

The flap was reflected and all excess gingiva was removed with a curette, both buccally and interdentally towards the palatal aspect.

The bone level was lowered on the buccal aspect, about 2mm from the original bone height.

During the session the roots of 12, 22 and 24 were removed, this was an uncomplicated matter.

The flap was replaced and 6 sutures were set.

Post operative information was given and the patient was instructed to rinse twice a day with an anti-septic mouthwash.



07.02.2008

The patient came back for suture removal. He had not experienced any severe pain.

There was a lot of plaque covering the sutures, but the gingiva was not particularly red or swollen. A fibrin-layer was covering the extraction alveoli and everything seemed to heal uncomplicated.

As one could see there was more space around the abutments than earlier; fig's. 36 and 37 compared to fig. 38.

Prognosis:

The prognosis for the endodontic treatment seemed to be good.

The overall prognosis of these teeth would depend on whether he received prosthetic constructions on these teeth in a reasonable time and the patient's ability to look after his teeth after he is finished with the treatment.

Discussion:

Myotonia congenital is an inherited condition that affects muscle relaxation. It is believed to be caused by a problem in the part of the muscle cells that are needed for muscles to relax. Abnormal repeated electrical discharges occur in the muscles, causing a stiffness called Myotonia (U.S. National Library of Medicine).

Two forms of Myotonia congenital have been classified. The less severe form has been termed Thomsen Myotonia congenita and is inherited in a dominant fashion; the more severe form has been termed Becker myotonia congenital and is inherited in a recessive fashion (Wikipedia).

The influence upon the oral health will show itself in difficulties in the ability to suck and masticate properly and a development into malocclusion may happen. A need

for follow-up of the oral health by a dentist or a hygienist is strictly necessary (Diderichsen 2004).

Silness (1980) found that margins of fixed prosthodontics significantly compromise gingival health, if placed below the gingival margin.

Crown lengthening is therefore a surgical procedure aimed at removal of hard and soft periodontal tissue to increase the clinical crown height (Lanning 2003).

It allows for longer clinical crowns (Palomo 1978) and reestablishment of the biological width (van der Velden 1982).

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CASE 11

Internal resorption in a maxillary left central



Figure 1

Patient: An 18 years old Norwegian man was referred to the postgraduate clinic in endodontics because of a resorptive defect in 21.

Medical history: Non-contributory

Dental history and chief complaint:

2006: At the end of November the patient had a trauma to 21 during practising judo. He did not seek a dentist at the time.

2007: January 2007 was the first time he saw a dentist. According to the patient the tooth was red/blue and painful at that time. Radiographs were taken from that date and the tooth had a normal appearance until the follow-up control 22.02.2007.

The discoloration had according to the patient slowly disappeared.

Radiographs taken at the public dental clinic:



Figure 2



Figure 3



Figure 4

In February 2007 the radiograph revealed a beginning obliteration of the pulp space in the apical third of tooth 21. At the control in April 2007 the changes were more obvious.

The patient was referred to the department for oral surgery and oral medicine at the Faculty of dentistry in April 2007. They referred the patient to the postgraduate clinic for evaluation and further treatment.

Clinical findings:



Figure 5

Extra and intra-oral: The skin and oral mucosa was normal.

Dental: No caries detected. There were no fillings in any of the front teeth. A small infracture line was seen on the palatal aspect of 21.

Periodontal: Normal marginal periodontal conditions.

Occlusal: No abnormal occlusal interferences.

Clinical tests:

20.06.2007

	12	11	21	22
EPT	41	32	25/?	21
Cold	Yes	Yes	No	Yes
Palpation	No	No	No	No
Percussion	No	No	Vertical	No

21.08.2007

	12	11	21	22
EPT	23	25	40/?	27
Cold	Yes	Yes	No	Yes
Palpation	No	No	No	No
Percussion	No	No	Vertical/horizontal	No

Other:

The tooth 11 was a bit greyish in colour, but no major differences compared to the neighbouring teeth.

The reaction to the electric pulp tester (scale 0-80) was very inconsistent. Sometimes he felt something, but not the same sensation as in the other teeth. If there was any reaction it occurred in-between 30-80, but sometimes there was no reaction at all.

The sensation to percussion was altered, but not painful.

The first consultation was in June 2007. It was then decided to wait until the autumn to see if the lesion had progressed since no development was seen on the radiographs between April 2007 and June 2007.

A CT-scan was scheduled to try to determine if the lesion was of an internal or external nature.

Radiographic findings:



Figure 6
Mesio-eccentric

Figure 7
Ortho-radial

Figure 8
Disto-eccentric

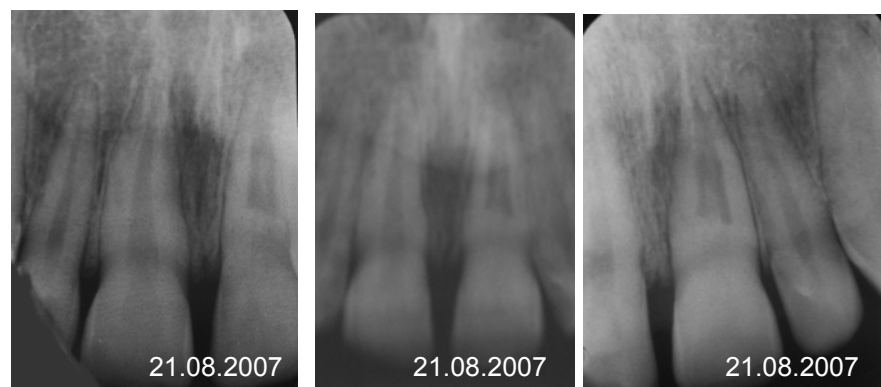


Figure 7
Mesio-eccentric

Figure 8
Ortho-radial

Figure 9
Disto-eccentric

There were no obvious changes visible on the radiographs from June to August.

Periodontal: No changes in the PDL around any of the teeth. The PDL was intact.

Dental: No caries could be seen.
11, 12, 22 had a normal appearance. The pulp space on these teeth seemed to be normal in appearance.
21: The radiographs showed radiolucent and radiopaque zones within the pulpal space. In the crown and cervical area there was an obliteration but mid-root and towards the apex the pulp space was more open. A bridge of tooth-structure/structure of radiopaque material was seen in the middle of the open space dividing it in two halves.

Problem-list: Whether it was possible to root fill the tooth properly was uncertain because of the extent the lesion seemed to have. Also what had to be settled before the treatment started was whether the lesion was external or internal.

Diagnosis: Pulpal: Internal/external resorption of 21, K03.30/K03.31

Periodontal: Normal periodontium.

Treatment plan:

1. CT-scanning of the tooth to get an overview of the damages and help with the diagnosis.
2. Root canal treatment and removal of the resorption tissue if possible.
3. If the CT-scan showed a perforation to the periodontal tissues a surgical intervention was perhaps necessary.
3. Evaluate the prognosis in relation to the extent of the lesion and discuss other treatment alternatives with the patient.

Treatment:

20.06.2007: Consultation with radiographs and clinical tests. There was no consensus whether the tooth should be treated or not since there had been no changes radiographic changes since April. It was therefore made a decision to wait-and-see until the autumn if any changes would arise. A CT-scan was ordered so that the extent of the resorption could be evaluated.

21.08.2007. Consultation with new radiographs. The lesion seemed to be the same; no changes were noticed since before the summer holiday. The clinical tests showed almost the same results as the first time. The patient was unsure about the endo-ice test, whether he felt cold or not. Further treatment was postponed until the CT-scan had been evaluated.

18.09.2007:

The CT scan probably showed that the resorption was internal of character. At least it seemed to be since no perforations to the periodontium was noted. Root canal treatment was therefore started.

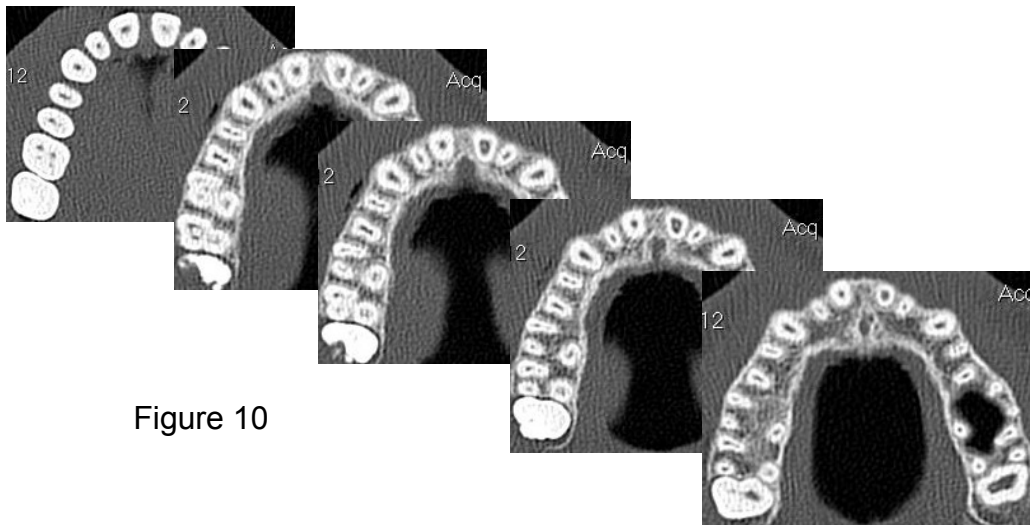


Figure 10

Figure 10 is a series of the CT-scan taken. It showed obliteration of the coronal part of the tooth; opening into a larger radiolucent area that could be followed towards the apex. In the middle of this zone radiopaque structure-lines were crossing into the open space. The pulp space of the affected tooth was much bigger than the pulp space of the comparing tooth 11. This was in alignment with the other radiographs taken. The lesion seemed to be internal according to the radiographs from the CT-scan.

Access cavity preparation was done. The cavum was obliterated of irregular dentin with a sugar-like appearance. Bleeding pulp tissue was lying scattered around in the vicinity of the obliteration.

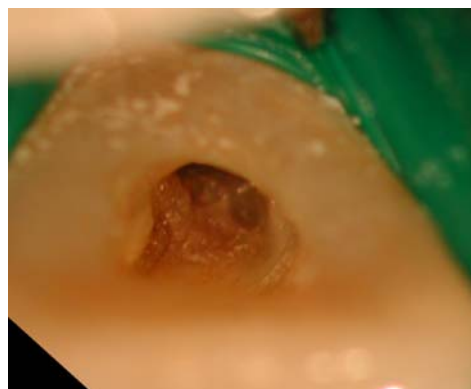


Figure 11

The obliteration was extending far into the canal but the root canal was found.

Rubberdam was applied and disinfected with a solution of 5% Chlorhexidine in 70% ethanol.

Working length radiograph was taken but the length was unfortunately not written down.

There was fresh bleeding from the canal and the pulp tissue was removed to prevent discoloration of the tooth. $\text{Ca}(\text{OH})_2$ was used as intracanal dressing and NaOCl 1% and EDTA 16% was used as irrigation-fluids. IRM was used as temporary filling.

09.10.2007:

Rubberdam was applied and disinfected with a solution of 5% Chlorhexidine in 70% ethanol.

The $\text{Ca}(\text{OH})_2$ was washed out since the last appointment.

A new working length radiograph was taken: K20/25mm/l. The apex-locator was inconsistent because the canal was very wide close to the apex and this made it therefore difficult to use.

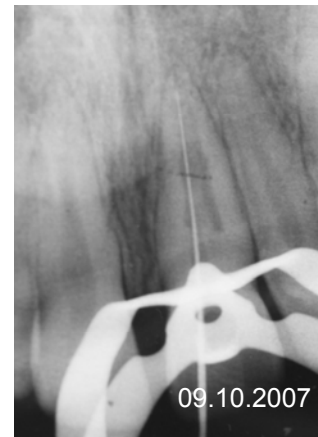


Figure 12

The canal was cleaned and shaped with NiTi-handfiles and K-files attached to an ultrasonic device to size #60. $\text{Ca}(\text{OH})_2$ was used as intracanal dressing and NaOCl 1% and EDTA 16% were used as irrigation-fluids.

25.10.2007:

The patient had felt some discomfort in connection to the tooth since the last appointment. The tooth was tender to percussion both in vertical and horizontal direction. No tenderness to palpation.

Rubberdam was applied and disinfected with a solution of 5% Chlorhexidine in 70% ethanol.

The $\text{Ca}(\text{OH})_2$ was wet when the canal was reopened. There was a constant seepage of fluid coming up from the canal and paper-points could not dry it out, the whole canal was filled with fluid after a while.

This could probably be because the resorption had resorbed out into the periapical area.
NaOCl 1% and EDTA 16% were used as irrigation-fluids and a K-file attached to the ultrasonic device was used to help the irrigation.
New Ca(OH)₂ was applied as intracanal dressing.

30.01.2008:

The tooth had been free of symptoms, but the patient said that it occasionally felt a bit different. No tenderness to percussion or palpation.

Rubberdam was applied and disinfected with a solution of 5% Chlorhexidine in 70% ethanol.

It was decided to fill the tooth today in spite of that the canal was not completely dry. It was not filling up with fluid like last time, only some moist was seen on the paper-point when it was pushed into the apical. This was probably due to a possible resorption in the apical area and tissue-fluid was keeping it wet there.

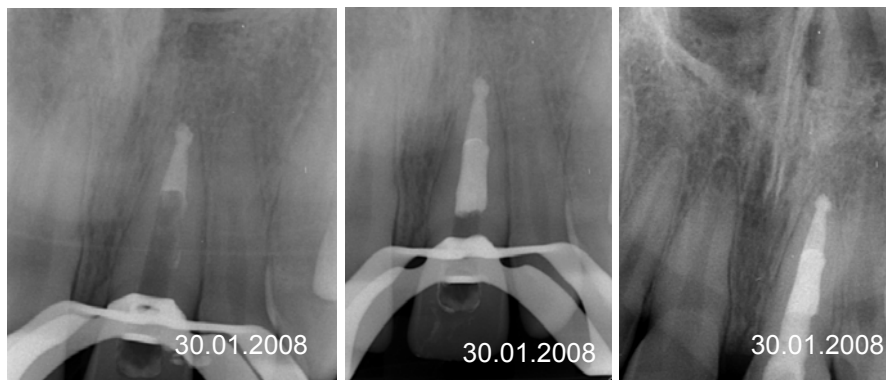


Figure 13

Figure 14

Figure 15

The tooth was root-filled with 4mm thick MTA and thereafter back-filled with warm gutta-percha (system B)

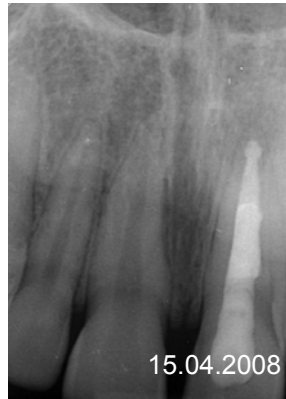
Elements obturation unit and system B



Figure 16

IRM was used as temporary.

15.04.2008:



The patient said that the tooth felt a bit different from the other teeth but nothing severe that bothered him in daily life. A wait-and-see period would be necessary to see the development.

A composite was laid as top-filling on the tooth. The placement was below the cervical area of the tooth.

Figure 17

Prognosis: The prognosis was uncertain.

Discussion:

Trauma seems to be a very common etiological factor for internal resorptions (Caliskan 1997, Bakland 1992).

Internal root resorption is marked by resorption of the internal aspect of the tooth via multinucleated giant cells adjacent to granulation tissue in the pulp (Levin & Trope 2002). A part of the pulp has to be vital in order to initiate and maintain the resorption process and it has been shown that communication between the coronal infectious, necrotic tissue and the vital pulp is through appropriately oriented dental tubules (Wedenberg 1985). Normally the mineralized tissue of permanent teeth is not resorbed since it is protected by a predentin and odontoblastic layer on the pulpal side and precementum and cementoblasts on the root surface (Wedenberg 1985). Internal resorption takes place only when the odontoblastic layer or predentin are lost or altered (Tronstad 1988).

