UNIVERSITY OF OSLO
FACULTY OF DENTISTRY

Department of Endodontics

Postgraduate Program in
Endodontics

Case Book

Thomas H. Myrhaug

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- AH Plus
- Epiphany/Real Seal

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- Gutta-percha
- Resilon

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Treatment of Tooth with Apical Periodontitis:

First Visit:

Anesthesia
If required building up the tooth for aseptic reasons
Removal of plaque, caries and leaking fillings
Application of rubber dam
Disinfection of the working area with 0.5% chlorhexidine in 70% ethanol
Access cavity preparation
Localization of canal orifices
Measurement of working length, using apex locator and working length radiograph

- Goal: 0.5-1 mm short of the anatomic apex

Instrumentation to desired apical size (figure 1)

- Frequent irrigation with 1% sodium hypochlorite (NaOCl)
- Final irrigation with 17% ethylenediaminetetraacetic acid (EDTA) and a final flush with 1% NaOCl
- In retreatment cases: Final irrigation with 17% EDTA and then 2% chlorhexidine digluconate (CHX)

Drying of the canals with paper points
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Temporary top filling: IRM
In special situations topped by a temporary composite filling
Removal of rubber dam

Second Visit:

If the patient is without symptoms and no sensitivity to palpation and percussion test from the tooth, the root canals are filled. (See above description of treatment of tooth without apical periodontitis.)

Time Plan:

Tooth without apical periodontitis:

- One-appointment treatment is the standard (goal)
- When time does not allow or there are other reasons, e.g. difficulty in controlling bleeding in the canal, the canal is filled with $Ca(OH)_2$ and the treatment will be finished at the second appointment, preferably 1-2 weeks later.

Tooth with Apical Periodontitis:

- Two-appointment treatment is the standard (goal)

- 1-3 weeks between first and second appointment is the standard
- Long-term Ca(OH)2 treatment (first for 2-3 weeks, then radiographic and clinical control after 3 months) is to be considered when:
    - A large lesion is present
    - Sinus tract does not close
    - Other symptoms continue

Emergency Treatment:

Acute Pulpitis:

- Eugenol pulpotomy
    - ZOE filling in a deep cavity
- Eugenol pellet in pulp chamber + IRM top filling
- Systemic medications
    - NSAID prescribed when pain is a problem
    - Systemic antibiotics not recommended

Acute Apical Periodontitis:

- Incision of abscess and drainage, if applicable
- In some cases 1-2 mm over-instrumentation with #10 K-file to release pus
- Preparation of canals and Ca(OH)2 treatment is the optimal treatment
- Ca(OH)2 dressing
- Systemic medications
    - NSAID prescribed when pain is a problem
    - Systemic antibiotics when general indications present

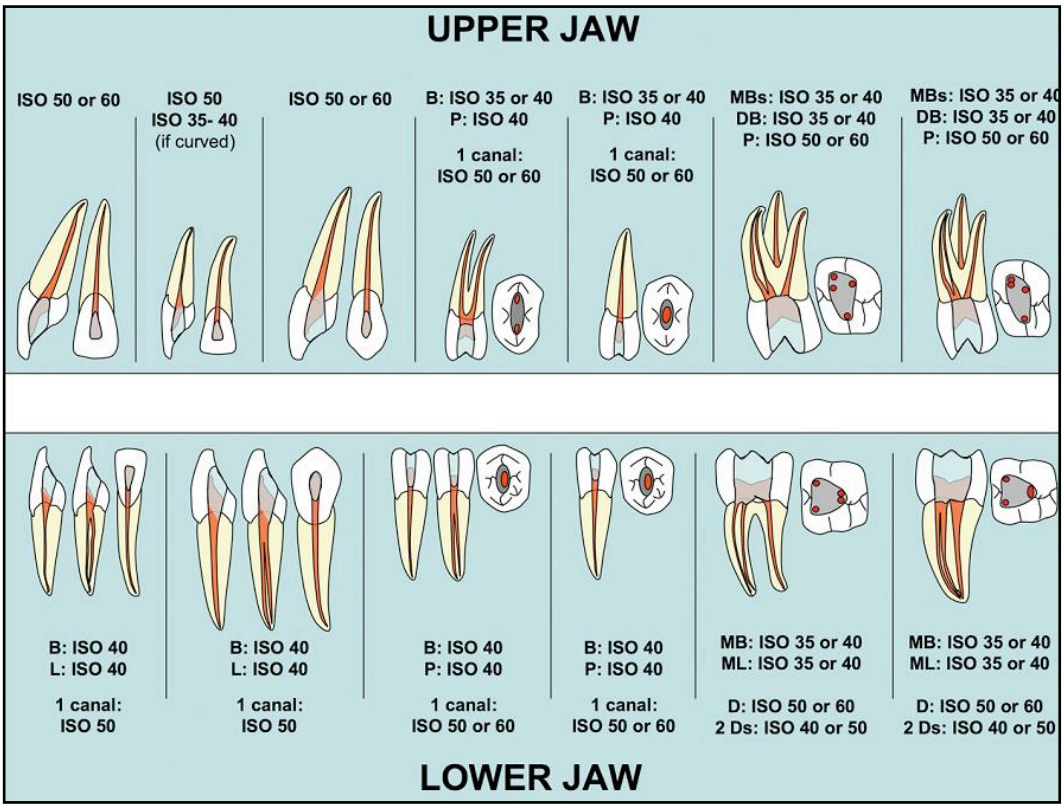

Figure 1: Normative apical sizes for safe and effective disinfection in permanent teeth. The clinician must use his or her clinical judgment in choosing apical sizes for each individual tooth.

Endodontic files for instrumentation of canals

Hand files:

- K-files
- Stainless steel files (SS files)
- Hedstroms files
- Nickel-titanium files (NiTi files)

Engine driven files

- ProTaper® (figure 2)
- BioRace® (figure 3)
- Race®

Figure 2: ProTaper®

Figure 3: BioRace®

Endodontic Surgery

- All relevant radiographs mounted on viewer or screen
- Anesthesia
- 1 minute mouth rinse with Corsodyl® (chlorhexidine 2mg/ml)
- Incision:
    - To provide a clearly defined opening to bone for maximum tissue thickness reflection, and to establish an easily identifiable and accessible border for re-approximation and reattachment.
- Elevation:
    - To gain access to bone by separating a full mucoperiostal flap of tissue and raising it from its underlying hard tissue attachment. The periosteum is retracted as an integral part of the flap.
- Retraction:
    - To hold the flap away from the surgical site, providing maximum access and visibility, without causing harm to the flap or the surrounding tissues.
- Flap design:
    - Intrasulcular flap:
        - Mainly indicated for treatment of cervical resorptions, perforations, and resections of short roots. Also mainly used in posterior apical surgery.
        - Comprises a horizontal incision extending to one or two teeth mesial and distal of the involved tooth and one vertical-releasing incision, usually placed at the mesial end of the flap.
        - If the access is too limited, the triangular flap can easily be converted into a rectangular flap by placing an additional releasing incision at the distal end of the horizontal incision.

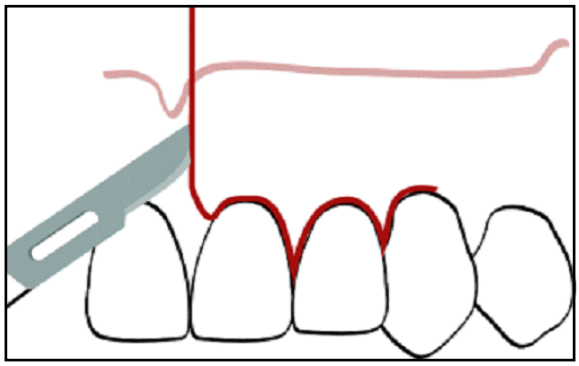

Figure 4: Triangular flap with intrasulcular incision (Velvart et al. 2002)

- Submarginal flap:
    - Fear of even small recessions is the driving force for considering the submarginal flap.
    - When properly planned and performed, the submarginal flap will leave the marginal gingiva untouched and does not expose restoration margins.
    - The submarginal flap design, also referred to as an Ochsenbein–Luebke flap, is similar to the rectangular flap, with the difference that the horizontal incision is placed within the attached gingiva.
    - The two vertical incisions are connected by a scalloped horizontal incision, performed roughly parallel to the marginal contour of the gingiva.
    - The submarginal incision should only be used when there is a broad zone of attached gingiva with a minimum of 3 mm

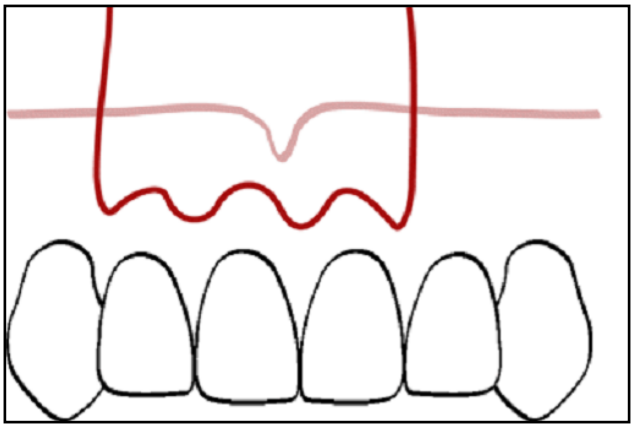

Figure 5: Submarginal flap (Velvart et al. 2002)

- Papilla base incision:
    - Fear of even small recessions is the driving force for considering the submarginal flap.
    - The technique involves the preservation of the entire papilla, thus eliminating any potential loss of height as a result of the surgical or healing process.
    - The first shallow incision severs the epithelium and connective tissue to the depth of 1.5 mm from the surface of the gingiva. The incision is placed at the level of the lower third of the papilla in a slight curved line going from one

side of the papilla to the other. The incision starts and ends in a 90 degree angle between the border of the tooth and the gingiva.

Fig. 6 Papilla based incision

- The scalpel is then placed to the base of the previously created shallow incision at the base of the papilla and subsequently inclined apically, almost parallel to the long axis of the tooth, aiming at the crestal bone (Fig. 7). With this second incision a split thickness flap is prepared in the apical third of the base of the papilla. The incision ends at the crestal bone level, where the periosteum is separated from the bone. From there on the preparation continues in a full thickness muco periosteal flap

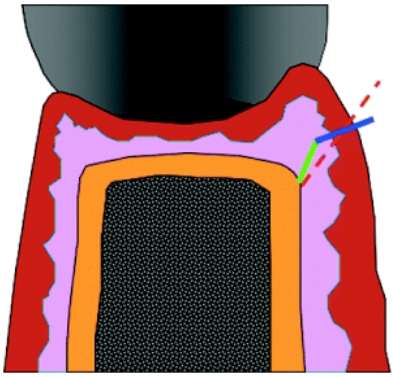

Fig. 7 (Velvart et al 2002)

- Osseous entry or osteotomy:
  Involves removal of cortical and cancellous bone to gain direct access to the apical portion, and the lateral aspects if necessary, of the root or roots of a tooth where periradicular periodontitis is present. There may be fenestration through the buccal cortical plate, thus providing instant access to the root tip. A periradicular soft tissue lesion may have perforated the cortical plate, in which case curettage of the lesion permits access to the root either without bone removal or minimal extension of the borders of the defect for improved access. Frequently, however, there

will be an intact cortical plate that requires removal to expose the surgical site. This is achieved routinely by using rotary instruments.
3–4 mm of the apical portion of the root should be clearly exposed.
Following resection of the required 3 mm of root tip, there should be good visibility of the resected root surface for the next stage of the procedure.

- Surgical curettage:
  To remove all pathological tissue, foreign bodies, and root and bone particles from the periradicular area.

- Biopsy:
  Although there is agreement in the literature that the vast majority of soft tissue lesions are either granulomas or radicular cysts, any soft tissue lesion removed during the surgical procedure should be submitted for biopsy.

- Root-end resection:
  To expose the foramen/canal for inspection by sectioning the apical segment of the root and/or bevelling it to the line of sight.

- Ultrasonic root-end preparation:
  To provide a clean, well-shaped class I cavity in an apically resected root that is parallel to the long axis of the root, sufficiently centered to offer adequate root wall thickness, and deep enough to receive and retain a non-toxic, biocompatible filling material.

- Hemorrhage control:
  - To maintain a clean, dry and highly visible surgical site, and spontaneously manage and control any abnormal bleeding. This is achieved through use of:
  - Local anesthetic solutions possessing vasoconstrictor properties - Xylocaine Adrenaline® (lidocaine hydrochlorid 10 mg/ml, epinephrine 5 µg/ml), Septocaine® (articaine hydrochloride 4% with epinephrine 1:200,000) or Septocaine® Forte (articaine hydrochloride 4% with epinephrine 1:100,000)
  - Stryphnon gauze (adrenalonchloride 0,33 mg/cm^2)
  - Ferric sulfate ($Fe_2(SO_4)_3$)

- Root-end filling using either IRM or MTA:
  - The surgical site must be aspirated of all fluids and bleeding controlled.
  - The cavity preparation is flushed clean and thoroughly dried with short-cut segments of sterile paper points.
  - The IRM or MTA is carried to the preparation in small semisolid increments with plastic instruments or carvers.

- Use of the MAP system® (Micro-Apical Placement) or the MTA pellet forming block will ease the application of MTA.
- Pluggers of various sizes and angles are used to effectively condense the material to the depth of the preparation.

- Prior to wound closure, the surgical site is irrigated with saline solution to remove debris, and tissue edges are re-approximated in their correct position to promote healing by primary intention. Compression of the repositioned tissue with a saline-moistened gauze will reduce the coagulum to a thin fibrin layer between the repositioned tissue and cortical bone. Tissue margins should rest passively in the desired place before suturing.
- Wound closure using non-absorbable suture material in sizes 4-0 and 6-0.
- Postoperative radiograph is taken for control of procedures and as reference for follow-up
- Postsurgical care:
  - A disposable ice pack is covered with a soft towel, and the patient instructed on where and how to hold the icepack firmly in position against the facial tissues approximating the surgical site.
  - Unless contraindicated for some reason, the patient is instructed to take 400 mg ibuprofen every 4 to 6 hours for the first 48 hours.
  - The patient is advised to rinse with Corsodyl® twice daily until suture removal.
- Suture removal:
  - The epithelial seal at the wound edges is evident within 2 days; suture removal can take place earliest after 48 h but not later than 6-7days.
- Standard prescription of:
  - Analgesics:
    - Ibuprofen 400 mg. No 30. Every 4 to 6 hours in 3 days.
  - Antibiotics (only on indications):
    - Phenoxymethylpenicillin (penicillin V) 660 mg. no 30 (1+1+2 per day for 7 days)

Case 1

Vital Pulp

Introduction

Seventeen-year-old white Norwegian male

Fig.1 Frontal view

Chief complaint

5.September 2007

The patient was referred to the Department of Endodontics for examination and endodontic treatment of the right maxillary second molar.