Internal resorptions are usually asymptomatic and first recognized clinically through routine radiographs (Gulabivala 1995). A pink spot due to granulation tissue in the coronal dentine undermining the crown enamel can also be seen, but that can also be a feature of cervical resorption, which must be ruled out before a diagnosis of internal resorption is made (Trope 2002). Often will internal resorptions have a characteristic radiographic appearance; disruption of the canal space, ovoid in appearance (Andreasen & Andreasen 1994).

Early diagnosis is critical for the prognosis. When diagnosed at an early stage endodontic treatment of such lesions is usually uneventful. At a late stage, the progression of the resorption has damaged the tissues in such extent that treatment may not be possible.

The reason we awaited treatment of this tooth was the unclear radiographic appearance. The lesion in this case was not what one could expect of the appearance of a internal resorption and whether it was of internal or external origin was unclear. This was the cause why we decided to wait for the CT-scan and not start treatment instantly.

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CASE 12

Cervical resorption after orthodontic treatment



Figure 1

Patient:

A 20 years old white Norwegian man was referred to the postgraduate endodontic department from the postgraduate clinic in prosthodontics due to a cervical root resorption in tooth 11.

Medical history:

Non - contributory

Dental history and chief complaint:



Figure 2



Figure 3

The patient had not been aware of the problem. The patient was for the time being under treatment at the prosthodontic department because of agenesis of the teeth 32 and 42. And it was also the intention to make a new

replacement for the tooth 12.

The dental practitioner accidentally discovered a cervical resorption on 11 during the phase of treatment planning.

The referring dentist noticed a red-spot buccally in the cervical area of the tooth.

Clinical findings:

Extra and intra-oral: The soft tissue and oral mucosa seemed to have a normal colour and texture.

Dental: No caries was detected on 11. The tooth had no restorations.
A red spot was seen at the cervical margin on the bucco-mesial side of 11. No entrances to the lesion could be detected by using the explorer.

Periodontal: No periodontal problems.

Clinical testing:

	13	11	21	23
EPT	32	5	29	38
Endo-ice	Yes	Yes	Yes	Yes
Palpation	No	No	No	No
Percussion	No	No	No	No
PPD	1mm	1mm	1mm	1mm

Figure 4

Even though the tooth gave positive responses to the clinical tests, the results were not quite the same. He responded much faster to the EPT and when applying cold to the tooth he responded different than on the other teeth.

Radiographic findings:



Figure 5
Ortho-radial projection



Figure 6
Disto-eccentric projection

Periodontal: Normal marginal periodontal relations.

Dental: A translucent area was seen in the 1-2mm above the cervical margin on the mesial side of 11.

Diagnosis: Pulpal: Healthy pulp 11

Periodontal: Cervical root-resorption of 11, K03.38
Normal periodontium in the apical aspect.

Problem list: Danger of fracture in the cervical area because of loss of tooth substance due to the resorption.
Whether the tooth should undergo a root-canal treatment or not was discussed since the pulp in these cases normally are unaffected.

Treatment plan:

1. Root canal treatment
2. Flap elevation and Curettage and sealing of the resorption lesion.

It was decided to do root-canal treatment because the lesion seemed so large that it would affect the pulp sooner or later.

Treatment:

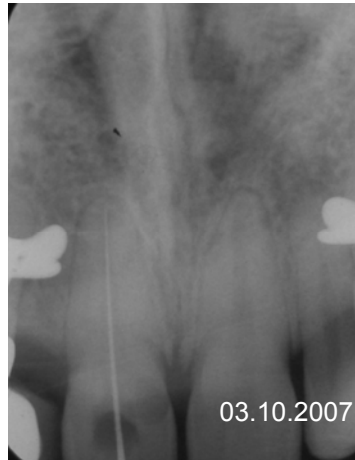
03.10.2007: A reddish discolouration was seen on the buccal side of the tooth near the gingival margin, towards the mesial aspect. The patient didn't have any symptoms. The lesion could not be inspected with the explorer.
From the radiographs the lesion seemed to be of a respectable size, and the sensibility test with EPT showed some irregular figures. The tooth responded very quickly compared to the neighbouring teeth.

Since it was possible that the resorption was affecting the pulp of the tooth it was decided to do a root canal treatment before doing curettage of the resorption from the buccal side.

The access cavity was prepared and the rubberdam was applied and disinfected with a solution of 5% Chlorhexidine in 70% ethanol. The rubberdam clamps were attached to the first premolars and the rubberdam was held down with dental floss around 11; this because it was assumed that the 11 could be weak in the cervical area.

It was a slight bleeding in the access cavity. The access cavity opened slightly towards the mesial aspect.

A working length radiograph was taken and working lengths were established with help from an apex locator (Root ZX from Morita).



WLR: K20/22mm/l
The canal was rinsed up to a size 60.

Ca(OH)₂ was used as intra-canal medicament. IRM was used as temporary filling.

1% NaOCl and 16% EDTA was used as irrigation solutions.

Figure 7

17.10.2007

Rubberdam was applied and disinfected with a solution of 5% Chlorhexidine in 70% ethanol.



A master-cone radiograph was taken: #60/22/l.

Figure 8



The tooth was root-filled with gutta percha and AH+. A 3mm plug of IRM was put down into the canal. IRM was used as top-filling.

1% NaOCl and 16% EDTA was used as irrigation solutions.

Figure 9



The lesion could be seen on the inside of the tooth because of the very strong, red discoloration but there was no communication to the lesion.

Figure 10

17.10.2007

Explorative surgery and curettage of the lesion on 11.

A marginal incision on the buccal side from 13d-22d was made. No realising incisions. The flap was elevated and the whole lesion appeared. Removal of about 1mm bone on the mesial aspect of the tooth was done to give the lesion free margins.

The lesion was rinsed by curettage with curettes. All undermined enamel was removed.



Figure 11

A U-formed matrix band was fit around the tooth and with this we kept the lesion dry.

The cavity was etched and dried. Prime&Bond. Tetric ceram A2.



Figure 12



Figure 13

The flap was replaced and fixed with 4 sutures.
Post operative information was given; the patient was instructed to rinse with corsodyl for a week.



Figure 14

A post operative radiograph was taken.



Figure 15

24.10.2007

Control and removal of sutures.



Figure 16

4 sutures were removed. The healing seemed to be good. The patient had experienced some pain since the surgery, but it had decreased.

Prognosis: The endodontic prognosis was good.
The prognosis for the cervical resorption seemed to be good as well.

Follow-up examinations: Follow-up was not possible on this patient. The reason for this was that he had moved to a residence abroad.

Discussion:

Pathologic root resorption is loss of hard dental tissue (i.e. cementum and dentin) as a result of osteoclastic cell action (Patel S & Pitt Ford T 2007) and can be classified based according to the site, nature, and pattern of the process (Benenati 1997, Ne 1999). Only resorption of primary teeth during exfoliation is considered physiologic (Hammarström & Lindskog 1985)

Resorptions may be internal or external. Cervical resorption is a form of external root resorption and may occur in any tooth in the permanent dentition (Heithersay G. 1999). The mechanism behind this pathological process is not fully understood but appears to follow an injury to the cervical attachment apparatus, most importantly to an area of the cervical root surface (precementum), below the epithelial attachment. Progressively, the resorption process will involve cementum, enamel and dentin, to eventually involve the pulp space late in the process (Heithersay 1999, Tronstad 1988)

It is important to realize that the pulp plays no role in this form of resorption and is usually normal in these cases, at least in the early stages of the condition (Tronstad 1988).

Clinical and radiological signs and symptoms of cervical resorption vary.

The condition is usually painless because the pulp remains protected by a thin layer of predentin and dentin until late in the process. If the pulp is influenced symptoms of pulpitis may occur (Trope & Chivian. Pathways of the pulp, 1994, Heithersay 1985). Occasionally a pink discoloration of the crown indicates the resorptive process. In early stages of the lesion a slight irregularity can be evident in the gingival contour. If the lesion is left untreated cavitation of the enamel overlying the resorbing tissue will occur.

The crestal bone is in most instances unchanged, unless there has been a superimposed periodontal ligament infection.

Radiograph features of the lesion vary from well-delineated to irregularly bordered mottled radiolucencies. A characteristic radiopaque line generally separates the image of the lesion from the root canal since the root canal is protected from the lesion (Heithersay 1999, Heithersay 2004)

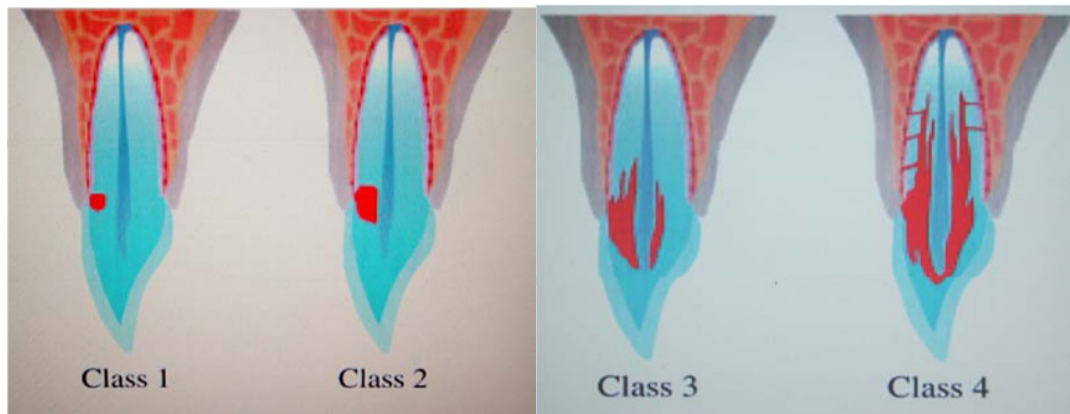
A classification system of the development of a cervical resorption:

Class 1 - Denotes a small invasive resorptive lesion near the cervical area with shallow penetration into dentine.

Class 2 - Denotes a well-defined invasive resorptive lesion that has penetrated close to the coronal pulp chamber but shows little or no extension into the radicular dentine.

Class 3 - Denotes a deeper invasion of dentine by resorbing tissue, not only involving the coronal dentine but also extending into the coronal third of the root.

Class 4 – Denotes a large invasive resorptive process that has extended beyond the coronal third of the root.



(Classification after Heithersay 1999)

Histologically the defect appears similar to any external inflammatory root resorptive defect. There is usually a small opening into the root, with large amounts of granulomatous tissue inside the defect and multinucleated giant cells resorbing the dentinal structure. In extensive defects, osseous tissue may be seen inside the granulomatous tissue, indicating quiescent periods in the process where healing with reformation of an attachment may have been attempted. Even in the most extensive defects, the predentin/odontoblastic layer is unaffected, demonstrating the resistant nature of this tissue (Trope 2002)

Resorption channels are created; these burrow deeply into the dentin surrounding the root canal and later interconnect more apically with the periodontal ligament. Ectopic calcifications can be observed in advanced lesions, both within the invading fibrous tissue and deposited on the resorbed dentin surface. (Heithersay 1999)

The circumpulpal dentin in close proximity to the predentin is often spared even though most of the peripheral dentin may have been resorbed which confirms the findings of Wedenberg 1987 and Nakamura 1996 in two separate studies that osteoclasts will not adhere to unmineralized matrix and that they are inhibited in contact with precement, predentin.

The aetiology of cervical resorption is unknown, but there are several predisposing factors. Heithersay 1999 looked at predisposing factors in 222 patients, 257 teeth were examined. The findings in this study indicated that orthodontics as a sole factor with 47 patients (21,2%) and 62 teeth affected (24.1%) were the most common factor of cervical resorption. This was followed by trauma with 31 patients (14.0%) and 39

(15.1%) affected teeth, surgery 13 patients (5.9%), bleaching 10 patients (4.5%), and periodontal therapy 4 patients (1.8%).

The treatment depends on the various classes of invasive cervical resorption, as the process becomes more complex, differing between non-surgical or surgical treatment will be required. The basic aims though are the same:

- Inactivation of the resorption tissue.
- Cover the unprotected root surface with a foreign material the clastic cells cannot be attached to or penetrate.

(Heithersay 1999)

Treatment of invasive cervical resorption has generally involved flap reflection followed by curettage of the defect and restoration with amalgam (Tronstad 1988, Frank & Bakland 1987), resin composite (Cvek M. 1994) or glass- ionomer cement (Cvek 1994, Heithersay 1985). Periodontal re-attachment cannot be expected with amalgam or composite resin, and is unlikely with glass-ionomer cement, but there is experimental evidence which suggest that this might be possible with MTA (Pitt Ford et al. 1995)

Guided tissue regeneration using Gore-Tex periodontal membrane material has also been tried out (Rankow & Krasner 1996)

In this case we decided to do a root canal filling despite of the status of the pulp and that the literature tells us that in most cases the pulp remains unaffected, at least in the stages 1 and 2.

The reason for this was that the radiographs gave an impression that the lesion was quite large and the clinical tests were not consistent. It therefore seemed likely that the lesion was in very close proximity to the pulp and that it was in danger of entering the pulp space. An endodontic treatment at this point would therefore give a better prognosis than if the pulp should get infected at a later stage and develop a apical periodontitis.

The opening of the cavum showed us that it was very close, but still was a thin barrier of dentin there protecting the pulp.

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CASE 13

Cervical resorption after a traumatic incident



Figure 1

Patient: A 12 years old girl was referred to the postgraduate clinic in endodontics from the clinic for treatment of children at the faculty of dentistry due to a cervical root-resorption in 11.

Medical history: Non-contributory

Dental history and chief complaint:

24.07.2001: The patient had an accident at home and a trauma towards the region 11/21. She went to the emergency dental-clinic near her home and composite was placed on both mandibular first molars to prevent the teeth from occluding.

31.07.2001: When she came back for control a week later the tooth was mobile II° and slightly extruded. Since there had been a week since trauma no attempt was done to splint the tooth. The patient had no symptoms at this point. The radiographs showed no signs of pathology.

06.08.2001: The control showed no altered signs or symptoms, only a slight tenderness to palpation in the vestibular mucosa.



Figure 2



Figure 3



Figure 4

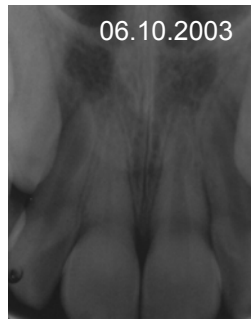


Figure 5

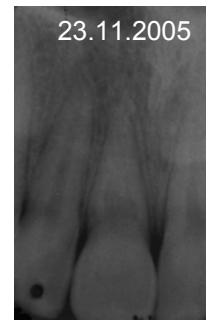


Figure 6

24.10.2005: The patient was referred to the department for children at the Faculty of dentistry because of cervical resorption in 11. She had a consultation there 23.11.2005 and they decided to refer her to the postgraduate clinic in endodontics. The tooth showed signs of obliteration in April 2003. The status was the same in October 2003. The control-appointments ceased after that and the resorption was discovered at a routine-control done in the autumn in 2005. It was noted in the referral that the tooth had responded positive to electric pulp testing at all controls including this routine control.

Clinical findings:

- Extra and intra-oral: The skin and oral mucosa are normal.
- Dental: No caries detected. No restorations. Dental plaque could be seen on the surfaces of the teeth and on the gingival margin.
- Periodontal: Normal marginal periodontal conditions.
- Occlusal: No abnormal occlusal interferences.

Clinical tests:

	12	11	21	22
EPT	43	65	32	46
Cold	Yes	No	Yes	Yes
Palpation	No	No	No	No
Percussion	No	No	No	No

Figure 6

Radiographic findings:



Figure 7



Figure 8

Periodontal:

The PDL was intact around all teeth.

Dental:

11: A radiolucent area could be seen in the cervical portion of the tooth stretching towards the distal aspect of the tooth. The findings could be consistent with a cervical resorption. There was no trace of the canal from mid-root to the apex.

12, 13, 21, 22: No apparent pathology was seen on these teeth.

Diagnosis:

Pulpal: The tentative diagnosis of the pulp of 11 would be that it was healthy.

Periodontal: Cervical resorption, K03.38.

Problem list:

The main problem would be the cervical area of the tooth. Due to the defect this area was very weak and it was a possibility that the tooth could fracture here. Another problem was the possible extension of the defect. In most cases it is larger than the radiographs tell us because it tends to create channels with anastomoses in between.