Medical history

Non-contributory

Dental history

February 2007

Numb feeling in the right cheek . At the Department of Oral and Maxillofacial radiology UiO, was a large cystic process found in relation to an impacted third molar in the right maxilla.

26. April 2007

Fig 2. Panoramic image showing an impacted right upper third molar

Fig. 3 CT scan. Coronal plane. Enlarged maxillary right sinus expanding into the nasal cavity and orbita.

Fig. 4 CT scan. Sagittal plane. Impacted upper third molar.

June 2007.

At Ullevål University Hospital a keratocystic odontogenic tumor and the impacted right maxillary third molar was removed.
During the operation the roots of the right maxillary second molar were exposed and lost their blood and nerve supply. Since the operation, tooth 17 has not responded to sensibility tests.

Clinical findings

5.september 2007

Extra-oral examination: within normal limits

Intra-oral examination

	17	16	14	13	12	11
EPT	-	60	-	-	60	-
Cold	-	+	-	-	+	-
Percussion	-	-	+	+	+	+
Palpation	-	+	+	+	-	-
PPD	Normal	Normal	Normal	Normal	Normal	Normal

Table 1. Clinical findings

Soft tissue:

Tooth 11: Gingivitis

Radiographic findings

5.september 2007

Tooth 17-15: Intact non treated teeth
Large maxillary sinus.

Fig. 5 Periapical radiograph

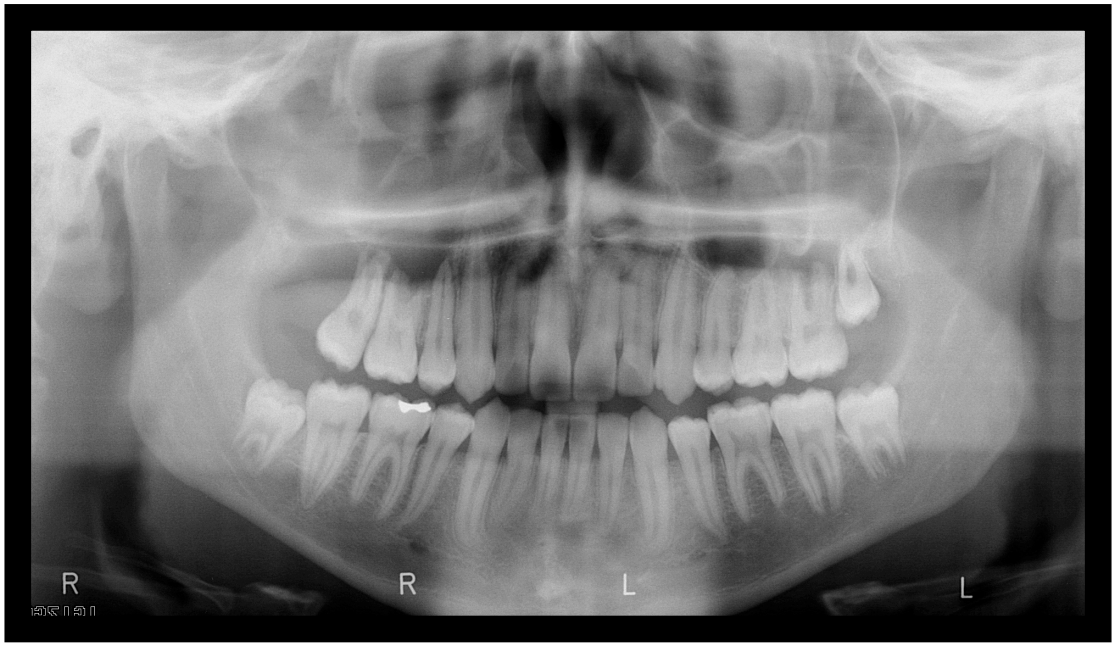

Fig. 6 Orthophantogram

Diagnosis

Tooth 17:

Pulpal: Necrotic pulp(K.04.11)
Periapical: Within normal limits
Marginal: Within normal limits

Treatment plan

Orthograde endodontic treatment of a necrotic pulp tooth 17

Treatment

25.September 2007

1,8 ml Septocaine®. Access cavity preparation in to a bleeding cavity. The pulpal diagnosis was altered to vital pulp(K04.a). Rubber dam. Length of the canal was determined by apex locator(Root ZX®) and a periapical radiograph. Root canal preparation was done mechanically with K-and NiTi hand files.
Three canals.
MB R45/22,5mm BC
DB R45/22,5mm PC
P R60/23mm PC
1% NaOCl and 17% EDTA were used for chemical root canal disinfection. The canal was dried with paper points and filled with Ca(OH)2. Temporary sealed with IRM.

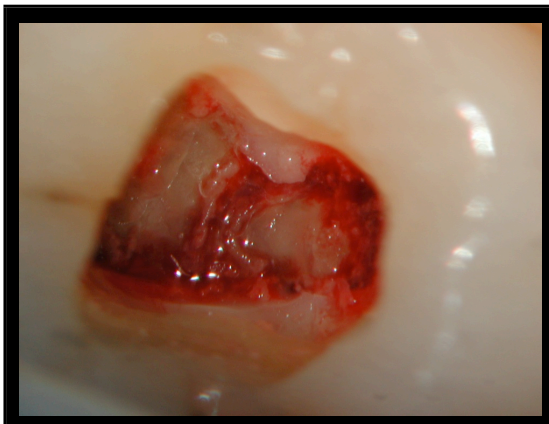

Fig. 7 Bleeding pulp cavity

Fig. 8 Working length radiograph

9. October 2007

The canals were rinsed with 1% NaOCl and 17% EDTA, dried with paper points and obturated with gutta percha and AH Plus. The tooth was temporarily sealed with IRM.

Fig 9 Master point radiograph

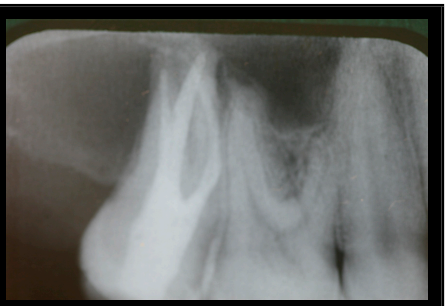

Fig. 10 Final radiograph

Result

Fig. 11 Before treatment

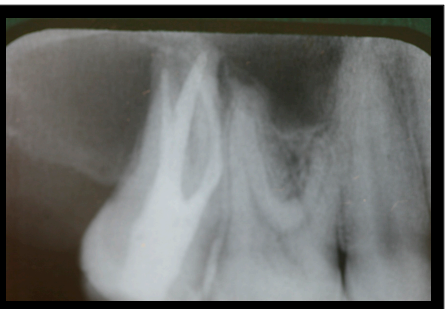

Fig. 12 After treatment

Evaluation

While a tooth with pulpitis can be treated in one session, because of the time limit during treatment this was done in two sessions. No complications during treatment. The root filling appeared dense and good.

Prognosis

Endodontic: good
Tooth: good

Follow-up examination

26. February 2008 (five months after endodontic treatment)

	17	16	14	13	12	11
EPT	-	60	-	-	60	-
Cold	-	+	-	-	+	-
Percussion	-	-	-	-	+	+
Palpation	-	-	+	+	-	-
PPD	Normal	Normal	Normal	Normal	Normal	Normal

Table 2. Clinical findings

Teeth 14 and 13 did not react to the percussion test.
Teeth 14, 13 and 11 were still not reacting to the sensitivity test.

2. June 2008

	17	16	14	13	12	11
EPT	-	61	70	72	62	55
Cold	-	+	+	+	+	+
Percussion	-	-	-	-	-	-
Palpation	-	-	-	-	-	-
PPD	Normal	Normal	Normal	Normal	Normal	Normal

Table 3. Clinical findings

All the teeth were responding to both the EPT and thermal test. The teeth experienced no sensitivity to the percussion or palpation test.

Fig. 13 Follow up radiograph

Discussion

Odontogenic keratocyst (OKC) is a unique cyst because of its locally aggressive behavior, high recurrence rate and characteristic histological appearance. It accounts for approximately 12% to 14% of all odontogenic cysts of the jaws(1). It has a predilection for the posterior part of the mandible, with a peak incidence in patients between 10 and 30 years of age and a slight male predominance. Radiographically, the lesion is most often unilocular or multilocular radiolucency, surrounded by smooth or scalloped margins with sclerotic borders.(1).

The etiology is probably closely related to the development of the dental lamina and in particular remnants of it after this organ has served its purpose. OKCs that occur in the dentate areas of both the maxilla and mandible probably derive from those remnants. However, one must realize that epithelial islands that are derived from the dental lamina are mainly found in the gingiva and probably in the periodontal ligament. This explains the often seen lateral periodontal or lateral follicular presentation of these cysts. It is not known why keratocysts develop from such epithelial residues. It is also not clear why a keratocyst

develops from one such epithelial island, while others remain dormant. The clinical implication may be, however, that if one removes such an OKC some of these epithelial residues may be left behind which may later give rise to a new keratocyst(2).

The tremendous degree of variability among the studies (all retrospective case series) precluded any quantitative analysis of recurrence. Clinicians have documented a wide range of recurrence rates (0% to 62.5%) associated with the various treatment modalities(3)

Malignant change in odontogenic keratocysts (OKC) has infrequently been reported. In a review of the literature, only 15 reports of squamous cell carcinoma (SCCA) developing from OKCs were found(4).

The recommended follow-up for OKCs is once a year the first 5 years postoperatively. The literature suggests that most recurrences will present the first 5 years after primary treatment. Because recurrences or newly developed OKCs may also present late, a follow- up once every 2 years thereafter seems a reasonable policy(5).

The endodontic treatment seems successful, and the teeth are now responding to sensitivity test. So further follow will be done at the Ullevål University Hospital.

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Case 2

Retreatment of a mandibular lateral incisor

Introduction

Forty-nine year old female originally from Pakistan

Fig.1 Frontal view

Chief complaint

5. November 2007

The patient was referred to the Department of Endodontics for examination and endodontic treatment of the left mandibular lateral incisor.

Fig. 2 Occlusal view

Medical history

High blood pressure.
Medicine: Atacand 8mg/2

Dental history
Spring 2001:

Endodontically treated at the student clnic.

Fig. 3 Periapical radiographs

Clinical findings
5. November 2007

Extra-oral examination: within normal limits

Intra-oral examination

	31	32	33
EPT	42	-	29
Cold	+	-	+
Percussion	-	+	-
Palpation	-	+	-
PPD	4mm	4mm	4mm

Table 1. Clinical findings

Soft tissue: within normal limits

Dental:

Tooth 32: Composite filling and stabilizing cord.

Radiographic findings
5. November 2007

Tooth 32: Endodontically treated tooth.
Widened lamina dura. Periapical radiolucency.
PAI 3. Radiopaque restoration in the crown.

Tooth 33,31,41: Intact non treated teeth.
Normal lamina dura. No apical radiolucency. PAI 2.
Stabilizing cord from 33-42

Fig. 4 Pretreatment radiograph

Diagnosis

Tooth 32:
Pulpal: Endodontically treated tooth (K04.19)
Periapical: Chronic apical periodontitis (K04.5)
Marginal: Chronic marginal periodontitis (k05.3)

Treatment plan
Orthograde endontic retreatment tooth 32

Problem list
Locating possible second canal

Treatment
7. November 2007

Access cavity preparation. Rubber dam.
Removal of gutta-percha and sealer.
Length of the canal was determined by apex locator(Root ZX®) and a periapical radiograph. A second canal was located lingually. Root canal preparation was done mechanically with K-and NiTi hand files.
Two canals.
B R55/17,5mm I
L R35/18,0mm I
1% NaOCl and 17% EDTA were used for chemical root canal disinfection. The canal was dried with paper points and filled with Ca(OH)2. Temporary sealed with IRM.

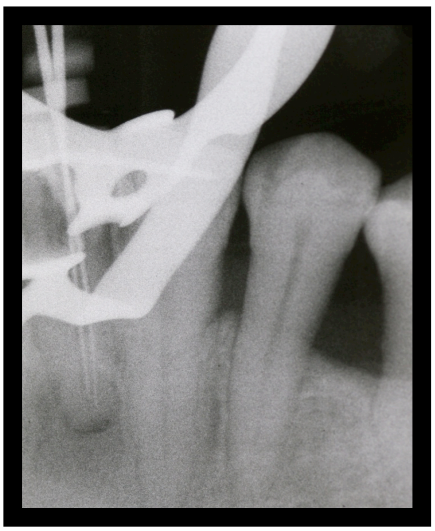

Fig. 5 Working length radiograph

27. November 2007

The canals were rinsed with 1% NaOCl and 17% EDTA and dried with paper points. Obturated with gutta percha and AH Plus. Temporary sealed with IRM.

Result

Fig. 8 Before treatment

Fig. 9 After treatment

Evaluation

Since we located an uninstrumented canal, we possibly eliminated the source of infection. No complications during treatment. The root filling appeared dense and good.

Prognosis

Endodontic: good

Tooth: good

Follow-up examination

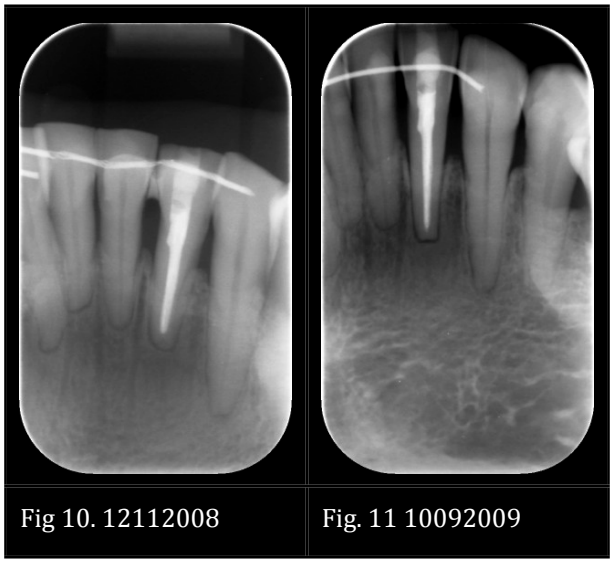

Fig 10. 12112008

Fig. 11 10092009

Radiograph showed evidence of healing of the periapical radiolucency, but the lamina dura is widened.
The patient was asymptomatic and experienced no sensitivity to percussion or palpation tests.

Discussion

To be able to distinguish between a radiographic good looking root filling, and the possibility of a missed second canal can be difficult, but very helpful when the tooth has symptoms. It is known from the litterature that initial treatment has a better prognosis than retreatment(1).When there is an untreated canal despite the appearence of a well treated tooth, the treatment would be classified as initial treatment.