Treatment plan:

1. CT-scanning of the lesion to get an overview of the lesion.
2. Root canal treatment if the lesion affects the pulp.
3. Another alternative is surgical intervention. It depends on where the lesion is seated and the size of it.

Treatment:

07.02.2006: Clinical and radiographic examination. The patient is scheduled for a CT-scan to see the spreading of the lesion.

21.03.2006: The CT-scan gave a better picture of the extension of the lesion.

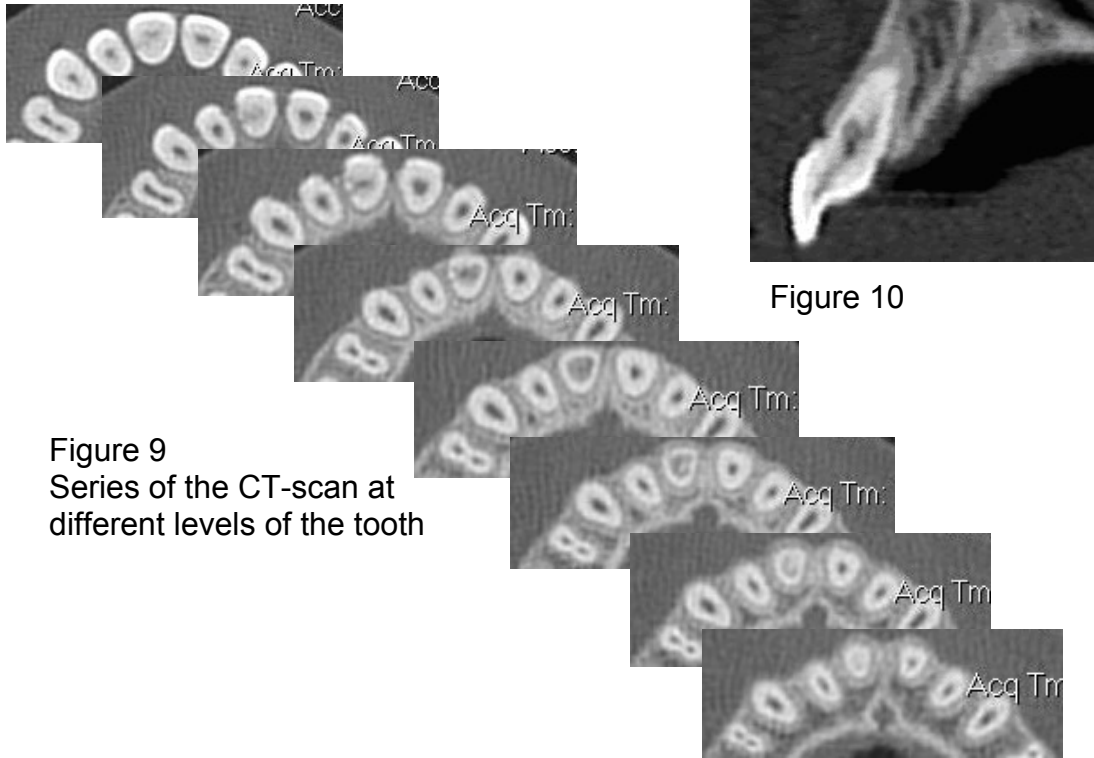


Figure 9
Series of the CT-scan at different levels of the tooth

Figure 10

The CT-scan showed that the resorption extended to the apical third of the tooth, and it was also quite broad in the circumferential aspect. It was seated towards the distal of the tooth in the cervical area where a small opening could be seen in the cervical area into the lesion (fig. 9). In the middle of the root the defect opens up to a large lumen before it becomes more and more sclerotic towards the apex fig. 9 and 10).

The resorption was classified as a grade 3-4, where 4 is the last stage; this was according to the classification after Heithersay (1999).

It was therefore decided to attack the resorption from the pulpal side since it was likely that it had involvement in the pulpal tissues.

Access cavity preparation was done and the canal entrance was located. Opening of the pulp cavity revealed massive amounts of resorption tissue and one could see that the lesion was stretching towards the distal aspect.

Calcified tissue with a sugar-like consistency was also present.

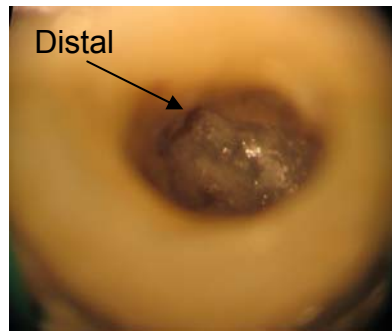


Figure 11

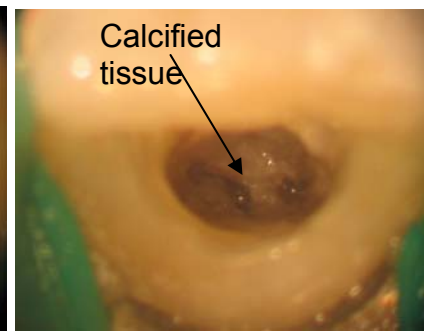


Figure 12

Rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol. In spite of the weak cervical area a butterfly-clamp was attached to the tooth. The canal could not be negotiated and a new attempt had to be done next appointment.

There was bleeding from the resorptive tissue which was stopped with a solution of FeSO_4 .

Irrigation-fluids used were NaOCl 1% and EDTA 16%.

$\text{Ca}(\text{OH})_2$ was used as intracanal medicament in the access cavity and a temporary IRM-filling was put on top.

05.04.2006:

Rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.

The root-canal treatment was continued and more resorptive tissue was removed from the canal with round burs and an ultrasonic device. A lot of osteoid-like-tissue and a lot of irregular dentin were seen.

Bur and ultrasonic was used as far down towards the apex as possible to shape the "canal", but no real root-canal could be found.

Irrigation-fluids used were NaOCl 1% and EDTA 16%.

$\text{Ca}(\text{OH})_2$ was used as intracanal medicament.

IRM was used as temporary filling.

23.05.2006:

Rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.

Since possible resorption-channels could be seen all the way down to the apex on the radiographs (figure 8) no further attempts was done to find the main root-canal. The lesion had created a perforation out into the PDL on the disto-palatal aspect; it could not be probed from the external of the tooth. There was no bleeding from the perforation. It was decided to finish the treatment.

The tooth was root-filled with MTA Angelus just below the cervical portion.

Fuji II LC was filled on top of the MTA sealing off the perforation on the distal aspect and a composite was placed on top of the glass-ionomer.

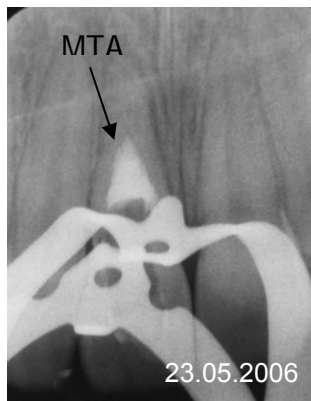


Figure 13

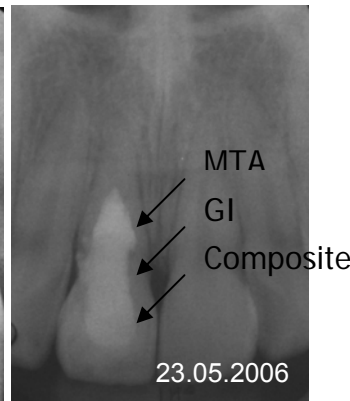


Figure 14

Irrigation-fluids used were NaOCl 1% and EDTA 16%.

There was no bleeding or seepage of fluid in the canal. The patient had no symptoms.

The decision to fill the tooth in one séance was taken to spare the patient for another treatment-session.

Prognosis:

The prognosis is uncertain both in an endodontic and restorative manner.

Follow-up examinations:

14.02.2007:

An OPG and a dental radiograph were taken. No visible pathology on the radiographs. The PDL seemed to be intact around the whole root of 11. The patient had no symptoms. No tenderness to palpation or percussion. The patient and her parents were informed of the prognosis of the tooth.

The patient was dismissed and further controls were to be done at the National Health Service where she lives.

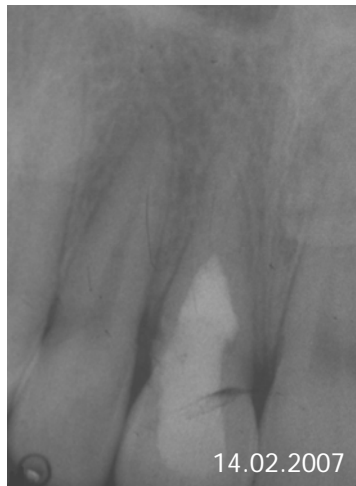


Figure 15

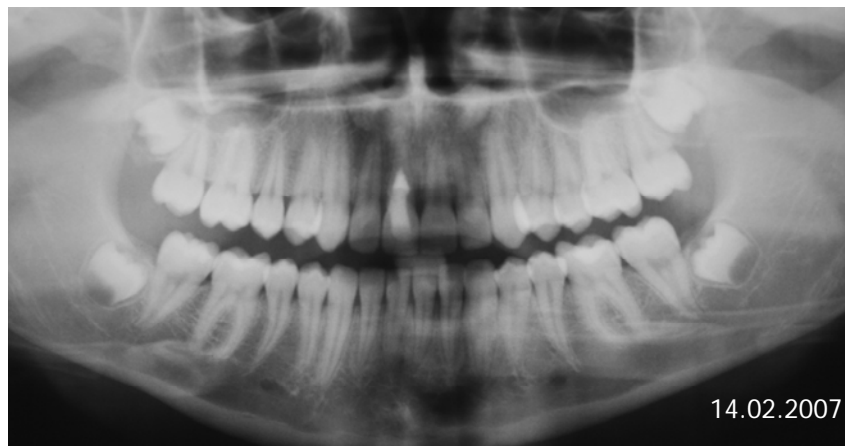


Figure 16

Discussion:

The etiology of root resorption requires two phases: injury and stimulation (Tronstad 1988, Trope 1998). Injury is related to non-mineralized tissues covering the external surface of the root, the precementum, or internal surface of the root canal, the predentin. The injury is similar to several types of root resorption and may be mechanical following dental trauma, surgical procedures, and excessive pressure of an impacted tooth or tumour. It may also occur, following chemical irritation, during bleaching procedures using hydrogen peroxide 30% or other irritating agents (Friedman 1998).

For cervical resorptions it has been postulated that bacteria in the sulcus of the tooth stimulate and sustain an inflammatory response in the periodontium at the attachment level of the root and therefore the pulp plays no role in this type of resorption (Tronstad 1988).

As the lesion progresses it may eventually reach into the pulp. This was the status of this tooth. When opening an access cavity a lot of granulation tissue and deformed calcified tissue were present. It was therefore assumed that it was a chance that the pulp had been invaded by bacteria. Thorough chemo-mechanical cleansing and the need for a period with $\text{Ca}(\text{OH})_2$ were therefore necessary.

But since it I was unable to find the apical part of the canal and the resorption was so extensive it is doubtful that the whole pulp-space together with all the possible resorption channels has been cleaned thoroughly.

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CASE 14

Rotational and intentional replantation after traumatic injury



Figure 1

Patient: 37 years old white, female from Eastern Europe was referred to the postgraduate clinic in endodontics from the postgraduate clinic in prosthetics. This was due to a complicated crown-root fracture in her left lateral incisor.

Medical history: Non - contributory

Dental history and chief complaint:

The patient had a cross-country skiing-accident in mid December 2006. She fell and one of the ski-poles hit her maxillary front teeth. She felt discomfort from the maxillary front teeth for some time afterwards but there were no specific or severe symptoms.

According to the patient right before Christmas the tooth felt a bit elongated compared to the other teeth and it was also mobile. She had some antibiotic at home which she took.

In the beginning of January 2007 she sought treatment at the faculty of dentistry in Oslo. The tooth had got an oblique fracture towards the palatal aspect.

The remaining root was gently extracted, rotated a 180° and put into place in the alveolus again. The procedure was done at the department of oral medicine and surgery. The patient was referred to the postgraduate clinic in prosthetics for further treatment and from there referred to the postgraduate clinic in endodontics.

Clinical findings:



Figure 2



Figure 3

Extra oral:

Normal skin.

Intra oral:

The oral mucosa around 21 and 22 showed signs of extensive gingivitis. A lot of plaque was seated around her front teeth both on the buccal and the palatal aspects.

Dental:

21: The tooth was tender to percussion and palpation. A yellowish discoloration was seen on the palatal aspect of the tooth.

22: Had no crown, only the root was standing in the alveolus. The canal of 22 was left open to the oral cavity. Only a buccal shell of composite bonded to the two neighbouring teeth 21 and 23 covered the buccal surface of the tooth, this for aesthetic reasons. A lot of food and plaque was impacted behind this shell and into the root.

The tooth was very tender to palpation. A percussion-test was difficult to carry out.

There was no mobility of the neighbouring teeth. Electric pulp-testing or thermal-tests were not done on any of the teeth.

Periodontal:

The pocket depths seemed to be within normal limits. There was gingivitis and bleeding on probing.

Other:

Since it was urgent to get started on the treatment of 22 we choose to concentrate on this tooth first. It was uncertain if 21 had to undergo a root canal treatment, but the tooth showed possible signs of inflammation and was kept under strict control.

Radiographic findings:



Figure 4

Periodontal: The marginal periodontal conditions seemed to be normal.
21: The PDL could be followed around the whole root.
22: Only the root was standing in the alveolus. The contours of the original alveolus could be seen bending towards the distal. The root was bending towards the mesial which indicated that the root had been turned around.
No visible PDL was seen around the root.

Dental: No caries was seen on the radiograph.

Diagnosis: Pulpal: Necrotic tooth 22, K04.11

Periodontal: Possibly apical periodontitis, K04.50

Problem list: The periodontal conditions around the tooth were uncertain since an intentional replantation had been done some few weeks before. The tooth seemed firm, but if any new attachment had started forming was uncertain. Great care was therefore taken not to get the tooth out of position.
Even though a successful root canal treatment may be achieved there are a lot of factors that have an influence on the prognosis of the tooth: Time before treatment was started, the root canal left open for several weeks, what kind of attachment would be achieved after extrusion and rotation.

Treatment plan: 1. Treatment of necrotic pulp 22

2. Extraction

Treatment:

14.02.2007: Consultation, clinical examination, radiographs and clinical photos. Not treatment was started at this session because there was no time. The patient had just got an emergency appointment.

21.02.2007: Anaesthesia: 1 carpule of Xylocaine® with adrenaline. An electrotome was used to remove excess of gingiva which had grown over the tooth. Rubberdam was applied. Used a split-dam attached to the neighbouring teeth. The uncovered gingiva under the rubberdam was sealed with opal-dam. The working field was disinfected with a solution of 5% chlorhexidine in 70% ethanol.



Figure 5



A working length was determined with the aid of an apex-locator and a radiograph: K15/14.0mm/P adjusted to 13.5mm.

Figure 6

NiTi-handfiles were used to shape and clean the canal to size #45.

Irrigation-solutions used were NaOCl 1% and EDTA 16%.

Ca(OH)₂ was used as intracanal medicament.

A temporary filling of IRM sealed the canal entrance and the temporary crown was cemented with Nobotec and

attached to the neighbouring teeth with composite Tetric flow.

20.03.2007:

The patient had not had any pain in the tooth since the last appointment.

Anaesthesia: 2 carpules of Xylocaine® with adrenaline. Rubberdam was applied. Used a split-dam attached to the neighbouring teeth. The uncovered gingiva under the rubberdam was sealed with opal-dam. The working field was disinfected with a solution of 5% chlorhexidine in 70% ethanol.

A master-cone radiograph was taken; #45/13.5mm/P. The tooth was root-filled with gutta percha and AH+.

Irrigation-solutions used were NaOCl 1% and EDTA 16%. A temporary filling of IRM sealed the canal entrance and the temporary crown was cemented with Nobotec and attached to the neighbouring teeth with composite Tetric flow. A post operative radiograph was taken.



Figure 7



Figure 8

Prognosis:

The prognosis is considered to be uncertain.

Follow-up examinations:

12.06.2007:

3 month follow-up.



Figure 9

The patient had not had any symptoms from the tooth. It was no tenderness to palpation or percussion in the area.