Studies have been reported on the presence of different root canal types from various countries. Root canal systems are evaluated after removing the pulp chemically either by pumping materials into this space with pressure which forces the material to take the shape of the space, by taking longitudinal sections from the teeth, by radiographic techniques, or by clearing the teeth(2). Vertucci classified and described the root canal systems of human permanent teeth into eight different types(3).

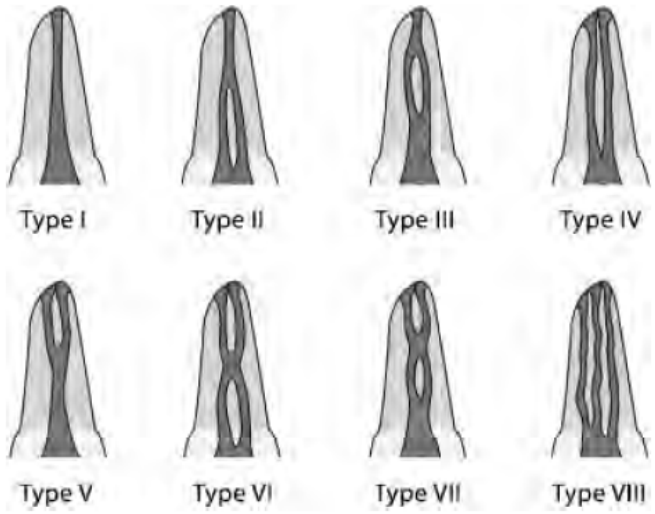

Fig. 12 (2)

Benjamin and Dowson(4) reported that the incidence of the presence of a second canal in a mandibular incisor was 41.4% whereas Madeira and Hetem(5) found the incidence to be 11.5% . Vertucci(6) found it to be 25.7%, Green (7)20% and Kartal and Yanikoglu(2) 45%. In the latter study, it was detected that two canals connect in the apical third 37% of the time and reach the apex as one canal. In

this case, one might think that filling only one canal, thus sealing the apex, might be enough. However, lateral canals can then cause problems.
The other very important point is that if two canals are present, they usually join together 1 to 2 mm from the apex. If root canal filling is shorter than this joining point, and only one canal is filled, the unfilled canal can cause failure. Finally, if apical resection is attempted in the presence of a second canal, one apical foramen will become two separate foramen and this will influence the prognosis negatively(4).

Radiographs may not always determine the correct morphology particularly when only a buccolingual view is taken(8). Nattress et al. (9) radiographed 790 extracted mandibular incisors and premolars in order to assess the incidence of twin canals as visualized on radiographs taken in the mesio-distal direction(see figure below). The ability to detect the presence of these twin canals by viewing radiographs taken in the standard bucco-lingual direction was then assessed. Using the guideline that 'disappearance or narrowing infers division' when viewing these radiographs resulted in a failure to diagnose one-third of the twin canals.

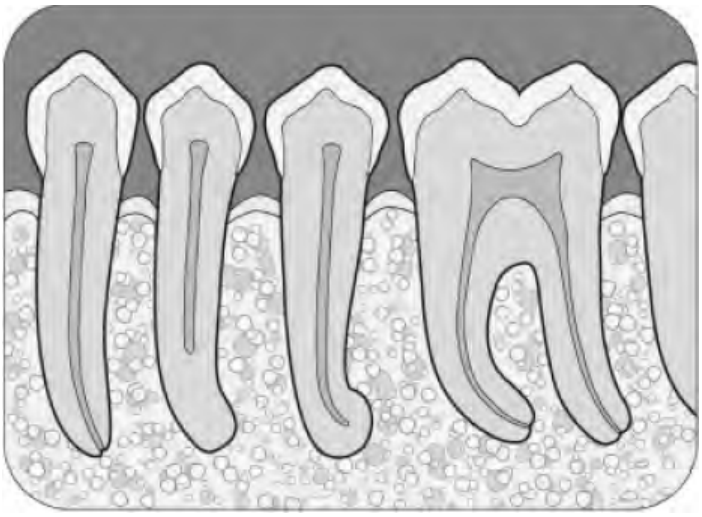

Fig. 13 Schematic representation of a premolar periapical radiograph
which reveals clues about root canal morphology. An abrupt disappearance
of the large canalin the mandibular first premolar usually signifies a canal bifurcation(8).

In this case, a closer look at the periapical radiograph before endodontic treatment in 2001, one might see an abrupt disappearance in the middle of the root. According to Vertucci´s classification this could be a type V.

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Case 3

Retreatment on a patient treated with radiotherapy

Introduction

Seventy-three years old white Norwegian male.

Fig.1 Frontal view

Chief complaint

30. October 2007

The patient was referred to the Department of Endodontics for examination and endodontic treatment of the right maxillary lateral incisor.

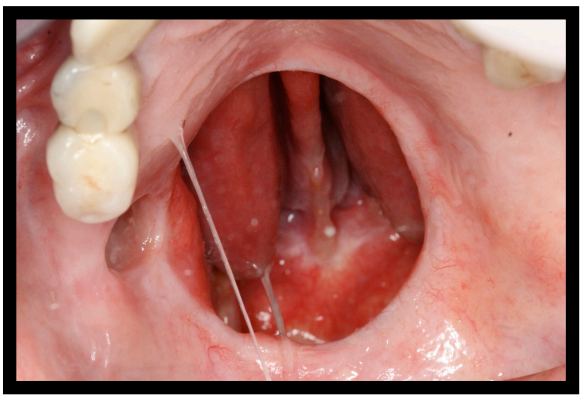

Fig. 2 Part of the palatal area is surgically removed

Medical history

Treated for squamous cell carcinoma in 2004

Radiotherapy 30 times 70Gy

Dental history

Endodontically treated tooth

Clinical findings
30. October 2007

Extra-oral examination: within normal limits

Intra-oral examination

	12	13	14
EPT	-	-	-
Cold	-	-	-
Percussion	-	-	-
Palpation	-	-	-
PPD	3mm	4mm	3mm

Table 1. Clinical findings

Soft tissue: within normal limits

Dental:
Tooth 12: Bridge restoration
Tooth 13: Bridge restoration
Tooth 14: Bridge restoration

Radiographic findings
30. October 2007

Tooth 12: Periapical radiolucency. PAI 3. Endodontically treated. Metal bridge. Some reduced marginal bone level.

Tooth 13: Normal lamina dura. PAI 1. Metal bridge. Some reduced marginal bone level.

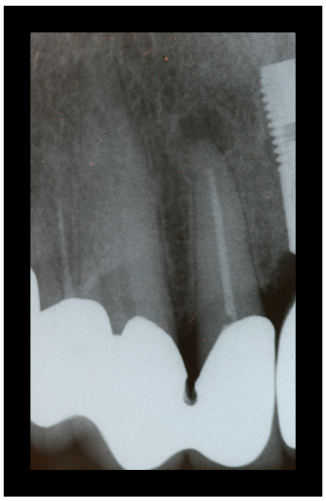

Fig. 3 Periapical radiograph

Diagnosis

Tooth 12:
Pulpal: Endodntically treated tooth(K04.19)
Periapical: Chronic apical periodontitis (K04.5)
Marginal: Chronic marginal periodontitis (k05.3)

Treatment plan

Non-surgical endontic retreatment tooth 12

Problem list

Osteoradionecrosis

Treatment

7. November 2007

Access cavity preparation. Rubber dam. Removal of gutta-percha and sealer. Length of the canal was determined by apex locator (Root ZX®) and a periapical radiograph. Root canal preparation was done mechanically with K-and NiTi hand files. One canal: R50/22mm/incisal edge
1% NaOCl and 17% EDTA were used for chemical root canal disinfection. The canal was dried with paper points and filled with Ca(OH)2. The tooth was temporarily sealed with IRM.

Fig. 4 Working length radiograph

14. November 2007

The canal were rinsed with 1% NaOCl and 17% EDTA and dried with paper points. Obturated with gutta percha and AH Plus. The tooth was temporarily sealed with IRM.

Fig. 5 Master point radiograph

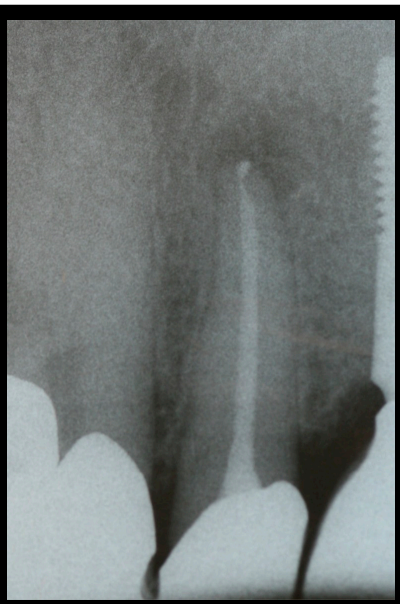

Fig. 6 Final periapical radiograph

Result

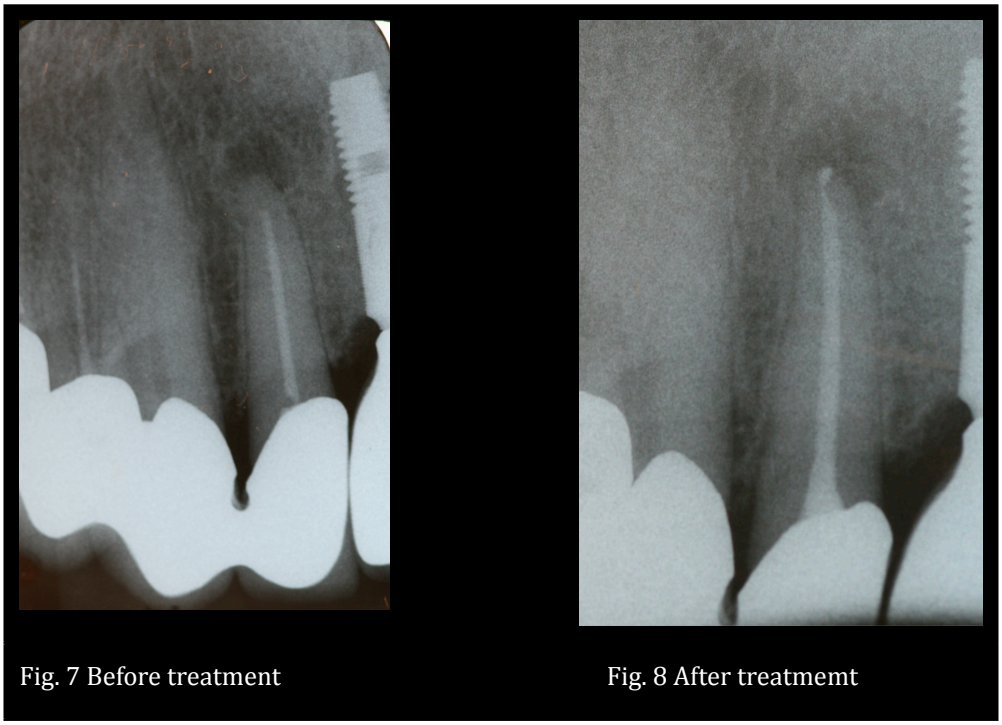

Fig. 7 Before treatment

Fig. 8 After treatmemt

Evaluation

No complications during treatment. The root filling appeared dense and good.

Prognosis

Endodontic: good
Tooth: good

Follow-up examination

The patient was asymptomatic and experienced no sensitivity to percussion or palpation tests.
The radiograph showed healing of the apical periodontitis.

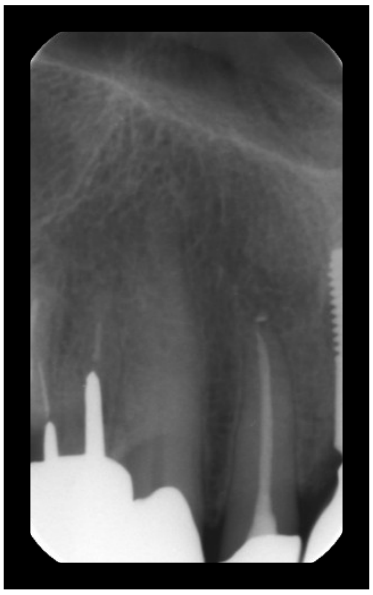

Fig. 9 Follow up radiograph

Discussion

In addition to anti-tumor effects, ionizing irradiation causes damage in normal tissues located in the field of radiation. This becomes particularly evident in the head and neck region, a complex area composed of several dissimilar structures that respond differently to radiation: mucosal linings, skin coverings, subcutaneous connective tissue, salivary gland tissue, teeth, and bone/cartilage (1).
The effects of cancericidal doses of radiation therapy on the tissues of the oral cavity and related structures are well studied. Changes have been noted in the mucosa, taste buds, salivary glands, bone, periodontium, teeth, oral flora, and muscles of mastication(2-4).

The most significant complication of irradiation for head and neck is neoplasmsis osteoradionecrosis(5,6). The irradiated bone becomes virtually a nonvital tissue as a result of a progressive obliteration of small vessels, a decrease in bone cells, a disorganization of the remodeling apparatus, and a progressive fibrosis. Such a bone exhibits a poor response to trauma or infection, and the incidence of osteoradionecrosis is high(7). The periodontium is affected in a very similar manner, with disorientation of the fibers, decreased vascularity and cellularity, and a thickening of the ligament. The behavior of the periodontal membrane, especially in its periapical aspects, is of considerable importance to the success of endodontic treatment(7).

Before and after radiation therapy an thorough and aggressive oral prophylaxis should be performed. The patient must be followed by weekly intervals during radiation therapy, and oral-hygiene instruction is repeated during these appointments. After therapy is completed, the patients should be placed on a regular recall schedule, usually requiring visits every three months during the first year. Strict adherence to oral-hygiene procedures must be demanded(6).

Seto et al evaluated eleven preradiation endodontically treated teeth (twentythree canals) and thirty-five postradiation endodontically treated teeth (fifty-four canals). The period of time from endodontic treatment to follow-up ranged from 6 months to 54 months (median, 21.6 months) for the postradiation group. There were no differences seen in postendodontic changes, regardless of whether the teeth involved were in the radiation field or whether the teeth involved were treated before or after radiation therapy. The overall retention of postradiation endodontically treated roots was 85% (46 of 54 roots). No osteoradionecrosis were associated with endodontically treated teeth(2).

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Case 4

Intra radicular perforation repair with MTA

Introduction

Sixty-five years old white Norwegian female.

Fig.1 Frontal view

Chief complaint

22. April 2008

The patient was referred to the Department of Endodontics, UiO, for examination and endodontic treatment of the left maxillary first molar, because of iatrogenic interadicular perforation during access cavity preparation at the student clinic.

Medical history

Diabetes type II
Medication: Amaryl 2mg*1
Glucophage 500mg*2

Dental history

February 2008

Started endodontic treatment at the student clinic, UiO. The treatment ended in a interradicular perforation and was referred to the specialist clinic.

Clinical findings
22. April 2008

Fig. 2 Occlusal view

Fig. 3 Occlusal view

Dental:
Tooth 23: Amalgam restoration at the distopalatal aspect of the tooth

Tooth 24: Composite restoration on the occlusal, distal and mesial aspect of the tooth. Palatal cusp fractured and exposed dentin.

Tooth 25: IRM restoration at the occlusal aspect

Tooth 26: IRM restoration at the occlusal aspect

Tooth 27: Amalgam restoration at the occlusal and mesial aspect

Extra-oral examination: within normal limits

Intra-oral examination

	23	24	26	27
EPT	26	24	-	36
Cold	+	+	-	+
Percussion	-	-	-	-
Palpation	-	-	-	-
PPD	3mm	3mm	3mm	3mm

Table 1. Clinical findings

Soft tissue: within normal limits

Radiographic findings
22. April 2008


Fig. 4 Periapical radiograph

Tooth 24: Normal lamina dura. No apical radiolucency. PAI 1. Radiopaque restoration on the occlusal and distal aspects of the crown.

Tooth 25: Discontinued lamina dura. Apical radiolucency. PAI 3. Radiopaque restoration on the occlusal aspect of the crown. Endodontically treated.

Tooth 26: Discontinued lamina dura. Apical radiolucency. PAI 3. Radiopaque restoration on the occlusal aspect of the crown. Interradicular radiolucency.

Tooth 27: Normal lamina dura. No apical radiolucency. PAI 1. Radiopaque restoration on the occlusal and mesial aspects of the crown.

Diagnosis

Tooth 26:
Pulpal: Necrotic pulp (K04.11)
Periapical: Chronic apical periodontitis (K04.5)
Marginal: Within normal limits

Treatment plan

Locate and close the perforation with MTA. Orthograde endodontic treatment of a non-vital pulp.

Treatment
22. April 2008

Rubber dam. Access cavity preparation. Located the interradicular perforation. Located the canal orifices.
Closed the canal orifices temporary with Cavit G, and then closed the perforation with grey MTA (Angelus, Brazil) using the MAP-system. A cotton pellet with saline water was placed over the MTA. IRM was applied as a temporary filling.

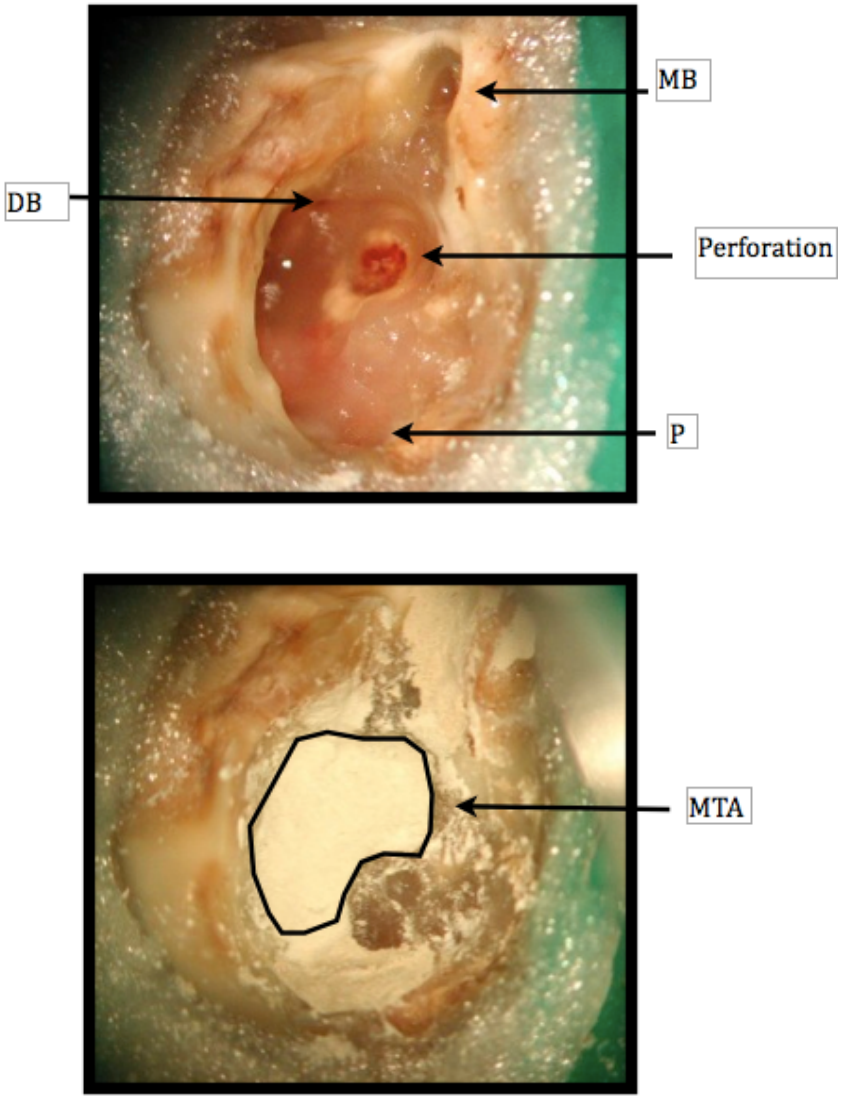

Fig. 5 & 6 Clinical photo of the pulp chamber

7. May 2008

Reconsidered the prognosis for the tooth. Asked the Department of Prosthodontics, UiO, and they recommended extraction of both 26 and 25, because of lack of tooth structure. New treatment plan was then to make a bridge from 27-24.

Fig. 7 Periapical radiograph

The next question was if tooth 24 needed preprosthodontic endodontic treatment. Department of Prosthodontic said it was not necessary to use a post. To observe the depth of the filling, some of the filling was removed. The tooth responded positive to the

sensitivity test and there was no obvious reason for doing an endodontic treatment at this point.

Fig. 8 Before treatment

Fig. 9 Removal of some of the filling.

The patient returned to the student clinic for extraction of 25 and 26.

Result

Fig. 10 Before treatment

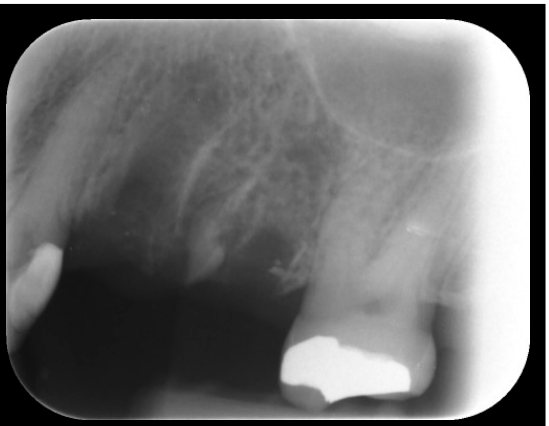

Fig. 11 After treatmemt

Follow-up examination
10. February 2009

At the student clinic, after they started bridge preparation, they reexamined tooth 24, and considered to do a preprosthodontic endodontic treatment.

Fig. 12 Before endodontic treatment

Fig. 13 After endodontic treatmemt

Fig. 14 Periapical radiograph with final restauration.

Discussion

Maintenance of a healthy pulp tissue is important for tooth function and survival. Secondary and tertiary dentin production serve to protect the tooth and jaw from infections, caries, and traumatic dentin exposure, and nervous stimuli from the pulp regulate the masticatory forces and help to prevent damage during function. However, wear, trauma, and disease may impair the barrier otherwise put up by the dentin coverage, and pulpal necrosis may occur after many insults during the lifetime of the tooth(1).

Tertiary dentin has been subclassified as either reactionary or reparative. Reactionary dentin is defined as a tertiary dentin matrix secreted by surviving postmitotic odontoblast cells in response to an appropriate stimulus. Reparative dentin is defined as a tertiary dentin matrix secreted by a new generation of odontoblast-like cells in response to an appropriate stimulus after the death of the original postmitotic odontoblasts responsible for primary and physiologic secondary dentin secretion(2).

In a larger study of 217 teeth, reactionary dentin deposition was observed beneath cavities with a RDT above 0.5 mm as well as beneath cavities with a RDT below 0.25 mm; however maximal reactionary dentin appeared to be beneath cavities with an RDT between 0.5-0.25 mm. The area of reactionary repair was also influenced by the choice of restoration material from greatest to least; calcium hydroxide, composite, resin-modified glass-ionomer cement and zinc oxide-eugenol. Odontoblast numbers were maintained beneath cavities with a RDT above 0.25 mm, cavities placed closer to the pulp appeared to injure underlying odontoblasts, reducing their numbers(3).
To reduce pulp injury and to promote pulpal repair activity, the correct use of appropriate materials are important. However, of relatively greater importance is the operative technique adopted, the need to avoid the excess removal of dentine and to minimize trauma during preparation(4).

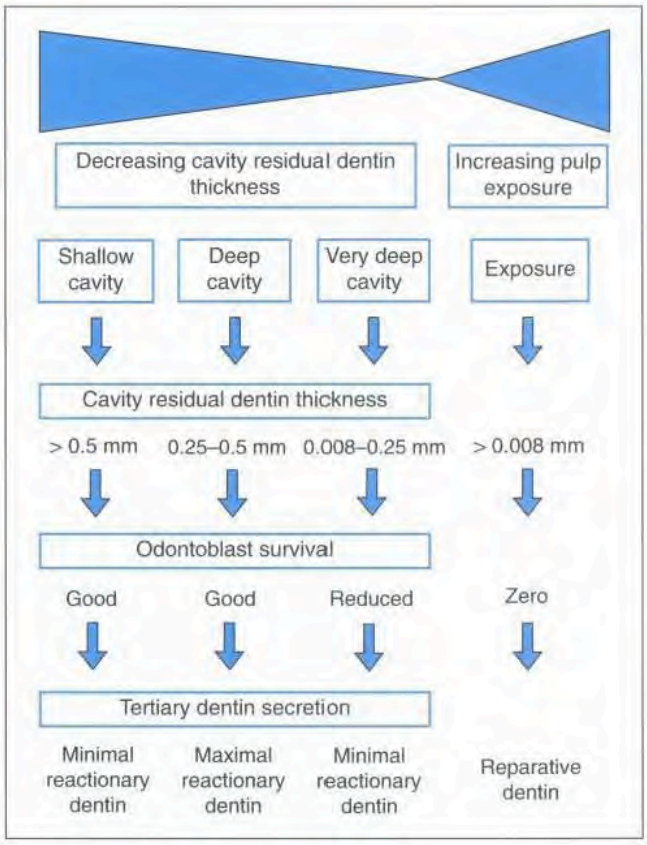

Figure 15. (3). Schematic diagram of the relationship between cavity residual dentin thickness, odontoblast survival, and tertiary dentinogenesis.

It is hard to determine the RDT in a clinical case. In this case there where no sign of the pulp, and the patient experienced no pain from the tooth, so there was no indication for endodontic treatment at the time before the beginning of bridge preparation.

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Case 5

Apical MTA barrier

Introduction

23 year old white northern european female

Fig.1 Frontal view

Chief complaint

29. October 2008

Patient was referred from Department of Orthodontics to the Department of Endodontics for treatment of right maxillary central incisor

Medical history

Non contributory

Dental history

Started Orthodontic treatment in 1996. Removed the orthodontic apparatus after six months because of short roots. Restarted the orthodontic treatment in 2004.

Clinical findings

29. October 2008

Extra-oral examination: within normal limits

Intra-oral examination

Fig 2. Occlusal view

Dental:
Tooth 12: Composite restoration at the mesial and distal aspect of the tooth. Orthodontic fixed appliance.
Tooth 11: Composite restoration at the mesial, distal and palatal aspect of the tooth. Orthodontic fixed appliance.
Tooth 22: Composite restoration at the mesial an distal aspect of the tooth. Orthodontic fixed appliance.

	12	11	21
EPT	22	-	34
Cold	+	-	+
Percussion	-	-	-
Palpation	-	-	-
PPD	2mm	2mm	2mm

Table 1. Clinical findings

Soft tissue: within normal limits

Radiographic findings
29. October 2008

Tooth 12: Normal lamina dura. No apical radiolucency. PAI 1. Radiopaque restoration on the mesial and distal aspects of the crown. Orthodontic fixed appliance.

Tooth 11: Discontinued lamina dura. Apical radiolucency. PAI 3. Radiopaque restoration on the mesial, palatal and distal aspect of the crown. Diffuse radiopaque material in the canal. Orthodontic fixed appliance

Fig. 3 Periapical radiograph

Tooth 21: Normal lamina dura.No apical radiolucency. PAI 1. Short root. Radiopaque restoration on the mesial and distal aspect of the crown. Orthodontic fixed appliance.

Diagnosis

Tooth 11:

Pulpal: Necrotic pulp (K04.11)
Periapical: Chronic apical periodontitis (K04.5)
Marginal: Within normal limits

Treatment plan

Orthograde endodontic treatment of tooth 11 with an MTA apical barrier.

Problem list

Open apex

Treatment
22. April 2008

Clinical examination.Tooth 11 diagnosed with chronic apical periodontitis. Access cavity preparation. Rubber dam. There was a perforation apically from previous endodontic treatment. Root canal length was determined by radiographic image. Root canal disinfection was done mechanically with K-and NiTi hand files.
One canal: R90/14mm
Irrisafe ® with 1% NaOCL, 17% EDTA and 2%CHX were used for chemical root canal disinfection. The canal was dried with paper points, filled with Ca(OH)2 and temporary sealed with IRM.

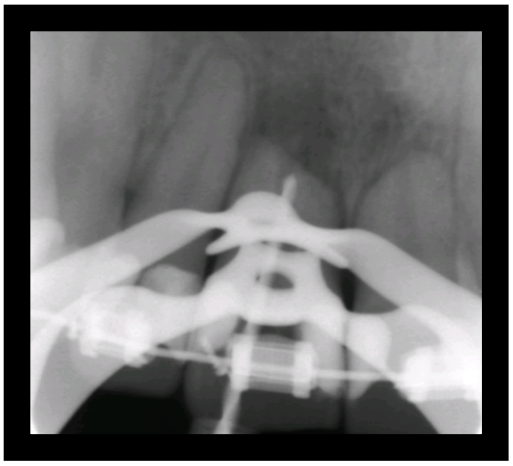
Fig 4. Working length radiograph

26. November 2008

The patient returned with no symptoms. The canal was irrigated and dried with paper points. Apical perforation is visible.(Fig 5.)
Grey Mineral trioxide Aggregate(MTA) (1mm thick) was placed as an apical barrier to prevent apical extrusion of gutta-percha during

obliteration(Fig 6). Ah-plus sealer was applied to the canal walls. SybronEndo Elements of Obturation Unit ® with gutta-percha was used for backfilling from the MTA plug. (Fig 7) To seal of the root canal filling IRM was used. The pulp chamber was cleaned and dried, ready for a composite filling. Phosphoric acid, Adper Scotchbond, Filtek Supreme A1.