The patient had to do a root-canal treatment on the 21 because of necrosis in the tooth. This was already indicated during the treatment of 22 and the endodontic treatment was started only a few weeks after finishing 22.

27.11.2007:

8 months follow-up.



Figure 10

The patient had no symptoms.

No obvious pathology could be seen on the radiograph. The PDL seemed to be slightly blurry around the apex but could be followed uninterrupted around the whole root. No signs of external root-resorption at this point.

She had no received a post in the tooth and it was ready to be crowned.

Discussion:

22 underwent a rotational, intentional replantation because it was a complicated crown-root fracture and the tooth was difficult to treat endodontically and restore due to the loss of the coronal fragment.

According to Grossman (1982) intentional replantation is “the purposeful extraction of a posterior tooth to perform extra-oral endodontic treatment, curettement of apical soft tissue when present, and the replacement of the tooth into its socket.

The treatment should be limited to those cases in which routine endodontic treatment cannot be achieved, or where it has failed and the prognosis for retreatment is poor”. Although no root treatment of any kind was done at the point of extraction on this tooth, it was removed from its socket and replaced in a rotated position. But surgical extrusion may perhaps also fill the requirements of the definition of the treatment.

Several studies have been done to investigate the prognosis of teeth exposed to this treatment.

Emmertsen and Andreassen (1966) reported a study of 100 teeth that had undergone intentional replantation and observed from one to 13 years. There was no evidence of root resorption in 67%. Inflammatory resorption was present in 27% and replacement resorption in 4 %.

Grossman (1966) reported 45 intentionally replanted teeth that were observed from 2 to 11 years, average 5.6 years. There was no radiographic evidence of either root resorption or periapical involvement in 28 teeth, 8 teeth showed inflammatory or replacement resorption, 9 teeth were failures. That is an overall success rate of 62%. This in comparison to:

Andreasen and Hjørting-Hansen (1966) did a study where 62 teeth were root-filled prior to replantation, 30 teeth underwent endodontic treatment 2 weeks to 3 months after replantation, and 18 teeth received no endodontic treatment.

No difference in the result of replantation was found between immediate and later root-filling of replanted teeth.

90% of teeth replanted less than 30 minutes after loss showed no resorption, a slightly lower frequency was found from 31-90 minutes, the majority of teeth replanted 90 minutes or more after loss showed resorption.

Only 27 teeth showed no resorption, 20% of these teeth were followed more than one year. The teeth in this study were teeth replanted after avulsion.

The prognosis of teeth intentionally replanted seems to have a higher success. This may be because the periodontal ligament of intentionally replanted teeth is not severed, unlike on teeth that are accidentally avulsed and replanted. If root resorption occurs it is caused by the damaging pressures to the PDL during the extraction (Grossman 1982).

The prognosis on this tooth is different . Even though the procedure of extraction and replantation seemed to be successful the tooth had been subjected to severe inflammation and infection weeks before, during and after this procedure took place. In addition, the tooth had to receive a post afterwards which also compromised the prognosis of the tooth. It is shown that 3 to 10% of root fractures are due to post and cores (Hatzikyriakos et al. 1992, Turner 1982). The overall prognosis of the tooth would therefore be most uncertain.

Reference list:

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CASE 15

Horizontal root fracture after a traumatic incident



Figure 1

Patient: 28 year old Norwegian female came to the private dental clinic where I work because of a pain in her maxillary right central.

Medical history: Non-contributory.

Dental history and chief complaint:

The patient came to the clinic because of a root fracture in 11. She also had problems with pain and swelling in the area.

During her holiday in Russia in January 2006 she fell on the ice and fractured her maxillary front teeth.

Immediately after she came home she sought her dental practitioner at that time and started treatment. She had also received emergency treatment when she was in Russia.

The treatment at the other clinic lasted from February 2006 to June 2006.

Recordings of the clinical findings and treatment from the previous dentist:

	11	12	21
Sensibility-tests	No recordings	No recordings	No recordings
Percussion	+	+	+
Palpation	No recordings	No recordings	No recordings
Mobility	+	+	-
Diagnosis (Tooth)	Crown fracture, non-complicated Root-fracture in the apical 1/3	Crown fracture in the enamel/cement border, complicated	Complicated crown fracture
Diagnosis (Endodontic)	?	Necrosis	Necrosis/extirpated in Russia
Treatment done	Wait-and-see	RCT	RCT

Figure 2

Radiographs taken by the previous dentist; date unknown.



Figure 3



Figure 4

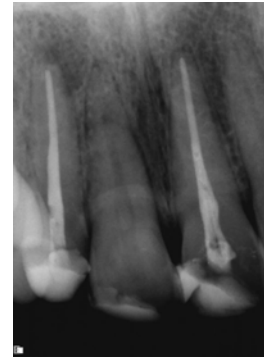


Figure 5

The radiographs showed that 12 and 21 had undergone endodontic treatment.

The root fracture on 11 was visible but no obvious pathology was present.

Clinical findings:

10.07.2006:

	12	11	21	22
Endo-ice	-	-	-	+
Percussion	-	+	+	-
Palpation	-	+	-	-
Mobility	-	+	-	-
PPD	WNL	WNL	WNL	WNL

Figure 6

The tooth 11 was fixed to 21 with composite, but 11 had not been entirely repositioned after the accident. When palpating the buccal side the root could be palpated and it was sticking a bit out towards the buccal aspect. The patient confirmed that the crown of the tooth was pushed a bit further against the palatal than before.

Radiographic findings:



Figure 7

Periodontal:

12: The PDL could be followed from the coronal down to the apex on the distal and mesial side. Around the apex, centred towards the mesial a radiolucent area of approximately 5-6mm in diameter was seen. There were possibly signs of root resorption on the apex.

11: A horizontal root-fracture in the apical 1/3 could be seen. Radiolucent areas were seen around the mesial and distal aspect of the fracture, but the PDL seemed to be more widened on the mesial side. The PDL was intact around the apex.

21: The PDL seemed to be normal and could be followed around the whole root.

Dental:

12: The tooth had a coronal filling in composite. The tooth was root filled. The root filling seemed to be stretching into the pulp chamber. A coverage of composite was lying on as a top filling.

11: A composite filling was lying on the incisal edge towards the distal aspect. It seemed to be close to the distal pulp-horn. The root-canal had a radiopaque oval-shaped structure lying in the cervical third which resembled a pulp-stone in structure. The canal was discontinued by the horizontal fracture line.

21: A composite filling was lying on the mesio-incisal aspect of the tooth. A small gap between the filling and the tooth was evident on the radiograph. The tooth was root-filled. The root-filling seemed to be stretching into the pulp chamber.

Diagnosis:

Tooth 11: Crown fracture, uncomplicated. S02.51
Root fracture in the apical 1/3. S02.53

Pulpal 11: Necrotic pulp, coronal fragment. K04.11

Periodontal 11: Lateral periodontitis in conjunction with the root fracture. K04.51

Treatment plan:

1. Root canal filling of the coronal fragment of 11

Alternatively

2. Extraction of 11, coronal fragment

Treatment:

10.07.2006: Consultation.

27.07.2006: Access cavity preparation revealed that the pulp indeed was necrotic. Rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.
WLR: K15/17mm/l



Figure 8

Root-canal instrumentation was done with NiTi and SS-handfiles to size #80.

Irrigation was done with 1% NaOCl/16% EDTA.
Interappointment dressing with Ca(OH)_2 .

Instrumentation was done only down to the fracture in the root.

10.08.2006:

The tooth was still tender to percussion and palpation, but it had improved since the last appointment. Rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.

The Ca(OH)_2 was changed. A radiograph was taken before treatment and the Ca(OH)_2 seemed to have been washed out of the canal in the fracture area (fig. 9). And since she still had symptoms new Ca(OH)_2 was therefore filled in. When a radiograph was taken after the session one could see that Ca(OH)_2 had been pushed out into the fracture area.

Irrigation was done with 1% NaOCl, 16% EDTA.

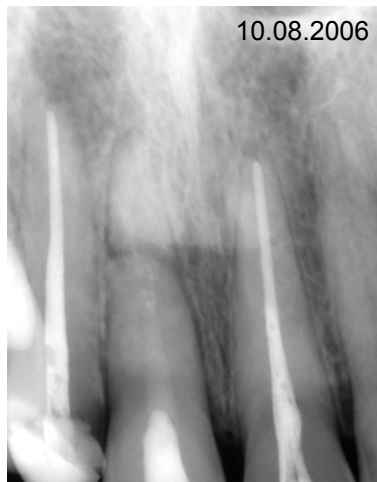


Figure 9
Before the treatment session.
Ca(OH)₂ washed out.

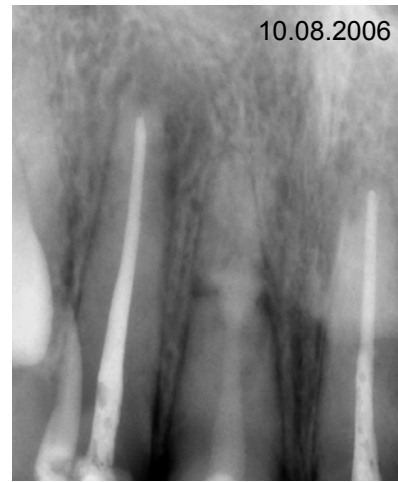


Figure 10
After the treatment session.
Ca(OH)₂ pushed into the
fracture area.

27.09.2006:

The tooth had fewer symptoms than last time, but it still was a bit tender to percussion and palpation. Rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.

The working length was adjusted with apex locator to 15.5mm and the canal was instrumented to size #100. Even though a size #100 was used the file went easy down to the fracture area.

New Ca(OH)₂ was filled in the canal.

Irrigation was done with 1% NaOCl and 16% EDTA.

16.10.2006:

Filling with MTA.

The tooth was not totally free of symptoms. The patient felt tenderness to percussion and palpation but it was decided to go forward with the filling with MTA despite of the symptoms.

Rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.

It was difficult to get the canal totally dry so a small plug of Ca(OH)₂ was condensed out in the opening of the fracture to stop the tissue-fluid from entering.

The tooth was root filled with white MTA (ProRoot) and a moist cotton pellet was placed on top of the MTA to facilitate setting.

Irrigation was done with 1% NaOCl and 16% EDTA.

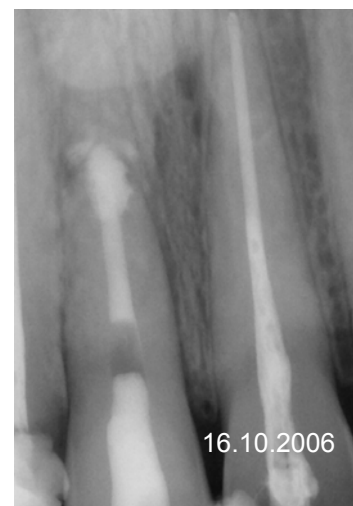


Figure 11

IRM was used as temporary top-filling.

26.10.2006:

Rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.
The MTA was set.
A top-filling of IRM and composite was laid onto the MTA.



Figure 12

Prognosis:

The prognosis was uncertain.

Follow-up examinations:

04.05.2007:

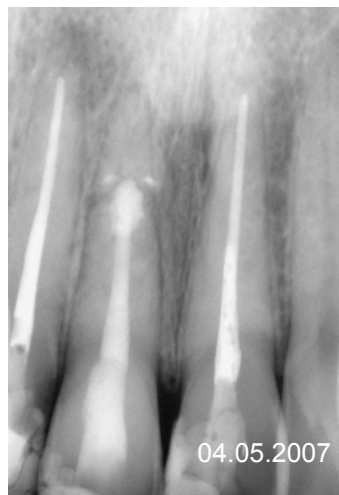


Figure 13

The patient had no symptoms from the area. No tenderness to percussion, but 11 had a bit altered feeling. No tenderness to palpation and no mobility.

The radiolucent area on both sides of the fracture especially on the mesial aspect of the tooth seemed to have disappeared.

Discussion:

Trauma to the oral region occurs frequently and comprises 5% of all injuries for which people seek treatment (Glendor, Marcenes, Andreasen 2007, Petersson 1997)

Traumatic injuries can be classified into:

Injuries to the hard dental tissues, which comprises enamel infraction, enamel fracture, enamel-dentin fracture, complicated crown fracture, uncomplicated crown-root fracture, complicated crown-root fracture, and root-fracture.

Injuries to the periodontal tissues, which comprises concussion, subluxations, extrusive luxation, lateral luxation, intrusive luxation, and avulsion.

Injuries to supporting bone, which comprises comminution of alveolar socket, fracture of alveolar socket wall, fracture of alveolar process, fracture of mandible of maxilla.

Injuries to the gingiva or oral mucosa (OM), which comprises laceration, contusion or abrasion. (Glendor, Marcenes, Andreasen 2007).

Management of traumatic injuries include, after examination and diagnosis, urgent care if indicated and definitive treatment. The latter requires planning both for the immediate and the long-term care (IADT Guidelines 2001).

The prevalence of root fractures ranges between 2% and 7% of the total of injuries to teeth, depending on whether primary or permanent teeth are involved (Forsberg & Tedestam 1993, Andreasen & Andreasen 1990). The maxillary central incisors are most commonly involved, making up 80% of cases (Forsberg & Tedestam 1993, Andreasen & Andreasen 1990).

Type of healing with fractures was classified according to the criteria listed by Andreasen & Hjørting-Hansen (1967):

1. Healing with interposition of hard tissue: healing with hard tissue, fragments are in close contact and the fracture line is not visible or indistinctly outlined.
2. Healing with interposition of bone and soft tissue (PDL) between the fragments: Fragments are separated by ingrowths of hard tissue surrounded by periodontal ligament-like soft tissue.
3. Healing with interposition of soft tissue (PDL): fragments are close but separated by a distinct radiolucent line and there is rounding-up of the fracture edges.
4. No healing: persistent or a widened space between the fragments and the presence of a radiolucency in the alveolar bone adjacent to the root fracture.

Cvek et al (2002) studied 94 incisors with transverse fractures limited to the cervical third of the root and oblique fractures involving both the cervical and middle parts of the root. They found healing of the fracture with hard tissue in 18%, healing with PDL and sometimes hard tissue in 66% and no healing with radiolucency adjacent to the fracture in 16%. Positive sensibility at the time of injury was significantly related to both healing and hard tissue repair. They also found that immature teeth had a better chance of healing than those with closed apices. The same applied to concussion or subluxation compared with dislocation of the coronal fragment, as well as optimal compared to suboptimal reposition of displaced coronal fragments. 44% of teeth with

transverse fractures and 3% of those with oblique fractures were lost after healing had taken place.

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CASE 16

Hemisection of the mesial root of a mandibular left first molar



Figure 1

Patient:

The patient, a 39 year old man, was referred to the postgraduate clinic in endodontics from the student clinic due to an instrument fracture in the mesio-lingual canal and a perforation in the furcation area near the mesial root.

Medical history:

Non-contributory

Dental history and chief complaint:

The patient needed a root canal treatment in 36 and started the treatment at the student clinic in august 2005. A bridge was planned in the area and the 36 was going to function as an abutment in the bridge. Due to the closeness to the pulp the tooth was scheduled for root canal treatment.

During the first session, fig. 2 & 3, the student fractured a file in the ML-canal of 36 and made a perforation in the furcation close to the mesial root. The patient was referred to the postgraduate clinic for further treatment.



Figure 2



Figure 3

Clinical findings:



Figure 4



Figure 5

Extra oral:

No remarks on the extra-oral conditions.

Dental:

33 was sound.

34 was missing.

35 had an MOD composite filling with a retaining pin towards the lingual aspect. The lingual cusp was fractured off.

36 had a large temporary in the pulp chamber, only some of the crown on the buccal side of the tooth was remaining.

37 had a metal ceramic crown.

Periodontal:

36 had a furcation involvement grade II and the gingiva had retracted on the buccal side of the tooth. An IRM was visible in the furcation area. No other periodontal problems.

Occlusal:

No abnormal occlusal interferences.

Radiographic findings:



Figure 6

Periodontal:

36 had bone loss in the furcation area, and a radiolucent zone of about 4mm in diameter could be seen there.

Otherwise, the marginal periodontal conditions were normal.

The periapical conditions were normal on all teeth in the area.

Dental:

35 had a composite filling.

36 had an IRM in the cavum which was pushed into the furcation due to a perforation in the furcal area. A part of a broken instrument could be seen in the mesial root of 36 in the middle-third.

37 had a metal ceramic crown.

Diagnosis:

Pulpal: Necrotic pulp 36, K04.11, with a fractured instrument,

Periodontal: Interradicular periodontitis 36, K04.51

Treatment plan:

While retrieval of the instrument and repair of the furcation perforation might be technically possible, the prognosis would be uncertain and subsequent persistent infection might jeopardize the bridge in planning. Therefore, the following was planned:

1. Root canal treatment of the distal root of 36.
2. Hemisection of the tooth in the furcal area and extraction of the mesial root.

Problem-list:

The root filling itself was considered unproblematic. The preservation of tooth structure and preparation of the distal root's mesial aspect needed special attention for the root to serve as a valuable abutment.

Treatment:

25.01.2006:

Rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.

The working-length was determined with an apex-locator (Root ZX, Morita) and a radiograph:
K25/19mm/dbc- correction to 18mm.



Figure 7

The canal was shaped with NiTi-files up to size 60 and irrigated with NaOCl 1% and EDTA 16%.
Ca(OH)₂ was used as intracanal medicament and IRM as temporary top-filling between appointments.

14.02.2006:

Rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.

A Master-cone radiograph was taken: #60/18mm/dbc.

The canal was root filled with gutta percha and AH⁺.

An IRM-plug was fitted into the canal entrance about 2-3mm in.

Irrigation with NaOCl 1% and EDTA 16%.

IRM was used as temporary top-filling.



Figure 8



Figure 9

The tooth was divided in the furcation area with a high-speed hand piece. The mesial root was gently extracted with a chisel and a forceps.

Unfortunately a radiograph after the extraction of the root was not taken.

Prognosis:

The prognosis was considered to be good for the endodontic treatment.

The prognosis for the remaining tooth was also good as long as the load on the tooth didn't get too heavy

Follow-up examinations:

16.03.2006:

The patient had no pain from the area. The tooth was not tender to percussion or palpation. The gingiva had healed nice. Still the extraction-alveolus could be seen on the radiograph, but the remaining distal root looked as if it had a



Figure 10

healthy surrounding periodontium.
The patient had still not received a permanent filling on the tooth.

09.06.2006:

No symptoms were present. The tooth was not mobile. The bone had healed well after the extraction. The PDL was still intact around the remaining root. The only negative thing was that the patient still had a temporary filling in the tooth, but it seemed to be intact. The patient said that he was scheduled for a bridge preparation in the autumn.

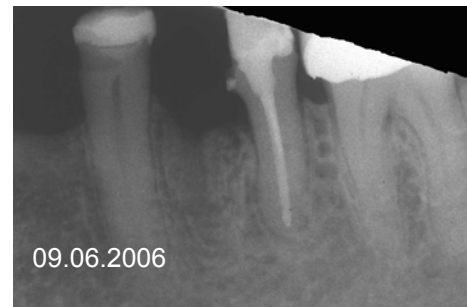


Figure 10

Discussion:

Pulp chamber floor perforations caused by resorptive defects, caries or iatrogenic events during endodontic procedures are undesirable damages. It creates an artificial communication between the root canal system to the supporting tissue of the teeth and the oral cavity (Fuss & Trope 1996). The frequency of root perforations has been reported to range from 3-10% (Lea & Febiger 1985, Seltzer et al 1967). Factors that affect the prognosis of perforation repair include time delay before the repair, location of perforation, ability to seal the defect and previous contamination with microorganisms (Roda & Gettleman 2006).

It is important to seal the perforation as soon as possible. Seltzer S and associates (1970) made artificial perforations in the pulp chamber floor in monkeys' teeth. Some of the perforated teeth were sealed immediately, some left open for a while before sealed and some not sealed at all. The monkeys were killed at intervals from one week to 18 months and the periodontal effects of the root perforations were evaluated. The reaction ranged from mild to severe, where the most severe reactions occurred when the perforated regions were not sealed immediately.

In the present case, the perforation represented an uncertainty for an unforeseeable future. When seeing the tooth clinically it was no doubt what had to be done. There were several months since the perforation had been sealed temporary and infection was obvious in the furcal area. It was therefore decided to do the hemisection procedure and maintain the distal root.

A hemisection is defined as the removal of half of a tooth performed by sectioning the tooth and removing one root. Root resection generally indicates the removal of a root whether or not the crown of the tooth (Shilinburg et al. 1997).

Using hemisection to preserve multirooted teeth that have furcation involvement has increased over the last years. A reported failure rate of 13.1% has been found over 5-10 years and comparing the results with implants the failure rates of the two treatments were not so different (Bühler 1994). Fugazzotto (2001) reported success rates ranging from 95.2% to 100% for various root resected molars in function. Only resection of the distal root demonstrated a lower success rate of 75%. Implants used in molar position had a success rate ranging from 97% to 98.6%. All the teeth and implants were restored with porcelain fused to metal crowns. Treatment with extraction and implant was also discussed, but the patient Opted for hemisection and root filling.

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CASE 17

Treatment of tooth with long-standing pain



Figure 1

Patient: A 55 years old man was referred from his private dental practitioner because of long-standing pain in the left side of the maxilla.

Medical history: Non-contributory

Dental history and chief complaint:

The patient had for the last 3-4 years experienced pain in his left side of the maxilla. The pain came especially when he was out travelling by aeroplane or even when he experienced changes in ambient pressure in daily life. The pain was so severe that he had to take painkillers when he was going out flying. During the early pain-period normal NSAID painkillers like panodil and pinex helped, but later on Codein-containing preparations as Paralgin Forte was necessary. Even using these medicaments did not ease the pain during flights.

In October 2005 the tooth 24 was root-filled by his dental practitioner under suspicion of the diagnosis pulpitis. After finishing the treatment the patient was out flying again and the pain was still the same.

He said that the pain was strong and intense and started when the plane had reached normal height. It came and went in waves but was so excruciating that he almost couldn't bear it. It stopped when the plane landed.

Once he even felt pain when driving over the mountain, but not as severe as when he was out flying.

The patient had difficulties of locating the source of the pain, but felt that it came from the roots of the teeth in the left side of the maxilla.

He sometimes also had pain reactions when he drank cold and warm drinks.

His dental practitioner referred the patient to the faculty of dentistry because he couldn't find any reasonable cause for the pain.

Clinical and radiological findings:

14.02.2006:



Figure 2



Figure 3

	24	25	26
EPT	-	No reaction	No reaction
Cold	-	Yes	Yes
Hot	-	-	-
Percussion	No	Vertical/horizontal	Vertical
Palpation	No	No	No
Periodontal	Loss of attachment	Loss of attachment	Loss of attachment, furc. involvm II
Restoration	Temporary crown	MOD Amalgam	MODL Amalgam
Radiograph	Root-filled Normal PDL	Normal PDL	The PDL seems to be normal.

Figure 4



Figure 5

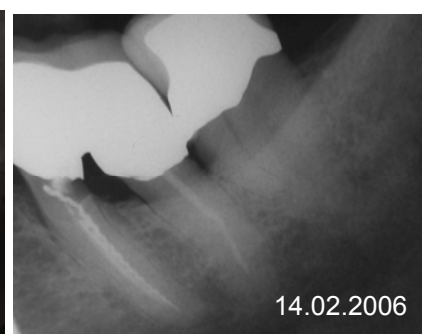


Figure 6

In addition radiographs were taken in the 4th quadrant. The patient had a metal-ceramic bridge stretching from 34-37. There was no tenderness to percussion or palpation in the area. 36 had a furcation involvement grade III and caries could be detected on the mesial root. This was confirmed on the radiograph. The tooth also had

a root canal filling and a broken instrument was seen in the mesial root. But there were no changes in the PDL.

It was clear that the patient reacted to changes in ambient pressure, but it was difficult to decide if the teeth were involved. The patient was instructed to be more aware if anything was provoking the symptoms to arise.

He was also instructed to seek his medical practitioner and have a CT-scanning of the sinuses done.

The patient was advised to do something about the problems in 36 and the referring dentist was noted about the problem.

The electric pulp test was used, but it gave no reflection on any teeth.

01.03.2006:

26 had possibly revealed itself to be a bit more painful than the other teeth, especially to hot and cold. The pain was not lingering and stopped immediately when the provoking agent was taken away.

It was decided to remove the amalgam filling in the tooth. There was caries under the filling, but no communication to the pulp. An infraction-line was seen stretching from the mesial to the distal aspect centred round the palatal cusp. An IRM covered with Fuji II LC was used as temporary.

The patient was instructed to wait-and-see for 1-2 months if the symptoms abolished or got worse.

30.03.2006:

The results from the Ct-scan revealed no abnormalities in the sinuses. Everything was normal.

18.04.2006:

After speaking with the patient in the telephone it was decided to schedule him for another appointment. The pain was still there, also more in every day life than before. The patient could tell that it was more painful with hot and cold food.

09.05.2006:

	24	25	26
Cold	-	Normal	Painful
Hot	-	Normal	Very painful
Percussion	No	Yes	Yes
Palpation	No	No	No

Figure 7

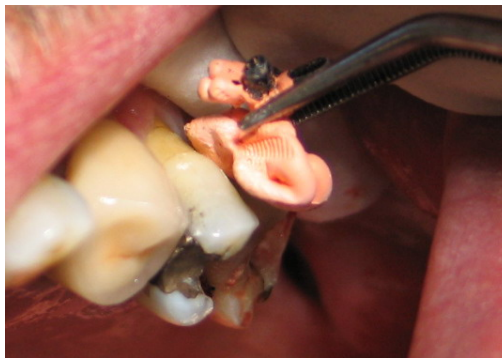


Figure 8

When warm gutta-percha was put onto the surface of 26 it was very painful and the pain lasted for a while but not very long. On 25 he could feel the warm GP but it was not painful. The teeth were isolated with vaseline before the warm gutta-percha was laid onto the tooth surface.

Diagnosis:

Pulpal: Chronic pulpitis 26, K04.03

Periodontal: Normal periodontium

Problem list:

The tooth had very long and curved roots.

Treatment plan:

Pulpectomy of 26

Treatment:

09.05.2006:

An access cavity was made and it was bleeding from all canals.

Rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.

Working lengths were only found only with the aid of an apex-locator.

MB: K10/24mm/mbc

DB: K15/25mm/dbc

P: K30/25mm/P

No further rinsing was done, a eugenol-pellet was put in the access cavity and IRM was used as temporary filling.

06.06.2006:

When the patient came back he said that he hadn't felt any pain since the last appointment.

Rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.

A working length radiograph was taken:

MB1: H15/24mm/mbc – 23mm

MB2: K15/25mm/pc – 24mm

DB: K20/23mm/dbc

P: K30/25mm/mbc – 24mm

The canals were rinsed to size #35 with NiTi-handfiles.
Irrigation-solutions used were 1% NaOCl and 16% EDTA.
Ca(OH)₂ was used as intracanal dressing.

It was very difficult to rinse and shape the mesial canals because of the curvature of the roots.
The build up on the tooth fell off so a new working length radiograph was necessary the next appointment.

23.08.2006:

Rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.

A new working length radiograph was taken:

MB: K15/21mm/mbc

MB2: H15/22mm/pc

DB: H20/20mm/dbc

P: K30/23mm/mbc – 22.5mm



Figure 9



Figure 10



Figure 11

The radiographs showed that the mesial canals ended in separate roots.

The MB and MB2 canals were rinsed to size #40.

The DB canal was rinsed to size #45.

The P canal was rinsed to size #60.

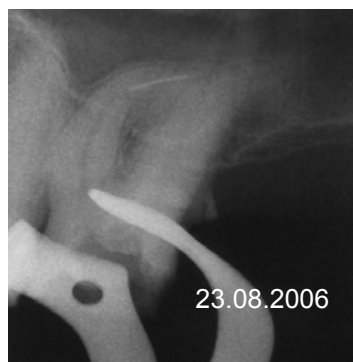


Figure 12

Unfortunately a file of size #40 fractured in the MB-canal at the apex, a piece about 3-4mm long. This was impossible to retrieve and had to be left there.



A master-cone radiograph was taken.
The tooth was root-filled with AH⁺ and gutta-percha.

Irrigation-solutions used were 1% NaOCl and 16% EDTA.

Figure 13

Post operative radiographs were taken.



Figure 14



Figure 15

Prognosis: The prognosis was good.

Follow-up examinations:

18.09.2007: One year follow-up.



Figure 16

The patient was very satisfied. He had not felt any pain since the root treatment started. He had been out flying several times the last year and had been totally pain-free.

The radiograph showed no signs of pathology around the roots. The tooth had been crowned.

Discussion:

Subjects exposed to a sudden reduction or increase of ambient pressure may sometimes complain of toothache. This problem is called barodontalgia. The pain is a result from a combination of two basic factors; change in pressure and the particular anatomical characteristics of the pulp chamber, which is richly innervated tissue surrounded by hard, rigid walls (Gonzales-Santiago 2004). The pulp will therefore be unable to adapt to an increase or decrease in pressure and thus pain is created.

A definition of barodontalgia would therefore be dental pain resulting from the inability of the pulp chamber to balance its internal pressure after changes have occurred in ambient pressure (Goethe 1989).

Barodontalgia may arise if entrapped air in carious lesions, defect fillings or infractions causes a stream of fluid in the dentinal tubules during flights. Nerve-endings in the pulp/dentin are affected via the dentinal tubules and this elicits a pain response. (Brännstrøm 1972, Jagger 1997). The pain reactions may be explained through the hydro-dynamic theory, with the stream of fluid in the dentinal tubules (Pashley 1996). If there is an outward movement of the fluid in the dentinal tubules the odontoblasts will be dragged towards the walls in the tubules and nerve fibres in close vicinity will be squashed between the wall and the odontoblast (Brännstrøm 1972). This may cause a sharp and localized dentinal pain and may be due to extreme reduction in pressure, as one can experience with cold against the dentin surface (Brännstrøm 1972, Brännstrøm 1992). If there is an inward movement of the contents in the tubuli another type of pain will arise. This pain has usually a slower onset, is longer in duration and may be described as a dull and aching pain (Brännstrøm 1972, Brännstrøm 1992). The two types of pain is the same as the description of the pain in A δ -fibres, which are fast conducting fibres, and C-fibres, which are slow conducting fibres, respectively (Bender 2000).

The type of pain described above may be transferred to the patient in this case. It was very difficult to diagnose the patient since he only had the pain when he was out flying. When he came to a consultation the symptoms were not that pronounced. The symptoms had started to be more pronounced over time and sometimes he could feel a hint of the same pain as he had when the change in ambient pressure occurred.

It was important to rule out other possible pathology that could elicit the pain. Pain in this area may also originate from the sinuses (Brandt 2004). A CT-scan was taken and the patient's GP ruled out this possibility.

When we removed the filling an infraction-line was seen. This is in line with the predisposing factors for this condition. It is also generally stated that it affect posterior teeth more than anterior teeth, and the maxillary teeth is more vulnerable than the mandibular teeth. Likewise teeth with heavy restorations are more exposed than teeth with smaller or no restoration (Lyons 1999).

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CASE 18

Endodontic- periodontal lesion



Figure 1

Patient: A 73 year old Norwegian female was referred to the postgraduate clinic from the student clinic for treatment of the upper left lateral.

Medical history: The patient had been diagnosed with primary Sjögrens syndrome. Her mucous membranes were very dry both in the mouth and eyes, so was her skin. No medication.

Allergy to penicillin (reacts with rash and nausea)
Allergy to smoke and cold. Her skin and eyes get very dry when it's cold.

Migraine

Progynova 2mg X 1; oestrogen derivat
Primolut 5mg X 3 for 10 days each month
Both in use because of low progesterone production.

She earlier had psychological problems: anxiety and neuroses.

Dental history and chief complaint:

The patient was referred because deep pockets were noticed around the upper left lateral and communication to the apex from the pocket was suspected.

The patient had been treated at the dental school since 1975.

Dental records from that time showed deep pockets around 22 on the distal and palatal aspect. (The pocket depth changed from 4-8mm deep depending on the examiner)

Generally there was strong attrition of her teeth. Almost all her teeth had crowns.