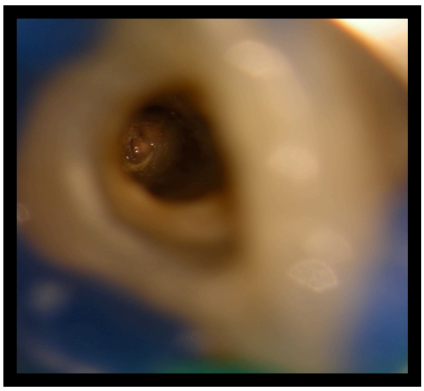

Fig 5. Apical perforation

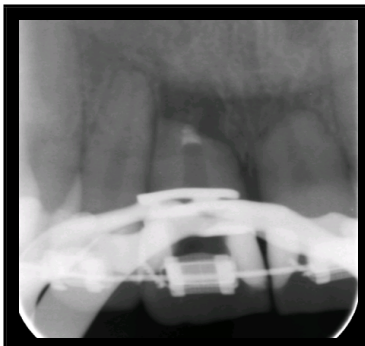

Fig 6. MTA apical barrier

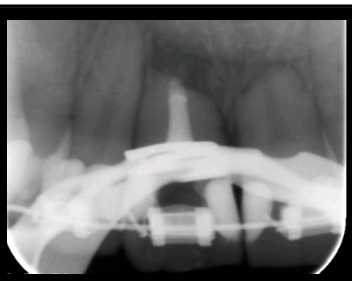

Fig 7. Gutta percha

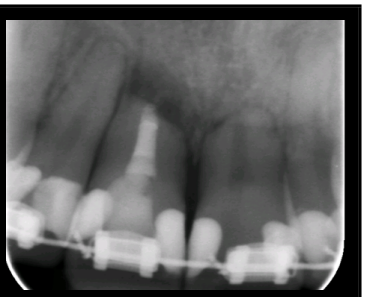

Fig 8. Final radiograph

Result

Fig. 9 Before treatment

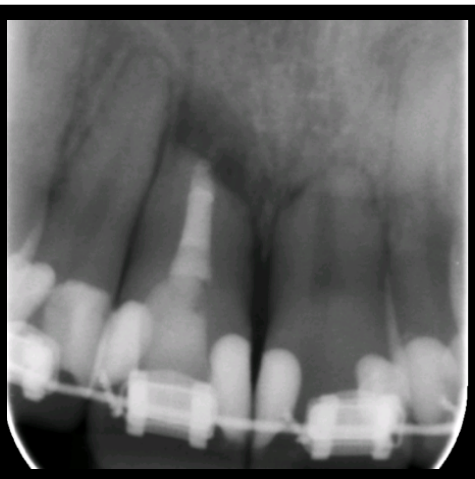

Fig. 10 After treatment

Evaluation

No complications during treatment. No extrusion of the MTA. The root filling appeared dense and good.

Prognosis

Endodontic: good

Tooth: uncertain - because of a short root.

Follow-up examination

9. March 2010

Fig. 11 Frontal view

The patient was asymptomatic and experienced no sensitivity to percussion or palpation tests

Fig. 12 Follow up radiograph

Fig. 13 Follow up radiograph

The radiograph showed evidence of healing of the apical periodontitis.

Discussion

Apexification is defined as a method of inducing a calcified barrier in a root with an open apex or the continued apical development of an incompletely formed root in teeth with a necrotic pulp (WE Glossary 6th edition 1998)(1).

Mineral trioxide aggregate (MTA) was developed and recommended initially as a root-end filling material and subsequently has been used for pulp capping, pulpotomy, apexogenesis, apical barrier formation in teeth with open apexes, repair of root perforations, and as a root canal filling material. MTA has been recognized as a bioactive material (2). One of the major consequences after repair of root perforations has been the inflammatory reaction in the surrounding tissues. MTA not only has been shown to be biocompatible to the surrounding tissues but also has demonstrated the ability to allow regeneration of these hard tissues(3).

Main et al looked at perforations in the apical, furcal and lateral area of the tooth, and strip perforations. Nine of 16 teeth had a presence of lesion before treatment. None of the teeth had lesions at the follow up radiograph(3). Some studies have questioned the use of a two step procedure, like in this case, where Ca(OH)2 is used as an inter appointment dressing. Simon et al did a prospective study where they looked at 57 teeth who undergone apexification using MTA in one appointment. It had a succes rate of 81%(4). Another study looked at 40 root canals from 20 maxillary and mandibular premolars of two 6-month old Beagle dogs. They were divided in two groups; One step MTA, and Ca(OH)2 for one week and then MTA. Immediate application of MTA showed three times the number of complete apical barriers. So their conclusion was that MTA favoured apexification and periapical healing regardless of Ca(OH)2(5). So these results can show that apexification in one visit by placing an apical plug of MTA is a predictable and reproducible clinical procedure(4).

In this case there is a good prognosis for the endodontic treatment, when we use these references to look at the outcome, regardless of the use of Ca(OH)2 as inter appointment dressing or not.

After a MTA apical plug is in place, it is easy to backfill the rest of the canal with a varm vertical technique without the risk of extrusion of the material.

Referenced by Tronstad (1988a), Cwyk et al. (1984) found that 5±10 years after completion of orthodontic treatment, 42.3% of the maxillary central incisors, 38.5% of the maxillary lateral incisors, and 17.4% of the mandibular incisors had undergone apical resorption. The overall incidence of resorption was 28.8% for the orthodontically treated incisors compared to 3.4% for the controls. Apical root resorption has been reported to be seen four times more often than lateral resorption(6).

So it is not unusual, like for this patient, that a resorption of the apical part of the root occurs. This tooth was under orthodontic treatment, and according to the

literature, endodontically treated teeth can be moved orthodontically as readily as teeth with vital pulps(6).

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Case 6

Removal of a cast post prior to retreatment

Introduction

38 year old white Northern European female

Fig.1 Frontal view

Chief complaint

11. March 2008

The patient was referred to Department of Endodontics for examination and treatment of the left maxillary first molar.

Medical history

Non contributory

Dental history

Tooth 26: Endodontically treated some years ago. Crown and post.

Clinical findings

11. March 2008

Extra-oral examination: within normal limits

Intra-oral examination:

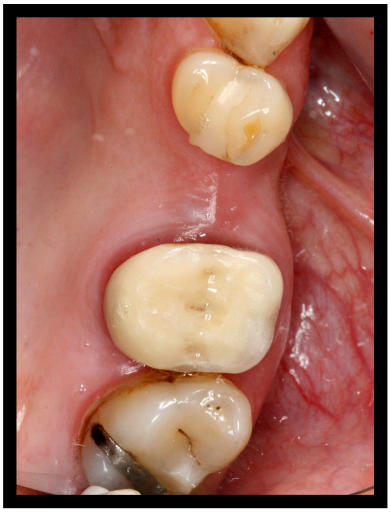

Fig. 2 Occlusal view

Dental:

Tooth 24: Composite restoration at the occlusal and distal aspect of the tooth.

Tooth 26: Porcelain fused to metal crown

Tooth 27: Amalgam restoration at the occlusal an palatal aspect of the tooth.

	24	26	27
EPT	24	-	34
Cold	+	-	+
Percussion	-	-	-
Palpation	-	-	-
PPD	2mm	2mm	2mm

Table 1. Clinical findings

Soft tissue: within normal limits

Radiographic findings

11. March 2008

Tooth 26: Discontinued lamina dura at the MB and DB root. Normal lamina dura at the palatal root. Apical radiolucency at the MB and DB root. No apical radiolucency at the palatal root. PAI 4. Crown and post.

Fig 3. Periapical radiograph

Tooth 27: Normal lamina dura. No apical radiolucency. PAI 1. Radiopaque restoration on the occlusal aspect of the crown.

Tooth 28: Normal lamina dura. No apical radiolucency. PAI 1. Radiolucent area in the occlusal potion of the dentin, similar to occlusal caries.

Diagnosis

Tooth 26:

Pulpal: Necrotic pulp (K04.11)
Periapical: Chronic apical periodontitis (K04.5)
Marginal: Within normal limits

Treatment plan

Orthograde endodontic retreatment of tooth 26 and removal of post.

Problem list

Difficult to remove the post.

Treatment

9. April 2008
10.

Clinical examination.Tooth 26 diagnosed with chronic apical periodontitis. Access cavity preparation. The post was located in the palatal canal. (Fig 4). Excessive metal around the post in the coronal part was removed with a high speed diamond bur. Ultrasonic and Sybronendo CT4 ® tip, with water coolant in continous movement was used around the post until it was removed. (Figure 5 & 6)

Fig. 4 Post in place

Fig. 5 Post loose in the canal

Fig. 6 Post removed

10. June 2008

Rubber dam. Localization of an untreated canal, MB2. Gutta percha and sealer in the coronal part was removed with Gates Glidden bur. In the middle and apical part it was removed mechanically with K-and NiTi hand files. Root canal length was determined by radiographic image and apex locator(Root ZX ®)
Four canals:
MB: R45/15mm
MB2: R40/14mm
DB: R45/14mm
P: R60/19mm

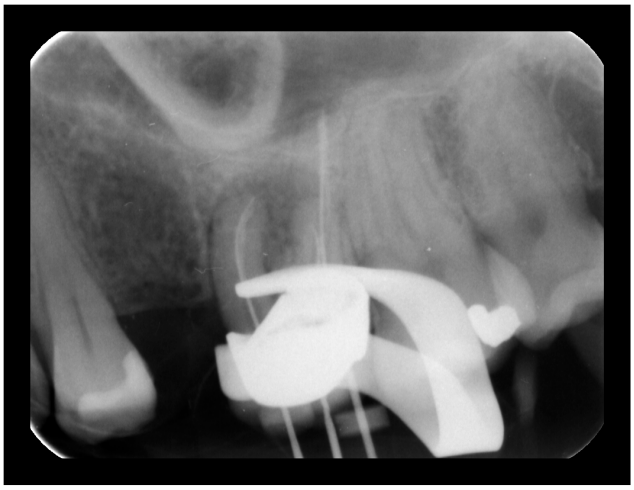

Fig 7. Working length radiograph

Irrisafe ® with 1% NaOCL, 17% EDTA and 2%CHX were used for chemical root canal disinfection. The canal was dried with paper points, filled with Ca(OH)2 and temporary sealed with IRM.

3. September 2008

The patient returned with no symptoms. 1% NaOCL and 17% EDTA were used for chemical root canal disinfection.
The canals was dried with paper points and filled with Ah-plus and gutta-percha. Surplus of Ah-plus from the MB-canals was evident on the periapical radiograph. IRM was applied as a temporary filling.

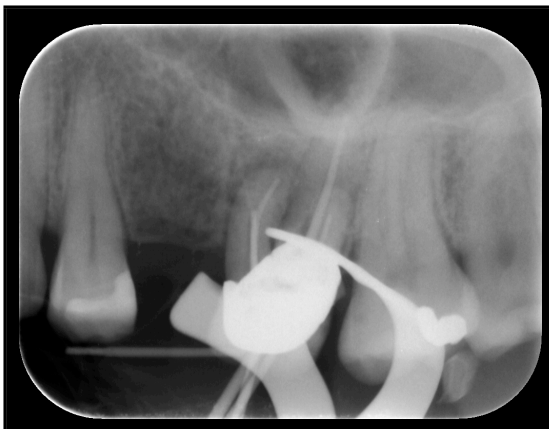

Fig. 8 Master point

Fig. 9 Final radiograph

Result

Fig. 10 Before treatment

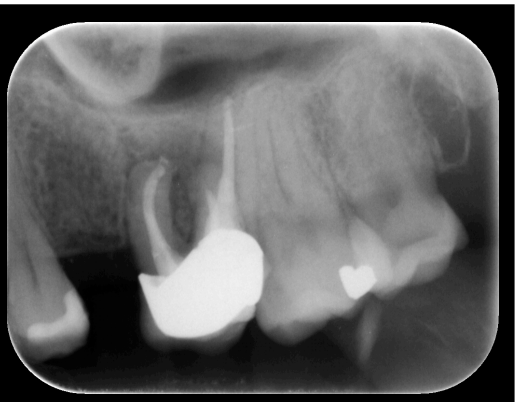

Fig. 11 After treatment

Evaluation

No complications during treatment. The root filling appeared dense and good.

Prognosis

Endodontic: good
Tooth: good.

Follow-up examination

22. September 2009

The patient was asymptomatic and experienced no sensitivity to percussion or palpation tests on tooth 26.
The radiograph showed evidence of healing of the apical periodontitis

Fig. 12: Follow up radiograph

Discussion

In 1957 ultrasonic instrumentation was introduced to endodontics. One of the many uses of ultrasonics in endodontics has been assisting in the removal of cemented posts(1). When ultrasonically activating a post, care should be taken to ensure that it does not overheat(2). Heat in the post is produced or moderated through 3 different mechanisms. First, friction is created between the post and the ultrasonic tip and between the post and cementing medium or tooth. The type of cementing medium might play a role. Next, absorption of acoustic ultrasonic energy by the post can produce heat. Finally, coolant flow through the handpiece can moderate temperature increase (1,5,6). Huttula et al (2006) measured external root-surface temperature changes, with and without irrigation. The ultrasonic tip was activated for 4 minutes and the maximum change in temperature was with water coolant in the coronal part, 3,2C and in the apical part 5,9C. Without the water coolant in the coronal part, 17,6C and in the apical part 15,2C. (3) Ettrich et al(2007) demonstrated a rapid increase in external root temperature, especially in the absence of a coolant. When the power level was adjusted from a medium to a high setting, the average heat rate significantly increased, regardless of the use of a coolant. They concluded with that the use of a continuous water spray during ultrasonic application should not exceed a period of 30 seconds(4).

There are many different types of posts and post materials. Satterthwaite et al (2003) found that post type had no influence on peak temperature. Temperature increase on the external root surfaces increased as the thickness of dentine between post and root surface was reduced(5).

One issue when removing a post is the reduced remaining tooth substance. There has to be a balance between what is necessary to remove and what is left to support the coronal restoration, and the incidence of crack formation in the dentin after the use of ultrasonic instrumentation during post removal.

Altshul et al (1997) showed that ultrasonic vibration of posts during removal caused significantly more cracks in the root at the surface or CEJ level compared with nonposted endodontically treated teeth. The potential for production of vertical root fractures may be increased(7).
Satterthwaite and Stokes(2004) stated that prolonged application of ultrasonic vibration to ceramic posts increased the incidence of root-face cracks(8).