Clinical findings:

Extra and intra-oral: The oral mucosa had normal colour and texture. The skin was very dry. The oral hygiene was good.

Dental: No caries could be detected on any of her teeth in the area. There was no tenderness to percussion or palpation. No teeth showed any reaction to cold by endo-ice.
Her teeth from 14 to 26 in the maxilla had crowns.

Periodontal: There was a general marginal bone-loss around the teeth.
22 had extensive pockets; 8mm palatal, 7mm distal and 4mm mesial. No mobility of the tooth.

Occlusal: The teeth in the mandible were grinded down as a result of attrition. Almost all teeth in the maxilla and the molars in the mandible were crowned or had gold onlays due to this.

Radiographic findings:

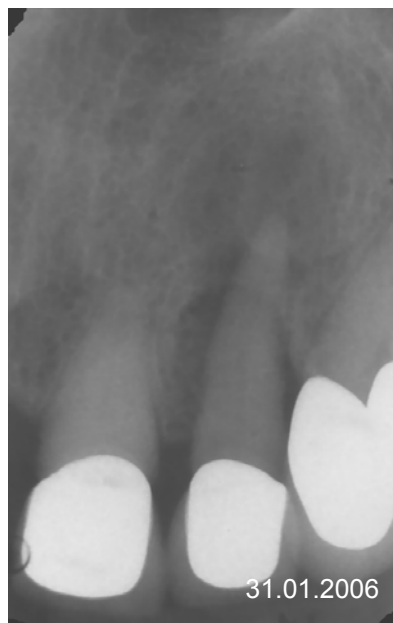


Figure 2



Figure 3

Periodontal: A general bone-loss could be seen.
21: The PDL was intact.
22: Bone-loss was seen either around the tooth. A large lucency was seen around the apex approximately 10mm in diameter.

A sinus tract radiograph was taken and it showed gutta-percha points leading from the pocket directly into the apical lesion.

Dental: All teeth seen on the radiograph had crowns consistent with metal-ceramic crowns. No other remarks.

Diagnosis: Pulpal: Necrotic pulp 22, K04.11

Periodontal: General chronic marginal periodontitis, K05.30 .
Chronic apical periodontitis 22, K04.50

There were two possibilities for the communication between the apical lesion and marginal lesion:

1. A chronic apical periodontitis with a draining sinus via the pocket.
2. A deep pocket meeting the apical lesion.

Treatment plan: Treatment of necrotic pulp 22.

The treatment of choice, independent of the two possibilities causing the lesion and the communication to the marginal aspect, would be treatment of the necrotic pulp of 22.

Problem-list: There were concerns about whether the communication between the deep periodontal pocket and the apical lesion could affect the healing of the apical periodontitis.

Treatment:

31.01.2006: Access cavity preparation was started. There were difficulties with locating the root canal because of an extensive obliteration in the pulp chamber and the coronal part of the canal. The search had to continue the next appointment and IRM was used as temporary top-filling.

21.02.2006: Continuation of the access cavity preparation. Searched for the canal with a K15. The file was secured with a dental floss.
The canal was found and rubberdam was applied and disinfected with a solution of 5% chlorhexidine in 70% ethanol.

A working length radiograph was taken:
K15/22mm/l- adjustment to 21mm.



Figure 4

The canal was instrumented to size #45 with NiTi-handfiles and irrigated with 1% NaOCl and 16% EDTA. Ca(OH)_2 was used as interappointment dressing. IRM was used as temporary top-filling.

14.03.2006:

The patient had no symptoms but the Ca(OH)_2 seemed to be washed out of the canal so it was decided to pack new Ca(OH)_2 today.



Figure 5

Rubberdam was applied and disinfected. The size of the apical box was adjusted to #55. Irrigation with 1% NaOCl and 16% EDTA was done. IRM was used as temporary filling.

18.04.2006:

Rubberdam was applied and disinfected. A master-cone radiograph was taken:
#55/21mm/l
The canal was filled with gutta-percha and AH^+ .

Irrigation with 1% NaOCl and 16% EDTA was done. Composite was used as top-filling and a postoperative radiograph was taken.

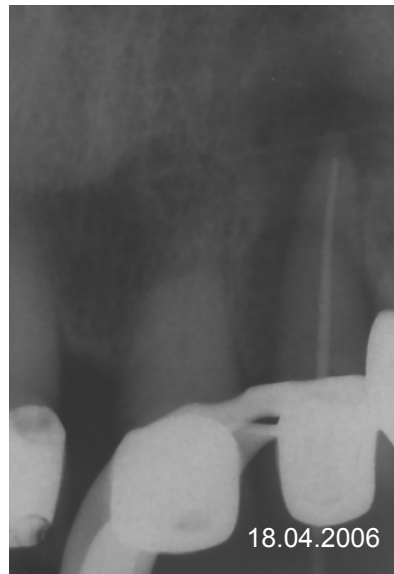


Figure 6

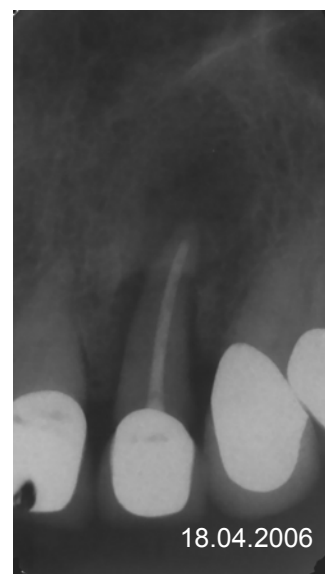


Figure 7

Prognosis:

The endodontic prognosis was considered to be uncertain.

The periodontal prognosis was considered to be poor.

Follow-up examinations:

03.05.2007:

1 year follow-up.

The patient had no symptoms. There was no tenderness to percussion or palpation. The radiograph showed that the periapical lesion had healed. The PDL could be followed around the whole root of 22. There were still pockets present, this was also confirmed both clinically and radiographic. An attempt to push a gutta-percha point into the pocket was done. It showed that there was no apparent communication to the apical area at that point; only an ordinary pocket present.

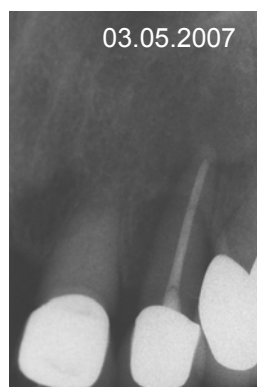


Figure 8



Figure 9

15.04.2008:
2 year follow-up.

The status was the same as the previous follow-up; no symptoms. There were still pockets around the tooth, 6-8mm on the palatal aspect. But there was no bleeding on probing or puss coming up from the pocket. No pathology was seen on the radiographs.



Figure 10



Figure 11

Discussion:

The radiographs showed healing of the apical lesion on both follow-up controls. There was no question about which initial treatment the tooth should receive; an endodontic treatment was necessary because of the infection causing the apical periodontitis.

What gave this case a character of uncertainty before the initial treatment started was the connection between the deep pocket from the marginal aspect and the apical lesion of the tooth.

Pulpal and periodontal problems are responsible for more than 50% of tooth mortality (Chen 1997)

According to Dietrich et al. () apicomarginal defects are a result of either endodontic infection, periodontal infection, or both. He classifies the defect into different categories (fig. 12)

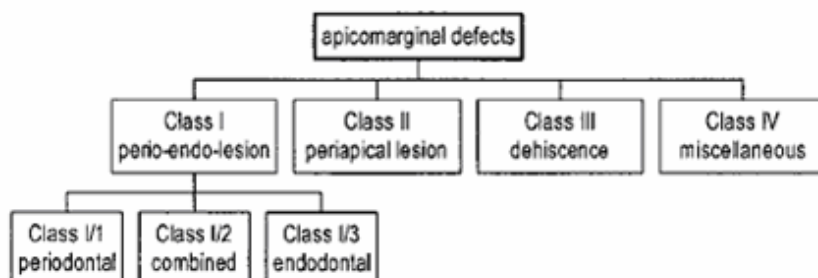


Figure 12 Dietrich et al. 2002

He states that the discrete subdivision of the class I lesions is a difficult task not always possible.

The pathways of communication and therefore for the extension of disease from a periodontal pocket to the pulp are through patent dentinal tubules, lateral canals, and the apical foramen or foramina (DeDeus 1975, Vertucci & Williams 1974); whether such relationship result in pulp necrosis have been looked at in several studies. Tagger and Smukler removed roots from molar teeth that had periodontal disease so severe that root amputation was required, and found that none of the pulps of the resected roots showed inflammatory changes. Czarnecki and Schilder (1979) performed a histological study of intact, caries-free teeth and compared the pulps of teeth with and without periodontal disease. They concluded that no correlations could be made between the presence or severity of periodontal disease and pulpal changes.

Another issue is whether the infected pulp can be of influence on periodontal health. This has been looked into by Miyashita et al. They used paired samples where a root filled tooth with apical periodontitis was compared to a healthy control tooth. The patients had minor degrees of periodontal disease. The study failed to demonstrate a correlation between a reduced marginal bone support and endodontic status. Nyman and Lindhe evaluated a group of patients who had lost 50% or more periodontal bone support and endodontically treated teeth. The bone height was followed over a period of time and they found that it was maintained equally well around endodontically treated as well around root filled teeth.

It was obvious that 22 had a deep pocket on the distal and palatal aspect, as well as general marginal bone-loss in both jaws. The tooth had been a problem for several years according to the patient's records with bleeding on probing and pus from the pocket.

There was also apical pathology on the root apex, but whether the pathology from the deep pocket was responsible for the apical periodontitis on the tooth was uncertain. Taken the studies mentioned into consideration, this was a situation where two conditions were present independently of each other and the sinus tract drained via the pocket because this was the pathway of least resistance.

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CASE 19

Osteomyelitis in the right side of the mandible in conjunction with an apical periodontitis in the mandibular right second premolar



Figure 1

Patient: A 38 years old Norwegian male came to the Faculty of dentistry/ endodontic department because he wanted a second opinion of a problem he had in his mandibular right side.

Medical history: Non-contributory. The patient was of good health and had not had any severe form of illness in his life.

Dental history and chief complaint:

The patient received a composite filling in 45 three to four years ago by his private dental practitioner. Before excavation of the caries there was an uncertainty if the lesion had entered the pulp. After preparation there were no signs of pulpal perforation so the tooth was restored with dycal and a composite filling.

The patient had not had any problems with the tooth until a few months before he came to the endodontic department.

The first symptoms presented in March 2007. The symptoms were then diffuse and he could feel a certain pressure in the jaw from the actual area. The discomfort disappeared and he didn't seek any help for the problem.

In mid September 2007 the symptoms from the area around 45 escalated with swelling and severe pain, and the patient sought a dental practitioner for emergency treatment. The patient had also a paresis in his lip and chin and possibly the teeth from the premolar region to the centrals in the 4th quadrant.

A large swelling had been apparent both intra- and extra oral in the region of 45. The dental practitioner had

drained a lot of pus from the area and done a partial pulpotomy of 45. After that, root canal treatment had been started with interappointment dressing with $\text{Ca}(\text{OH})_2$. Antibiotics had been prescribed twice by his dental practitioner, of the type penicillin VK.

The swelling and pain were intermittent in character, but the paresthesia was consistent.

The patient recalls that there had been draining sinuses both on the buccal and the lingual aspect of the dental ridge in the area.

The patient wanted a second opinion and sought therefore help at the Faculty of Dentistry.

The patient had no recollection of any trauma towards the jaw in that particular area.

Clinical findings:

31.10.2007 was his first appointment at the postgraduate clinic and clinical notes about the situation and clinical findings were taken.

Extra oral:

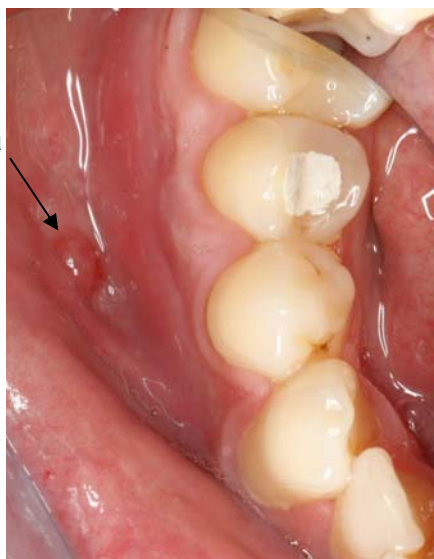
A slight swelling could be seen extra-orally on his right chin in the lower region of the mandible.



Figure 2

Intra oral:

Bulk in the oral mucosa



The oral mucosa had a normal appearance and texture. No major swelling could be noted. A "bubble" could be seen in on the vestibular mucosa, possibly a remnant after the sinus tract that had been there.

Figure 3

Dental: No caries could be detected on any of the teeth in the 4th quadrant. The 45 was the only tooth with a restoration in the quadrant.

Periodontal: Normal marginal periodontal conditions.
No mobility of any of the teeth.

Occlusal: No abnormal occlusal interferences.



Figure 4

Clinical tests were taken:

	32	31	41	42	43	44	45	46
Endo-ice	Yes	Yes	Yes/No	Yes	No	Yes/little	-	Yes
Percussion	No	No	No	No	No	Altered	Altered	No
Palpation	No	No	No	No	No	No	No	No
EPT	17	32	NR	43	NR	27	-	45

Figure 5

NR = no response

The patient said that he felt cold in 43/44, but not ice-cold. In 41/42 he felt ice-cold but not as spontaneous as in the teeth in the 3rd quadrant.

Other: There was a slight tenderness or altered feeling towards palpation when palpating the cheek and down in the vestibular mucosa.
The patient had a steady pain in the area which was dull in quality.
The patient said that he had a tingling sensation in the area from 3 to 10 times a day. The sensation seemed to appear more often after a cure of antibiotics.

Radiographic findings:



Figure 6
Ortho-radial projection



Figure 7
Disto-eccentric projection



Figure 8
Front

Periodontal: Normal periodontium could be seen around all teeth in the 4th quadrant

Dental: No caries detected on the radiographs. A temporary filling/IRM was seen in the 45.

Other : On the periapical radiographs radiolucent areas could be seen scattered around in the bone in the area around 44 and apically to 45 (white arrows). It was difficult to interpret the findings but it seemed not to be consistent with radiographs of normal sound bone. More radiographs were required to investigate the matter.

Diagnosis: Pulpal: Necrotic tooth 45.

Periodontal: Normal periodontium 45.

Tentative diagnosis: Osteomyelitis in the mandible. This was very uncertain and had to be further investigated with radiographs and possibly other tests.

Treatment plan:

1. Root canal treatment of 45
2. Referral to the department of Oral Radiology at the Faculty of Dentistry.
3. Referral to the department of Oral medicine and Oral surgery at the Faculty of Dentistry.

Problem-list: Ordinary endodontic treatment of 45 would most likely not be enough in this situation. And also other teeth in the area had to be examined thoroughly to exclude their interference in this condition.

Treatment:

- 31.10.2007: Extra oral and intra oral examinations were done. Radiographs were taken. Clinical tests were taken. The radiographs revealed radiolucencies in bone that was difficult to interpret. The patient was therefore referred to the department for Oral Radiology to have an OPG taken. After the specialist in radiology had looked at the OPG he required a CT-scan of the lower jaw.
- 07.11.2007: The radiographic interpretations of the OPG and CT-scan were ready from the Radiographic department. It showed possible osteomyelitis in the right side of the mandible, towards the front. The oral mucosa was also affected. The department of Oral medicine and Oral Surgery was contacted and the patient was immediately set on a cure of antibiotics containing Flagyl 400mg and amoxicillin 500mg. The patient was scheduled for an appointment at the department of Oral surgery the next day to be viewed by an oral surgeon. The swelling had subsided considerably since his first appointment but the paresthesia was still there.