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Case 7

Strip perforation repair with MTA

Introduction

25 year old white Northern European female

Fig.1 Frontal view

Chief complaint

17. March 2009

The patient was referred to Department of Endodontics for examination and treatment of the right mandibular first molar.

Medical history

Non contributory

Dental history

Tooth 46: Endodontically treated some years ago in Austria. Composite filling.

Clinical findings

11. March 2008

Extra-oral examination: within normal limits

Intra-oral examination:

	47	46	45
EPT	35	-	24
Cold	+	-	+
Percussion	-	-	-
Palpation	-	-	-
PPD	2mm	2mm	2mm

Table 1. Clinical findings

Soft tissue: Sinus tract at the buccal in the attached gingiva.

Dental:

Tooth 45: Sound tooth.
Tooth 46: Composite filling at the occlusal, mesial and distal aspect of the tooth.
Tooth 47: Sound tooth.

Radiographic findings
17. March 2009

Tooth 46: Discontinued lamina dura at the M and D root. Apical radiolucency at the M and D root. PAI 4. Composite filling. Fractured instrument in the distal canal. Sinus tract to the interradicular area.

Tooth 47: Normal lamina dura. No apical radiolucency. PAI 1.

Tooth 45: Normal lamina dura. No apical radiolucency. PAI 1.

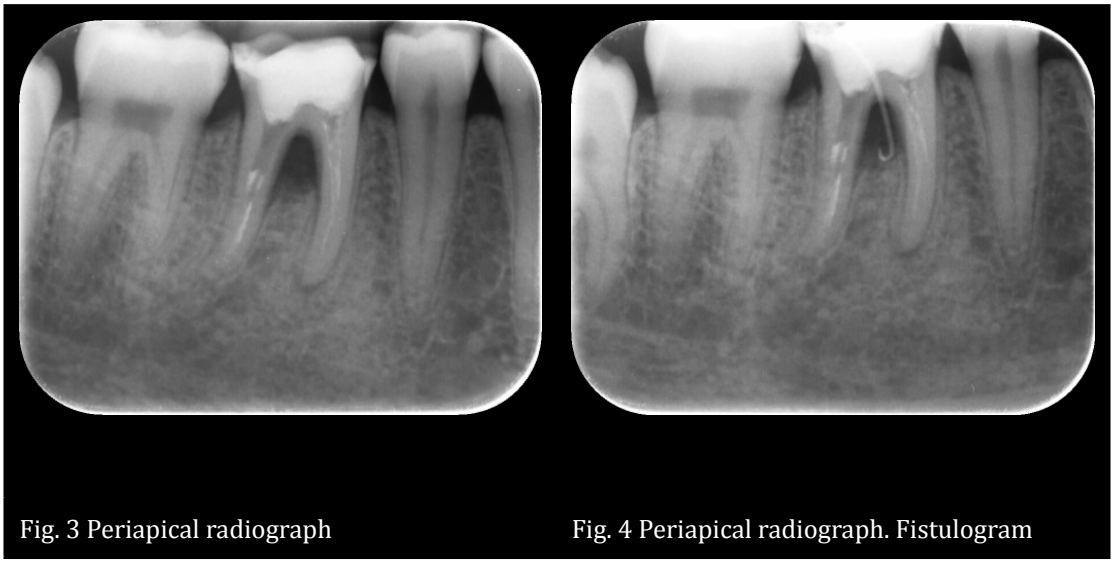

Fig. 3 Periapical radiograph

Fig. 4 Periapical radiograph. Fistulogram

Diagnosis

Tooth 46:
Pulpal: Endodontically treated tooth(K04.19)
Periapical: Chronic apical periodontitis (K04.5)
Chronic lateral periodontitis (K04.51)
Sinus tract(K04.62)
Marginal: Chronic marginal periodontitis (K05)

Treatment plan

Orthograde endodontic retreatment of tooth 46. Removal of fractured instrument in the distal canal.

Problem list

Difficult to remove the fractured instrument. Locate a possible perforation to the interradicular area.

Treatment
17. March 2008

Clinical examination.Tooth 46 diagnosed with chronic apical periodontitis. Access cavity preparation. Rubber dam. Slurry and very little root canal material was seen (Fig 4). The material was easily removed with Hedstrøm files. (Fig .5) A strip perforation was seen in the occlusal third of the distolingual canal. (Fig. 6)

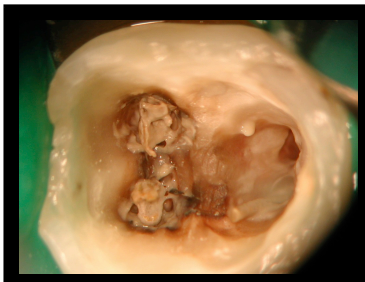
Fig. 4


Fig. 5

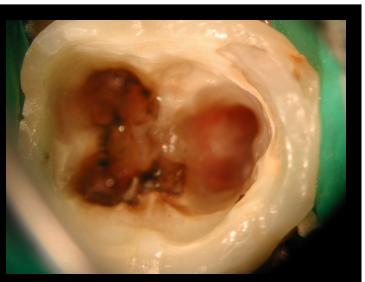
Fig. 6

Instrumentation was done mechanically with K-and NiTi hand files. It was a step in the mesial canals. A fractured endodontic instrument was found in the DL canal. Root canal length was determined by radiographic image.
Four canals:
MB: R40/18mm
ML: R45/16mm


Fig. 7 Working length

DB:R45/17mm
DL: R45/15mm
1% NaOCL, 17% EDTA and 2%CHX were used for chemical root canal disinfection. The canal was dried with paper points, filled with Ca(OH)2 and temporary sealed with IRM.

15. April 2009

There was still an sinus tract at the buccal aspect in the gingiva.(Fig. 8)
The fractured instrument in the DL canal was removed. It was possible to bypass and retract it with an Hedstrøm file size 40.(Fig. 9)
1% NaOCL, 17% EDTA and 2%CHX were used for chemical root canal disinfection. The canal was dried with paper points, filled with Ca(OH)2 and temporary sealed with IRM.

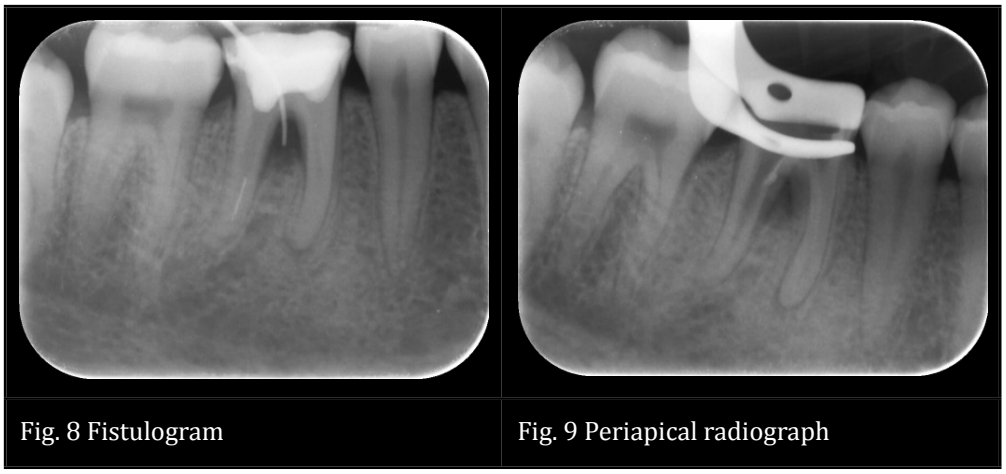

Fig. 8 Fistulogram | Fig. 9 Periapical radiograph

14. May 2009

The patient returned with no symptoms. The sinus tract was gone.1% NaOCL and 17% EDTA were used for chemical root canal disinfection. The canals was dried with paper points and filled with Ah-plus and gutta-percha. In the DL canal, the canal was filled with Ah-plus and gutta-percha to the perforation. The perforation and the rest of the canal was filled with MTA. IRM was applied as a temporary filling.

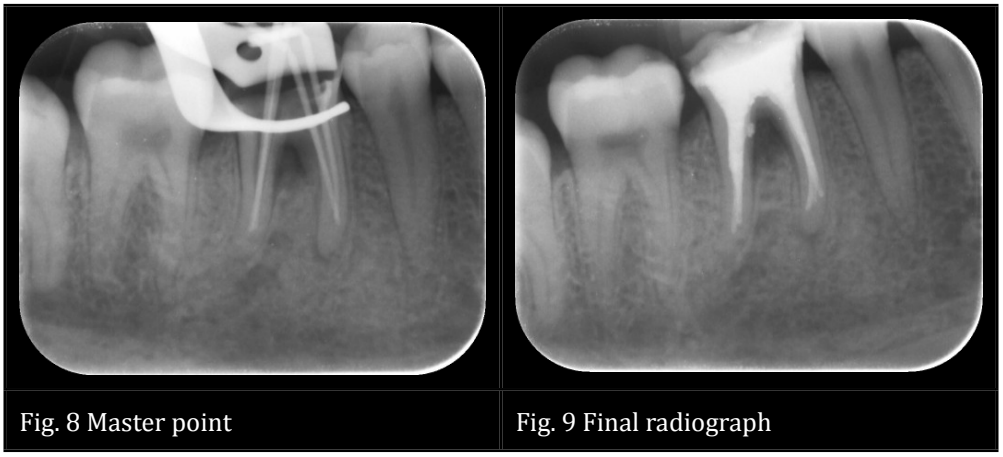

Fig. 8 Master point | Fig. 9 Final radiograph

Result

Fig . 10 Before treatment

Fig. 11 After treatment

Evaluation

No complications during treatment. The root filling appeared dense and good, but 3mm short in the mesial canals

Prognosis

Endodontic: uncertain
Tooth: uncertain

Follow-up examination

1. December 2009 and 2. March 2010

The patient was asymptomatic and experienced no sensitivity to percussion or palpation tests

The radiograph showed evidence of healing of the lateral and apical periodontitis.

Fig. 12 1122009

Fig. 13 2032010

Discussion

Different complications during endodontic treatment can occur. One of them is strip perforations, and it is not always easily detected before obturation.
In this case there was a large interradicular radiolucent zone, and one could suspect a perforation from the previous treatment.

Root perforations are common complications of endodontic treatment or post preparation and often lead to tooth extraction. Successful treatment depends mainly on immediate sealing of the perforation and prevention of infection. Several factors affect the achievement of these goals, most important of which are: time of occurrence, size, and location of the perforation(1).
The time elapsed from the development of the defect is a critical factor influencing the post treatment prognosis; a delay in repairing a perforation opens the way to bacterial contamination. In animal studies, teeth with contaminated intentional lateral perforation were associated with a poorer repair process than teeth with no contaminated defects(2,3)
The following materials have been recommended for sealing root perforations: Cavit, silver amalgam, super EBA cement, calcium hydroxide, hydroxyapatite, calcium phosphate cement, light-cured glass ionomer , and decalcified freeze-dried bone . None of these perforation sealing materials is adequately biocompatible to ensure a good treatment outcome when it comes into direct contact with the neighboring tissue(4).

MTA was first described in the dental literature in 1993(5), and the material was approved for endodontic use by the FDA in 1998(5). It is a mixture of Portland cement and bismuth oxide. It is mixed in a 3:1 ratio with sterile water and will form a colloidal gel before it solidifies in 3-4 hours(7,8). During this time, the pH will rise from 10,2 to 12,5(8,9). Leakage studies on MTA have shown that the material has less leakage than traditional material when used as an apical restoration and furcation repair. MTA has also been shown to be biocompatible both in cell culture and when embedded in bone, with new cementum covering the material when used as an apical plug.
Mente et al (2010) investigated treatment outcome of root perforations repaired with MTA on 21 teeth. Eighteen teeth (86%) were classified as healed(3). Pace et al (2008) selected ten cases of furcal perforation. All the perforations were cleaned with NaOCl, EDTA, and ultrasonic tips and sealed with MTA without internal matrix. After 5 years, the absence of periradicular radiolucent lesions, pain and swelling along with functional tooth stability indicated a successful outcome of sealing perforations in 9 out of 10 teeth(10). In conclusion from this studies, a high success rate for treatment of root perforations in all areas of the root can be achieved with MTA(3).
As in this case, even with a longstanding perforation which has led to a lateral periodontitis with a sinus tract, a complete healing of the lesion is seen.

When a retreatment is performed, it can be difficult to reach the optimal obturation length if there already is made a step. And that will effect the prognosis for the tooth. Sjøgren et al (1990) studied retreatment cases, and

found that when the root filling was more than 2mm from the radiographic apex, they achieved healing in only 65% of the cases(11).

In this case the root canal filling was a little short in both of the roots, but even though it completely healed.

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Case 8

Pulpectomy

Introduction

56 year old white Northern European female

Fig.1 Frontal view

Chief complaint

8. September 2009

The patient was referred to Department of Endodontics for examination and treatment of the left mandibular second molar. Further treatment plan for tooth 37 was a crown.

Medical history

Non contributory

Dental history

Tooth 37: Large fractured amalgam filling. The tooth is waiting for crown treatment

Clinical findings

8. September 2009

Extra-oral examination: within normal limits

Intra-oral examination:

Fig. 2 Occlusal view

Dental:

Tooth 35: Amalgam restoration at the mesial, occlusal, distal and buccal aspect of the tooth.

Tooth 36: Porcelain fused to metal crown

Tooth 37: Amalgam restoration at the mesial, occlusal, distal, lingual and buccal aspect of the tooth. Temporary filling in the buccoocclusal aspect of the crown.

	35	36	37
EPT	35	-	-
Cold	+	-	-
Percussion	-	-	-
Palpation	-	-	-
PPD	3mm	3mm	3mm

Table 1. Clinical findings

Soft tissue: within normal limits

Radiographic findings

8. September 2009

Tooth 35: Normal lamina dura. No apical radiolucency. PAI 1. Radiopaque restoration on the occlusal aspect of the crown.

Tooth 36: Discontinued lamina dura at the M and D root. Apical radiolucency at the MB and DB root. PAI 5. Crown and post.

Fig. 3 Periapical radiograph

Tooth 37: Discontinued lamina dura at the mesial root, and widened lamina dura at the distal root. PAI 4.
Radiopaque restoration on the occlusal aspect of the crown.

Diagnosis

Tooth 37:
Pulpal: Necrotic pulp (K04.11)
Periapical: Chronic apical periodontitis (K04.5)
Marginal: Within normal limits

Treatment plan

Orthograde endodontic treatment of tooth 37.

Treatment
8. September 2009

Clinical examination.Tooth 37 diagnosed with chronic apical periodontitis. Access cavity preparation. Bleeding in all three canals. The pulpal diagnosis was altered to vital pulp(K04.a). Rubber dam. Length of the canal was determined by apex locator (Root ZX®) and a periapical radiograph. Root canal preparation was done mechanically with K-and NiTi hand files in conjunction with Bio-Race.
Three canals.
MB R40/18 mm MBC
ML R40/18mm MLC
D R60/20mm DC
1% NaOCl and 17% EDTA were used for chemical root canal disinfection. The canal was dried with paper points and filled with Ca(OH)2. Temporary sealed with IRM.

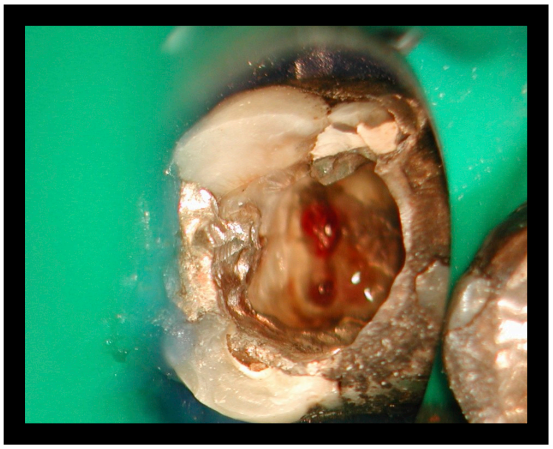
Fig. 4 Clinical photo of bleeding pulp


Fig 5. Working length radiograph

15. September 2009

The canals were rinsed with 1% NaOCl and 17% EDTA and dried with paper points. Obturated with gutta percha and AH Plus. Temporary sealed with IRM.

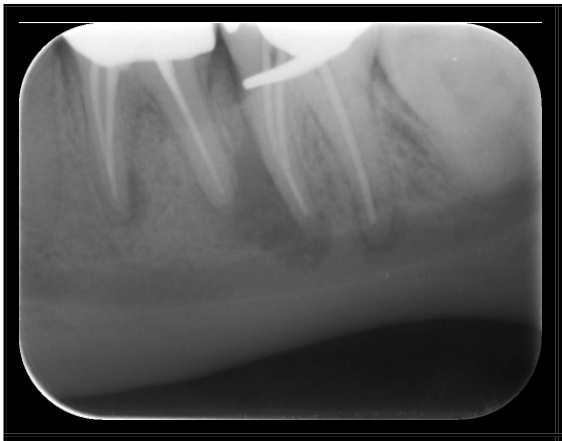

Fig. 6 Master point radiograph

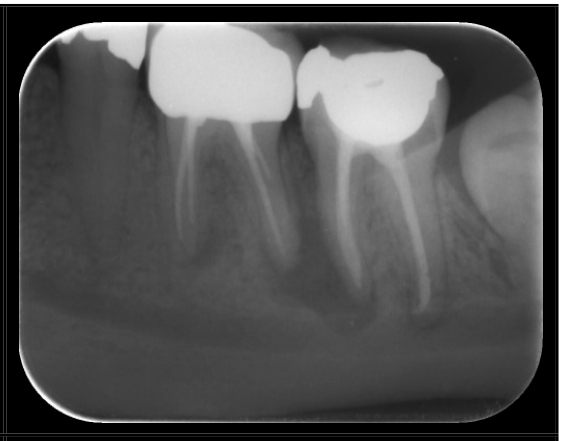

Fig 7. Final radiograph

At the final appointment the patient brought an x-ray from 2004 when tooth 36 was endodontically treated.

Fig 8. Periapical radiograph from 2004

Fig. 9 Periapical radiograph 2009

The periapical radiographic image from 2009 show some sign og healing, but there is still a large lesion at the distal aspect og the D root. The patient was set up for reatreatment of tooth 36

21. October 2009

Access cavity preparation. Rubber dam. Removal of gutta-percha and sealer. Length of the canal was determined by apex locator(Root ZX®) and a periapical radiograph. Root canal preparation was done mechanically with K-and NiTi hand files in conjunction with Bio-Race.

Four canals.

ML R45/18,5mm MLC
MB R45/18,5mm MBC
DL R45/19mm DLC
DB R45/19mm DBC

1% NaOCl, 17% EDTA and 2% CHX were used for chemical root canal disinfection. The canal was dried with paper points and filled with Ca(OH)2. Temporary sealed with IRM.

Fig 10. Working length radiograph

3. November 2009

The canal were rinsed with 1% NaOCl and 17% EDTA and dried with paper points. Obturated with gutta percha and AH Plus. Temporary sealed with IRM.

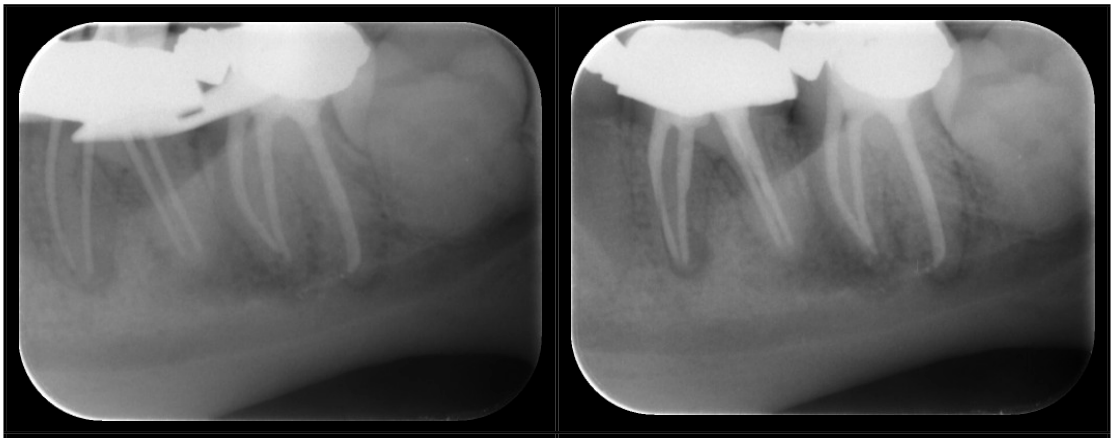

Fig. 11 Master point

Fig. 12 Final radiograph

Result

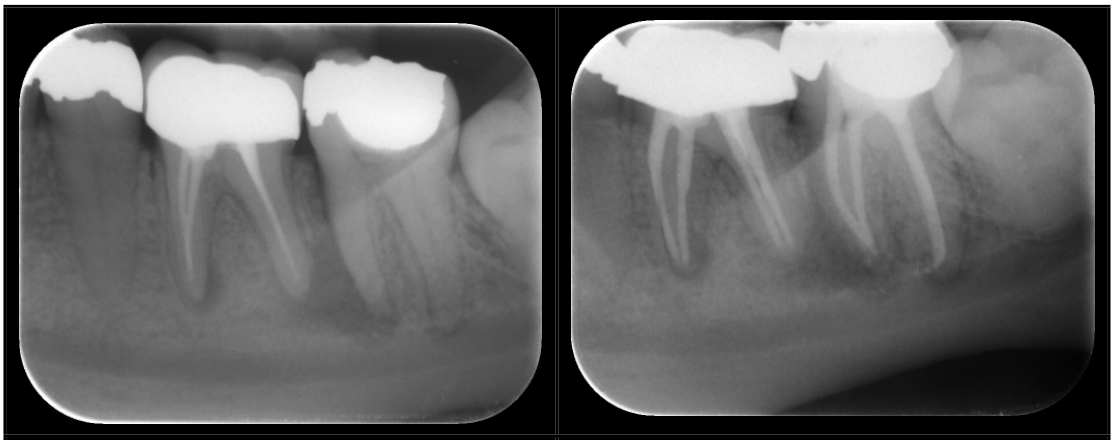

Fig. 13 Before treatment

Fig. 14 After treatment

Evaluation

No complications during treatment. The root fillings appeared dense and good.

Prognosis

Endodontic: good
Tooth: good.

Follow-up examination
13. April 2010

The patient was asymptomatic and experienced no sensitivity to percussion or palpation tests

The radiograph showed evidence of healing of the apical periodontitis.

Fig. 15. Follow up radiograph

Discussion

Before treatment starts a pulpal and periapical diagnosis has to be established. The diagnosis should be based on the clinical and radiographic findings.
In this case both the clinical and radiographic findings indicated pulp necrosis.

Petersson et al (1999) evaluated the ability of thermal and electrical tests to register pulp vitality. First they defined sensitivity, specificity, positive predictive value, the negative predictive value and accuracy.
Sensitivity is the ability of a test to identify teeth that really are diseased. Diseased is teeth with necrotic pulp. The sensitivity was calculated according to the formula TP/(TP+FN)
Specificity is the ability of a test to identify teeth without disease. Without disease is teeth with vital pulp. The specificity was calculated according to the formula TN/(TN+FP).
Positive predictive value is the probability that a positive test result really represents a diseased tooth. That is a tooth with necrotic pulp. The positive predictive value was calculated according to the formula TP/(TP+ FP).
Negative predictive value is the probability that a tooth with a negative test result really is free from disease. A tooth free from disease is a tooth with vital pulp. The negative predictive value was calculated according to the formula TN/(TN + FN).
Accuracy is the overall rate of agreement between the diagnostic test and the gold standard. The accuracy is calculated according to the formula (TP+TN)/

(TP+FP+FN+TN).
They found in their study that for the cold test (ethyl chloride), the sensitivity was 0.83 and the specificity 0.93. For the heat test (hot gutta-percha rod), the sensitivity was 0.86 and the specificity 0.41. For the electrical test, the sensitivity was 0.72 and the specificity 0.93(1).

There was little tooth substance left in this case, but the two mesial cusps were present. According to Lin and Candler, who referenced Lilja (1980) found that the highest concentration of neural elements was in the pulp horn region. A progressive decrease in the number of nerve fibres in the cervical and radicular areas was observed(2).
Presumably the direction of the dentinal tubules is also important in establishing pulp test responses in various parts of the tooth crown(2). The dentinal tubules run an almost straight course from the incisal edge of anterior teeth to the pulp horn. Elsewhere in teeth the course of tubules is somewhat curved and resembles an 'S' shape. Because it is principally the fluid in the tubules that conducts electrical impulses from the pulp tester electrode to the pulp, the shorter the distance between the electrode and the pulp, the lower the resistance to the flow of current (3).

As we can see in the literature, the reliability and the reproducibility of the electrical and thermal tests has its limitations. More precise methods to evaluate the pulpal condition are Laser Doppler flowmetry, pulse oximetry and dual wavelength spectrophometry which all are based on monitoring of the vascular integrity of the pulp(4). Laser Doppler flowmetry is a non-invasive electrooptical technique which allows the semi-quantitative recording of pulpal blood flow. Laser Doppler flowmetry was found to be a reliable method of assessing the pulpal status of traumatised anterior teeth, although it is technique-sensitive and time-consuming to use(11) But these methods are still, although not totally new, at a certain experimental level and not for use in general practice (4).

With vital pulpectomy, the clinical aim is removal of the entire vital pulp tissue short of the anatomical apex followed by a bacteria tight, biocompatible and stable root filling. With this treatment, diseased, infected and often also non infected and non-inflamed tissue is removed to an apical level where the wound surface can be kept to a minimum, the residual pulp tissue is well vascularized, and the conditions for healing are optimal, provided the entire treatment can be carried out under aseptic conditions(4).

A single treatment session has both practical and monetary advantages, including reduced total time for the treatment and less travel time for the patient(5). From a management aspect, on the other hand, the 2-step treatment allows the clinician to optimize the preparation of the root canal space. Pulp tissue remnants may inadvertently, and not infrequently, be left on the canal walls(6).

Study confirms that pulpectomy may be carried out at a high rate of success if due attention is given to aseptic operating procedures, proper instrumentation

and filling. Under these conditions an interappointment dressing with calcium hydroxide does not seem to influence outcome(7).

Endodontic treatment of the vital pulp has a very good prognosis. The prognosis varies in different studies ranging from 93-97%(8,9,10).

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Case 9

Multiple cervical root resorptions

Introduction

42 year old white Northern European male

Fig. 1 Frontal view

Chief complaint

1. September 2009

At the Department of Oral Radiology, UiO, it was detected new cervical resorption. The patient was referred to Department of Endodontics for examination and treatment.

Medical history

Non contributory

Dental history

1980's: The patient went through orthodontic treatment at the Department of Orthodontics, Faculty of Dentistry, UiO.
June 2007:Referred from specialist in endodontics for examination and treatment of cervical root resorption teeth 11 and 16.

August 2007-March 2009: Tooth 11 treated both surgically and non-surgically at the specialsit clininc, Department of Endodontics.

Fig. 2 Before treatment

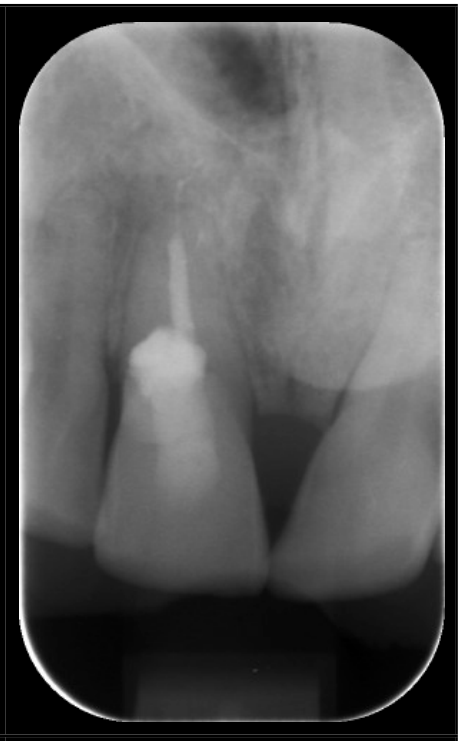


Fig. 3 Final radiograph

March 2009: CT at the Department of Oral Radiology, UiO.
September 2009: Examination

Clinical findings
1. September 2009

Extra-oral examination: within normal limits

Intra-oral examination:

	21	22	23	16	26
EPT	-	27	31	37	33
Cold	-	+	+	+	+
Percussion	-	-	-		
Palpation	-	-	-		
PPD	2mm	2mm	2mm	2mm	2mm
Restoration	-	-	-	Amalgam(o)	Amalgam (OD)

Table 1. Clinical findings

Soft tissue: within normal limits. No communications from the oral cavity to cervical root resorptions teeth 21, 23, 16 and 26 could be found. Good oral hygiene.

Radiographic findings
1. September 2009

Fig. 4 Orthopantomogram

Fig. 5 Pariapical radiograph

Tooth 11: Endodontically treated tooth. Cervical composite filling. Normal lamina dura. No apical radiolucency. PAI 2. Reduced marginal bone level.

Tooth 23: Diffuse radiolucency in the coronal and middle segment of the root. No apical radiolucency. PAI 2

Tooth 13: Diffuse radiolucency on the mesial aspect of the coronal segment of the root. No further radiographic findings.

Tooth 16: No change since examination 30. August 2007.