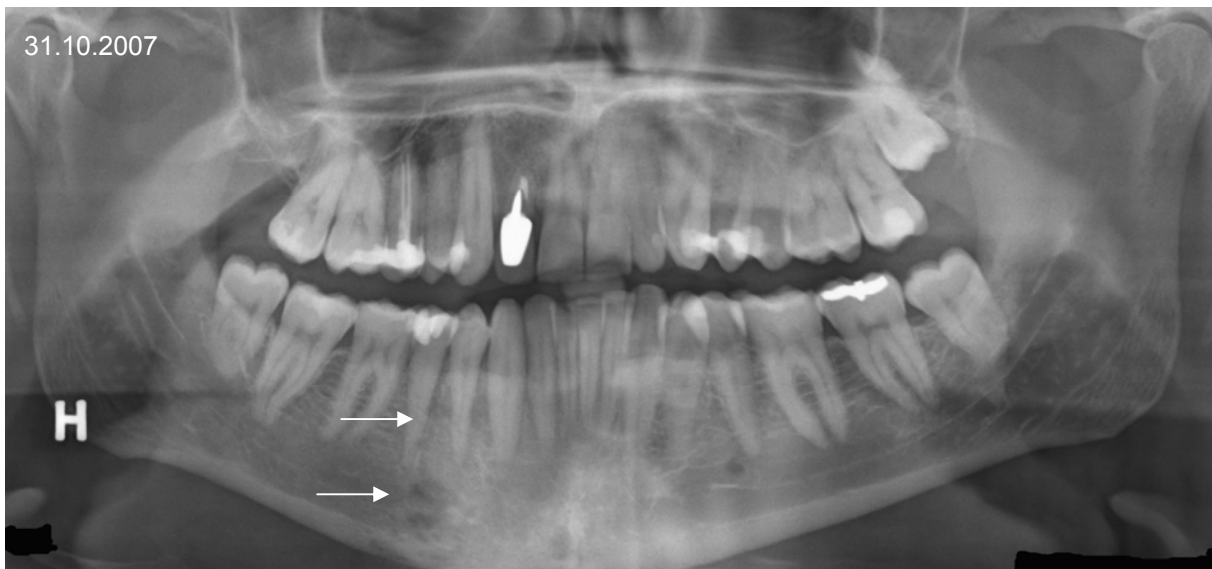


Figure 9 OPG

The OPG showed an irregular radiolucent area around the mental foramen and lingual of 44.

Axial images taken 31.10.2007. The patient was lying slightly aslant so the image of the mandible on both sides was not exactly parallel to each other.

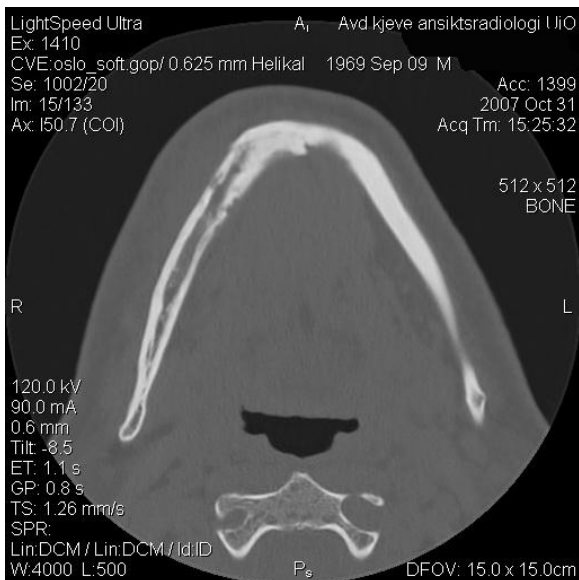


Figure 10

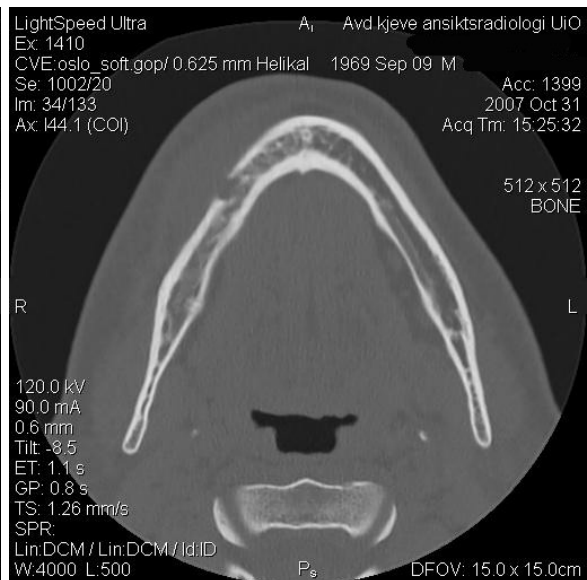


Figure 11

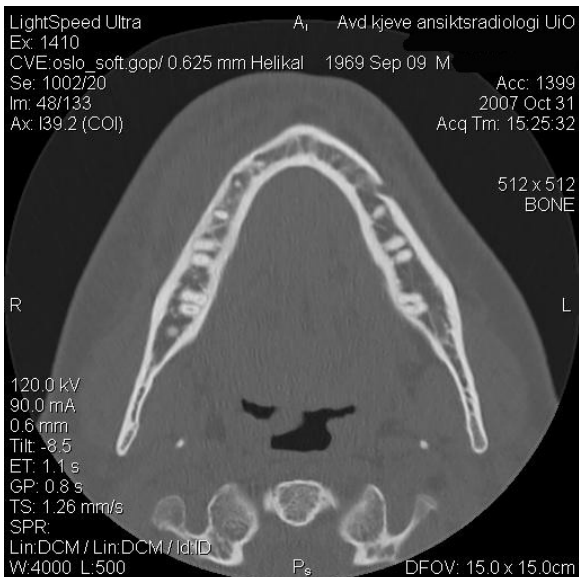


Figure 12

The radiographic description from the Department of Jaw- and Facial Radiology:

Destructive changes were seen in the right premolar region of the mandible, around the mental foramen and down to the margo inferior. Irregularities were seen in both the buccal and lingual lamella of corticalis. Sparse periosteal reaction, possibly indicated around the mental foramen. A diffuse swelling in the mucosa and blurring of the structures in the connective tissue around the mimic muscular tissue in the right foremost perimandibular area. No sequestering was seen.

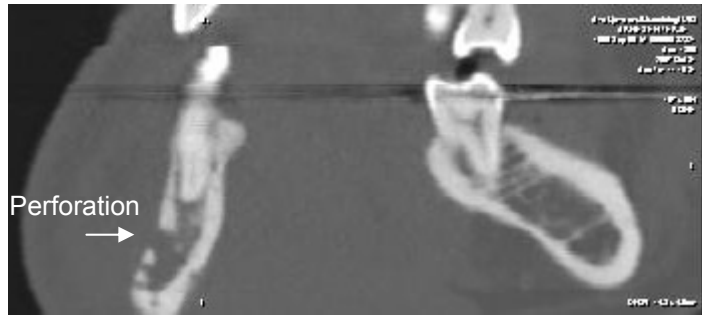


Figure 13 Oblique coronal image Figure 14

The oblique coronal image showed that the cortical bone had been perforated on the buccal aspect (fig. 14).

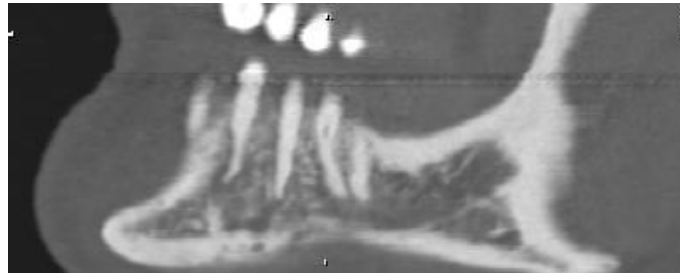
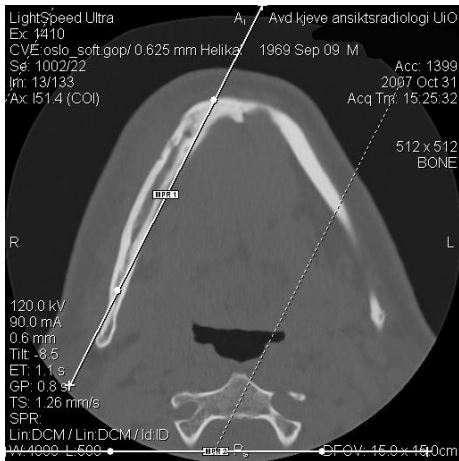


Figure 15 Oblique sagittal image Figure 16

The oblique sagittal image showed an irregular bone structure in the mandible.

08.11.2007:

The patient had an examination done at the department of Oral medicine and surgery. The patient was informed that there was a possibility that a surgical intervention was needed.

13.11.2007:

Root canal treatment of 45 was continued at the Department for endodontics, postgraduate clinic. It had previously been started by the patients' dental practitioner and the tooth was filled with $\text{Ca}(\text{OH})_2$.

Rubberdam was applied and disinfected with solution of 5% chlorhexidine in 70% ethanol. The canal was dry and the $\text{Ca}(\text{OH})_2$ was not discoloured when opening the cavity.

A working length radiograph was taken:
K50/24mm/B-cusp



Figure 17

The tooth was cleaned and shaped with NiTi-handfiles. Irrigation-solutions used were NaOCl 1% and EDTA 16%. Ca(OH)_2 was used as intra-canal dressing. IRM was used as temporary filling in between the appointments.

The patient revealed that the sensation in his lip and chin had improved after starting with the antibiotic treatment.

14.11.2007

A new control at the department of Oral Surgery. The antibiotics were changed to Clindamycin/Dalacin 150mg for the next three months.

A blood-test taken showed that the patient was a bit low on B-lymphocytes, but no other changes showed on the test.

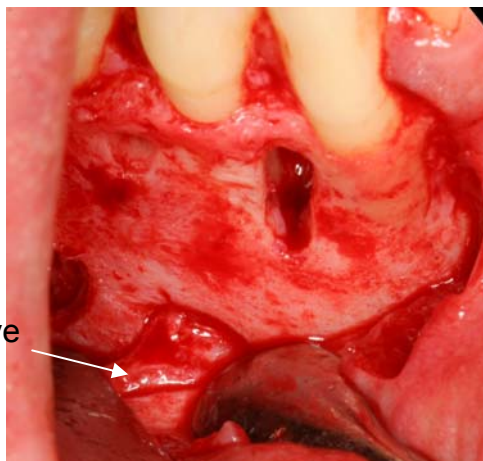
A new appointment was scheduled of a surgical intervention in the area.

17.01.2008:

Explorative opening done by an oral surgeon.

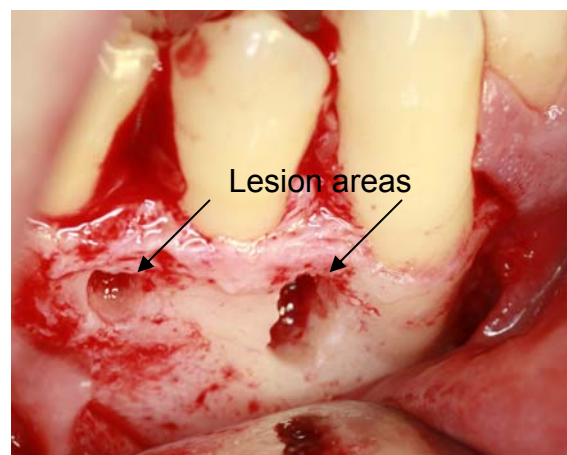
A marginal incision was made from 43 to 48, the mental nerve was taken care of.

Porous defects in the bone was localized in the region 33/34 and 44/45. A decortication was done around the defect areas and granulation tissue was scraped out with a curette. The tissue was sent for testing.



Mental nerve

Figure 18



Lesion areas

Figure 19



Figure 20 Sequestering of bone removed from the lesion

24.01.2008:

Sutures were removed and a control of the area was done.

29.01.2008:

The results from a bacterial-test taken in the operation showed no growth of anaerobic bacteria. Moderate growth of Staphylococcus epidermis, which is a penicillinase-producing bacterium normally found on the skin. It could be a contaminant of the test. There was sparse growth of Streptococcus mitis which is a normal inhabitant of the oral flora.

05.03.2008:

Continuing root-canal treatment of 45. Rubberdam was applied and disinfected with solution of 5% chlorhexidine in 70% ethanol.

The tooth was free of symptoms.
Master-cone radiograph:
K50/24mm/B-cusp



Figure 21

Irrigation-solutions used were NaOCl 1% and EDTA 16%. The tooth was root-filled with Epiphany and Resilon. Top-filling Tetric Flow/Ceram.



Figure 22

The patient had more sensation in his lip and chin compared to before. Endo-ice was tried and cold was felt in 41, 42 and 46, but nothing was felt in 44, 43.

Prognosis:

The endodontic prognosis seems to be good. The prognosis of the osteomyelitis is uncertain, but hopefully good. It is important that 43 and 44 are followed for some time ahead so that eventual necrosis will be discovered.

Follow-up examinations:

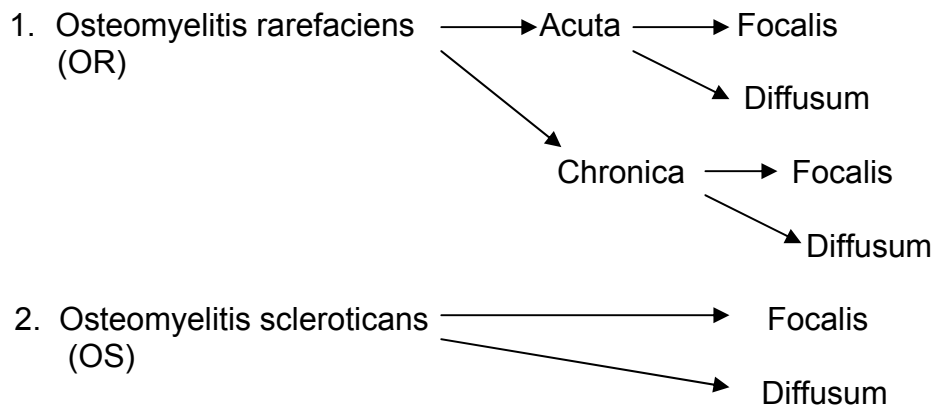
No follow-up has been done on this patient. Only telephone contact, where the patient reveals that he has no sensation in his chin and teeth in the 4th quadrant in front of 45. He may perhaps feel something once in a while. No pain or swelling has been noted and he is still on antibiotic treatment. He is scheduled for an appointment at the Department for Oral Medicine and Oral Surgery, Faculty of Dentistry, in May 2008 for a control of the area. Further assessment and antibiotic treatment will be planned at that point

Discussion:

Definition: Osteomyelitis is inflammation in the trabecular bone and bone marrow (Regezi & Sciubba 1993).

A classification was done by Hjørting-Hansen in 1977 (Gilhuus-Moe & Malmstrøm 1995).

The osteomyelitis was divided into two main groups, where the reaction pattern of the bone was the main feature and basis for division:



OR was the term for suppurative osteomyelitis, where resorption of the bone tissue was present.

OS was the term for sclerosing osteomyelitis, where bone apposition was present.

He subdivided the two main groups into:

OR acuta focalis: This is the term for normal acute periapical periodontitis.

OR chronica focalis: This is the term for a well-defined and local infectious process in the jaw, namely the chronic apical periodontitis.

OR acuta diffusum: This is the classic acute osteomyelitis. Almost always in the mandible with very classic symptoms. May develop into a chronic form; OR chronica diffusum.

OR chronica diffusum: Developed from the acute form.

OS focalis: Sclerosing apical periodontitis.

OS diffusum: This is a primary form of osteomyelitis which cannot be traced back to any of the OR forms. It is a proliferate type and another name for this type is Garrès osteomyelitis.

(the underlined cases are the osteomyelitis cases)

A more simple division is just acute and chronic suppurative forms of the disease (Koorbusch 1992). A time limit of 1 month is usually used to separate the acute from the chronic stages. So if the condition lasts over 1 month it is deemed to be in a chronic stage (Hudson 1993).

Aetiology:

Osteomyelitis is primarily caused by bacteria from a local infection in the jaw (Bernier 1995). Bacteremia may also result in osteomyelitis (Regezi & Sciubba 1993). The bacteria responsible were earlier believed to be mostly *Staphylococcus aureus*, as in long bone osteomyelitis, but in the jaws it is considered to be a polymicrobial disease reflecting the microflora normally present in the oral cavity, and no specific organism has been identified as a predominant etiologic agent (Koorbusch 1992, Storoe 2001).

Predisposing factors:

The mandible is the most common location in the maxillofacial area, and odontogenic infections and fractures (trauma) are the most frequent predisposing factors (Scolozzi 2005). Chronic systemic diseases, alcoholism, immunosuppression, malnutrition, diabetes mellitus, intravenous drug abuse, malignancy, and diseases that can result in hypovascularized bone (such as osteoporosis, Paget's disease, florid cemento-osseous dysplasia, and radiation therapy) have also been associated with an increased frequency of osteomyelitis (Hudson 1993, Storoe 2001).

Symptoms:

OR acuta diffusum (acute suppurative) have frequent findings like swelling, pain and sometimes fever and significant leukocytosis. An early sign is paresthesia or hypoesthesia in the area for the corresponding nerve. Abscess formation and draining sinuses will be apparent and will sometimes be difficult to differentiate from an acute odontogenic abscess. (Koorbusch 1992, Gilhuus-Moe & Malmstrøm 1995)

OR chronica diffusum (chronic suppurative) will be a transition from the acute form with variation between silent phases and exacerbations. Sinus formations, swelling in the connective tissue and an increase of the bone in the affected area are normal findings to the chronic form. (Koorbusch 1992, Gilhuus-Moe & Malmstrøm 1995)

OS diffusum have few obvious clinical symptoms and because they don't undergo the typical phases of the previous mentioned forms the illness is difficult to diagnose.

But characteristics are long-standing pain, often hypoesthesia or anaesthesia in the innervated area and sclerosing of the affected bone. (Gilhuus-Moe & Malmstrøm 1995)

Radiographic findings:

OR acuta diffusum will show no or few radiographic changes in the early stages. But after a week to 10 days or so radiolucent areas will be apparent. The trabeculae will decrease in density and their outlines become blurred and fuzzy. Subsequently, solitary or multiple small radiolucent areas appear on the radiograph representing enlarged trabecular spaces caused by foci of necrosis and frank bone destruction. Erosion or rupture of the cortex may appear. (Goaz & White 1994).

OR chronica diffusum shows single or multiple radiolucencies of variable size with irregular outlines and poorly defined borders. A moth-eaten appearance will be distinct as the radiolucent areas enlarge and the bone will remain irregular in outline and will be separated into islands of normal appearing bone. Segments of necrotic bone may be detached and appear as sequestrae (Goaz & White 1994).

OS diffusum in early stages resembles the previous described. As the lesion progresses it becomes more and more sclerotic and an increase in size of the involved bone will be apparent (Goaz & White 1994).

Treatment:

Most cases of osteomyelitis will need both medicaments and surgery. Sometimes antibiotic treatment will give a satisfying result. Treatment with hyperbaric oxygen therapy can in addition to antibiotic and surgical treatment be of help. This might improve the circulation in the area. Surgery is often necessary. Incision and drainage, surgical exposure and curettage of the lesion or extraction might be necessary (Gilhuus-Moe & Malmstrøm 1995).

The patient treated in this case had most likely a osteomyelitis of the type OR acuta diffusum. He is on a long-term treatment of clindamycin/ Dalacin and had to undergo surgical treatment. No teeth had to be extracted and hopefully he started with the treatment in an early stage and that no other teeth will be involved in the process.

Radiographs in endodontics are of importance for the study and management of conditions in the jaw. One of the most important roles played by imaging in clinical endodontics is the possibility of diagnosing and describing lesions in the jaw bones and surrounding tissues.

Radiographs are the two-dimensional projection of three-dimensional (3D) structures; most of the times they are not sufficient to provide information on the actual size of the lesions (Bender 1961, van der Stelt 1985) and the spatial relationship with anatomic landmarks (Marmary 1999), and it has been proposed that the amount of bone that has to be resorbed before a lesion becomes clearly visible is quite extensive (Marmary 1999). Radiographs are limited to visualization of hard tissues and not of soft tissues; therefore, they cannot guide the clinician towards a diagnosis of the soft tissue characteristics of the lesions (Nair 1998). Furthermore, they require careful interpretation and are prone to observer bias (Huomonen 2002, Goldman 1972).

Dental CT was introduced in 1987 and it is defined as a technique, which uses a specific protocol of investigation (Schwarz 1987a, Schwarz 1987b). In dental CT, axial scans of the jaws are acquired using the highest possible resolution, and curved as well as orthoradial multiplanar reconstructions are obtained. The coronal

plane is not generally used for the scans in dental CT, since the metal artifacts from teeth fillings and other metal-dental work are frequent and appear in these sections. Using the axial planes, the occlusion plane will still have the artifact displayed, but the bone will be left undistorted. Dental CT-scan is performed with a spiral CT or a multi-slice CT scanner. The device should give high-resolution scans with a small focal spot and the acquired slices should be of 1.5mm thickness or less. The slower the rotation of the tube, the more detailed is the information gained (Gahleitner 2003).

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CASE 20

Treatment of a maxillary right first molar with irreversible pulpitis, taurodontic tooth



Figure 1

Patient:

29 years old female of Norwegian origin was referred to the post graduate clinic, University of Oslo, Norway, by her general practitioner august 2005 for treatment of the right maxillary first molar.

Medical history:

The patient had a hereditary form of high cholesterol and used Zocor for the problem, but the illness was non contributory to the dental treatment.

Dental history and chief complaint:

The patient came to her general practitioner in July 2005 complaining about severe pain in the region around the right maxillary first molar. The tooth had earlier been restored with a distal-occlusal composite filling in April 2003 due to a deep carious attack.

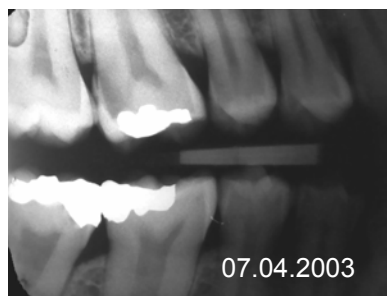


Figure 2

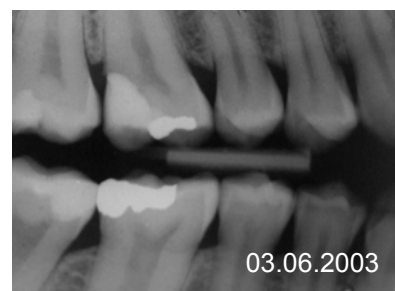


Figure 3

The tooth got the diagnosis irreversible pulpitis and the general practitioner started treatment with pulpectomy of the tooth. But because of an irregular cavum resembling a taurodontic tooth it was difficult finding the canals and the tooth was referred to the post graduate clinic at the dental school for further treatment.

The only treatment done in general practise was extirpation of upper part of the crown pulp and covering the cavum with a eugenol pellet. IRM was used as the temporary top-filling.

An interesting feature looking at the patient bitewings was that all her molar and premolar teeth in the upper jaw had signs of being taurodontic teeth.

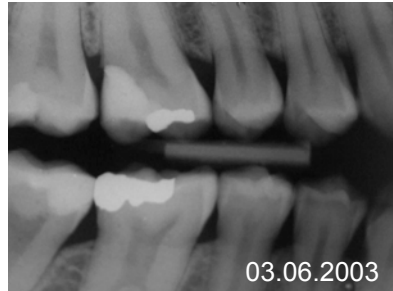


Figure 4

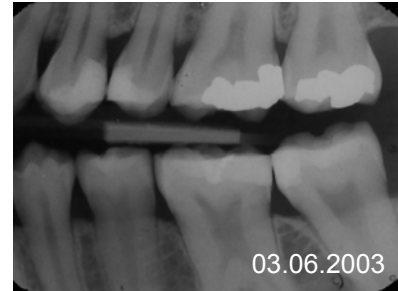


Figure 5

Clinical findings:

Extra and intra-oral:

Normal skin and oral mucosa.

Dental:

14: Sound tooth.

15: Sound tooth.

16: The tooth was restored with a composite filling on the distal aspect and an IRM was on the occlusal.

17: The tooth was restored with an occlusal composite filling.



Figure 6

Periodontal:

The gingiva was healthy and there were no periodontal problems such as bleeding on probing or pathologic pockets.

Occlusal:

No abnormal occlusal interference.

Clinical testing:

16 was slightly tender to percussion, but no tenderness to palpation was felt. The tooth showed sensitivity against cold from endo-ice, but within normal limits comparing with neighbouring teeth.

16 was responding to electric pulp test in a vague and insecure way, whereas the adjacent teeth had a positive reaction and responded around 20 (scale 0-80).

Radiographic findings:



Figure 7



Figure 8

Periodontal:

The lamina dura was intact around the whole root on all the teeth; 14, 15, 16 and 17.

Dental:

14 and 15 had no caries or fillings.

16 had a filling stretching from the occlusal to the distal aspect. The filling seemed to stretch into the cavum and the cavum and canals were a bit blurry.

17 had an occlusal filling. The root canal was clearly visible.

Diagnosis:

Tooth: Taurodontic tooth, K002

Pulpal: Irreversible pulpitis 16

Periodontal: Normal periodontium 16.

Problem list:

The tooth had features of being a taurodontic tooth and one could expect difficulties in cleaning, shaping and filling the root canals.

Treatment plan:

Pulpectomy of 16

Treatment:

Before each treatment session the patient received either 5 mg of sobril or valium, a calming medication because of anxiety regarding the dental treatment.

27.09.2005:

An access cavity was made.

Bleeding was noticed when extending down into the cavum.

Rubber dam was applied and the working field was disinfected with a solution of 5 % chlorhexidine in 70% ethanol.

The cavum was very broad and deep, extending almost $\frac{3}{4}$ down in the root and dividing into three root canals. The orifice to the palatal root canal was easy to detected, but the buccal orifices were covered of a decalcified tissue that looked like a pulp stone in texture and colour and therefore not that easily detectable. Everything became more difficult because the cavum floor was so deep down in the tooth. The long explorer was to short and only the very long root canal instruments were able to reach down to the floor of the cavum.

Started to remove the pulp stone with an ultrasonic device and the entrance to the disto-buccal canal was found. The search for the mesio-buccal canal orifice had to continue next time.

Irrigation was done with 1 % NaOCl and 16% EDTA.

Ca(OH)₂ was used as interappointment dressing and IRM as temporary filling.

25.10.2005:

Rubber dam was applied and the working field was disinfected with a solution of 5 % chlorhexidine in 70% ethanol.

The mesio-buccal orifice was difficult to locate since it was lying in the buccal aspect of the wall of the tooth and it was not a straight access to the entrance from above. After thorough work with the ultrasonic and different small, long shank burs the entrance to the mesio-buccal canal was exposed. Now all three canal orifices were located.

Irrigation was done with 1 % NaOCl and 16% EDTA.

Ca(OH)₂ was used as interappointment dressing and IRM as temporary filling.

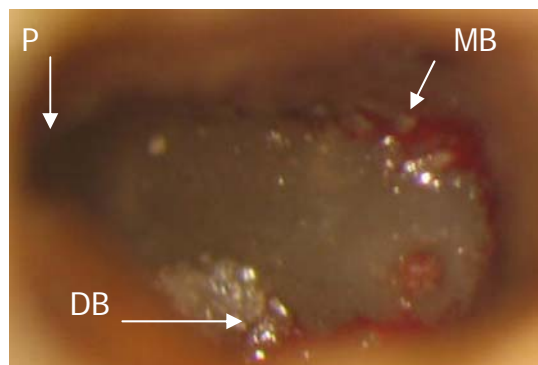


Figure 9

16.11.2005:

Rubber dam was applied and the working field was disinfected with a solution of 5 % chlorhexidine in 70% ethanol.

The working lengths were determined by the aid of an apex locator and a radiograph.

The apex locator was inconsistent when measuring the mesio-buccal canal. It was quite difficult to get an unambiguous answer since the canal was very short and almost ended straight into the periodontium from the access cavity.

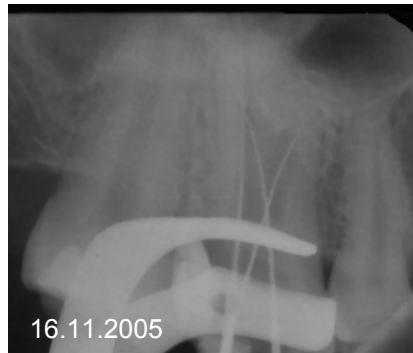


Figure 10



Figure 11

Working lengths: MB: K20/20.5mm/P – adjusted to 19mm
DB: H20/20.5mm/P
P: K35/20.5mm/DB

The MB, DB and P canals were instrumented to size #40, #50 and #80, respectively. NiTi handfiles were used.

Irrigation was done with 1 % NaOCl and 16% EDTA.

Ca(OH)₂ was used as interappointment dressing and IRM as temporary filling.

13.12.2005:

The patient was symptom-free. The tooth was not tender to percussion or palpation.

Rubber dam was applied and the working field was disinfected with a solution of 5 % chlorhexidine in 70% ethanol

Before the master-cone radiograph was taken it was decided that the MB-canal should only be filled with IRM. The reason was because the canal was very short, only 2-3mm from the cavum to the periodontium. Another issue was that it was very difficult to access.



A master-cone radiograph was taken. There was only gutta-percha in the DB and P canals. The MB-canal was covered with IRM.

Figure 12

A post operative radiograph was taken.

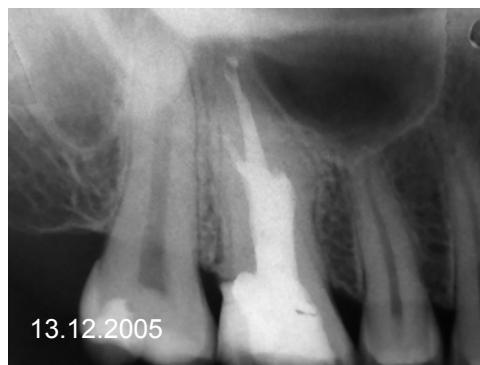


Figure 13

Prognosis:

The prognosis was considered to be good.

Follow-up examinations:

18.04.2007:

The patient had not felt any symptoms from the tooth since it underwent endodontic treatment. The radiograph revealed healthy periodontal conditions. The PDL was intact and could be followed around the root. The tooth had been crowned straight after the endodontic treatment was finished.

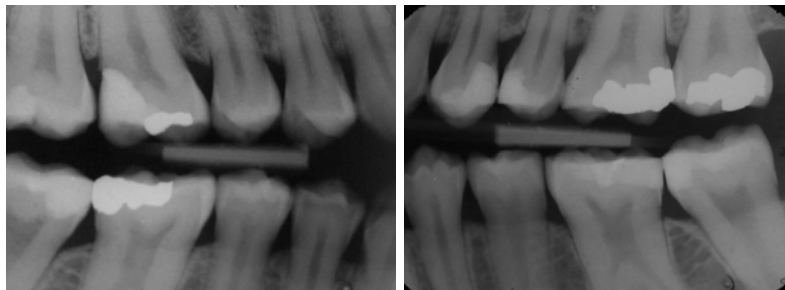


Figure 14

Discussion:

Taurodontism is a developmental disturbance of teeth that results in abnormally large pulp chambers (Bender & Hargreaves 2002). This is characterized by vertically elongated pulp chambers, apical displacement of the pulpal floor, and bifurcation or trifurcation of the roots (Witkop 1988, Jaspers 1981). The term taurodontism comes from the Latin term *tauros*, which means “bull” and the Greek term *odus*, which means “tooth” (Terezhalmay 2001).

Taurodontism is probably caused by failure of Hertwig’s epithelial sheath diaphragm to invaginate at the proper horizontal level (Hammer 1964). The state occurs most frequently in molars and may be expressed unilateral or bilateral. In this patient there was bilateral findings.



A prevalence of 2.5-3.2% of the population is reported in the US (Neville et al. 2002). What was particularly difficult in this case was the cleaning and shaping of the canals. Also the obturation with gutta-percha tended to be difficult because the floor of the pulp chamber was in the apical third of the tooth and hence the canal-orifices likewise. Placing the instruments into the orifices were not easy because they were seated very close to the pulp chamber walls, and the instruments used to vertically condensate the gutta-percha tended to become too short. Dürr et al (1980) suggested that morphology could hamper the location of the orifices, thus creating difficulties in instrumentation and filling, this was indeed the case in this situation.

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