Tooth 26: No change since examination June 2008.

Fig. 6 Periapical radiograph August 2007

Fig. 7 Periapical radiograph
1. September 2009

Fig. 8: Periapical radiograph
June 2008

Fig. 9 Periapical radiograph
1. September 2009

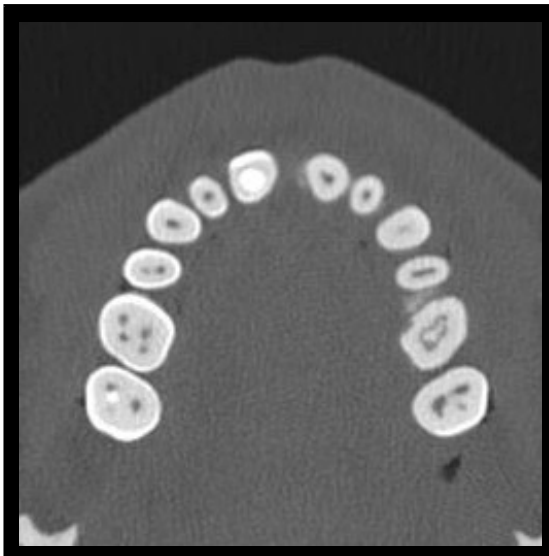


Fig. 10 Axial CT Maxilla

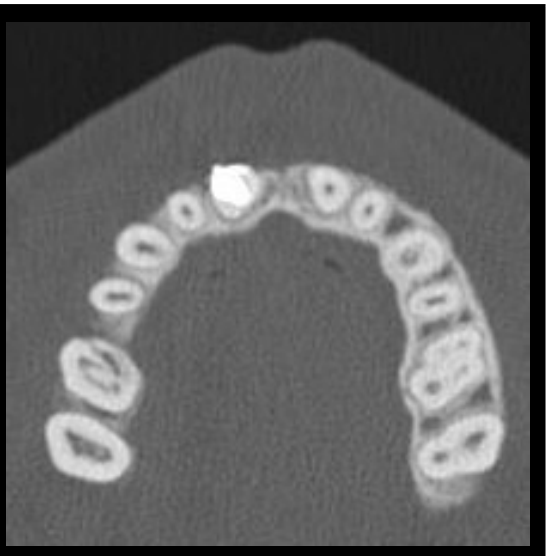
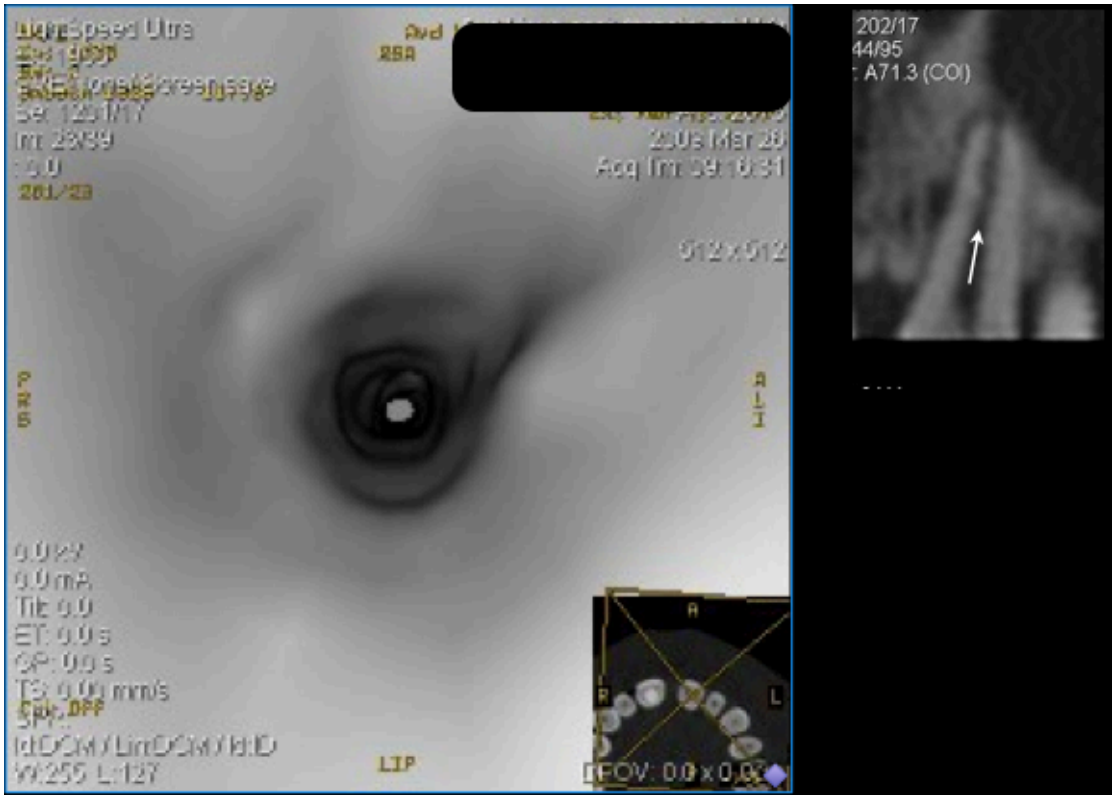


Fig. 11 Axial CT Maxilla

Fig. 12 Axial CT Maxilla

Fig. 13 Axial CT Maxilla



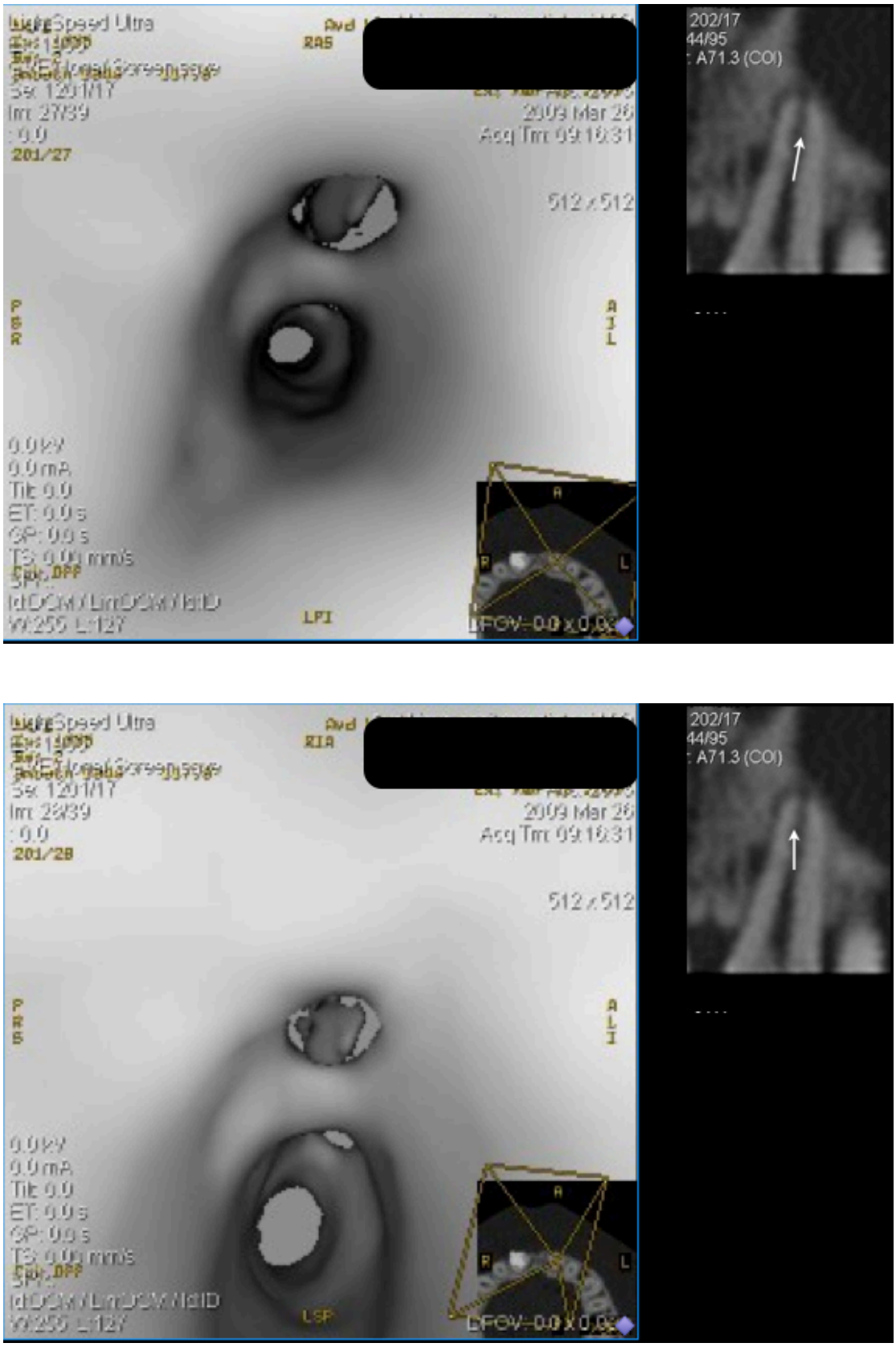
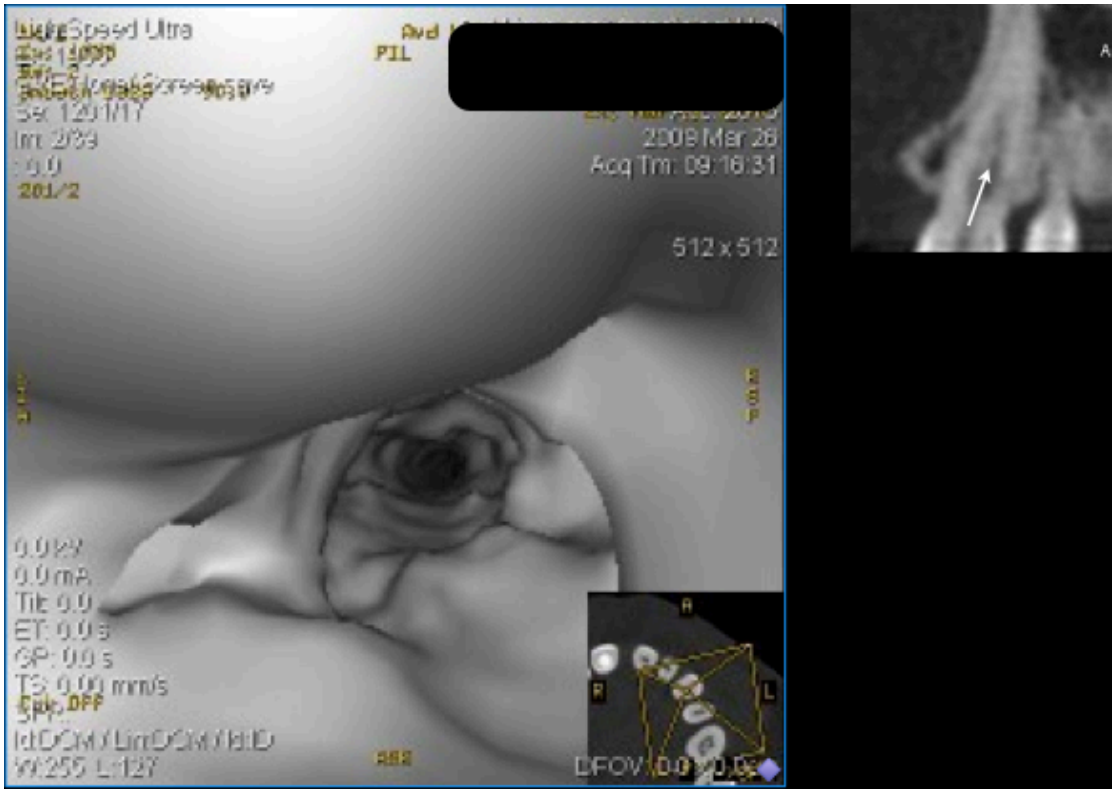
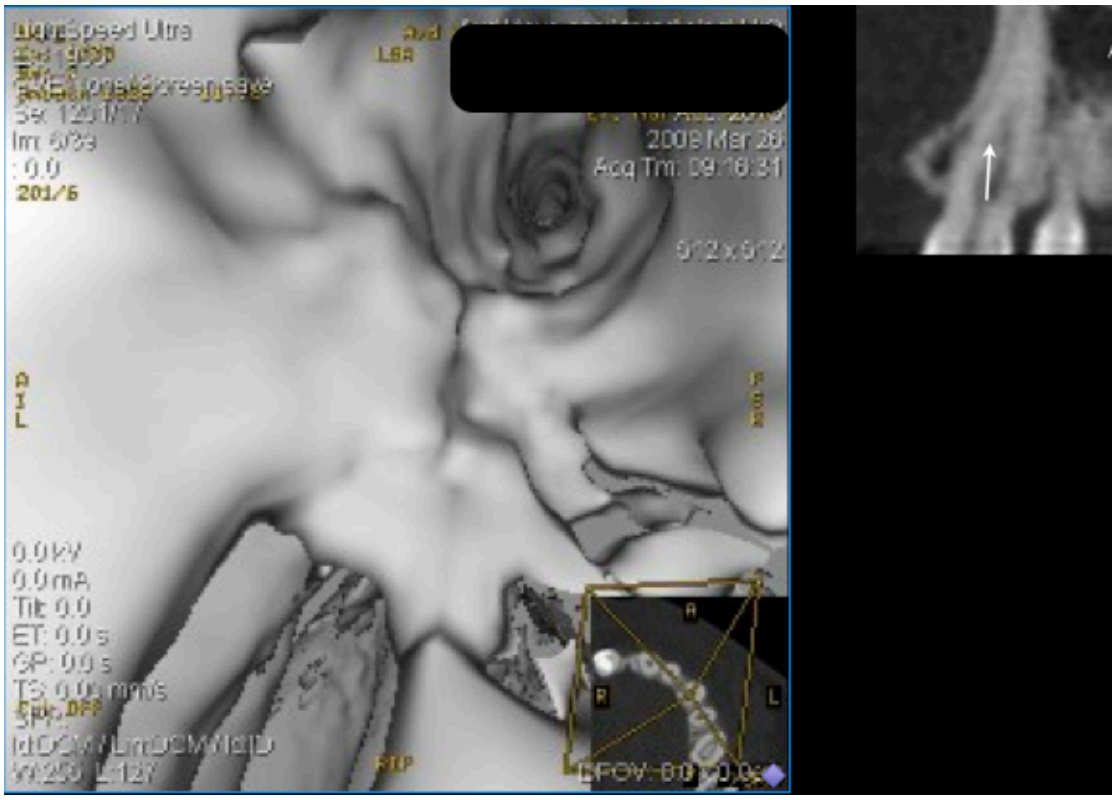
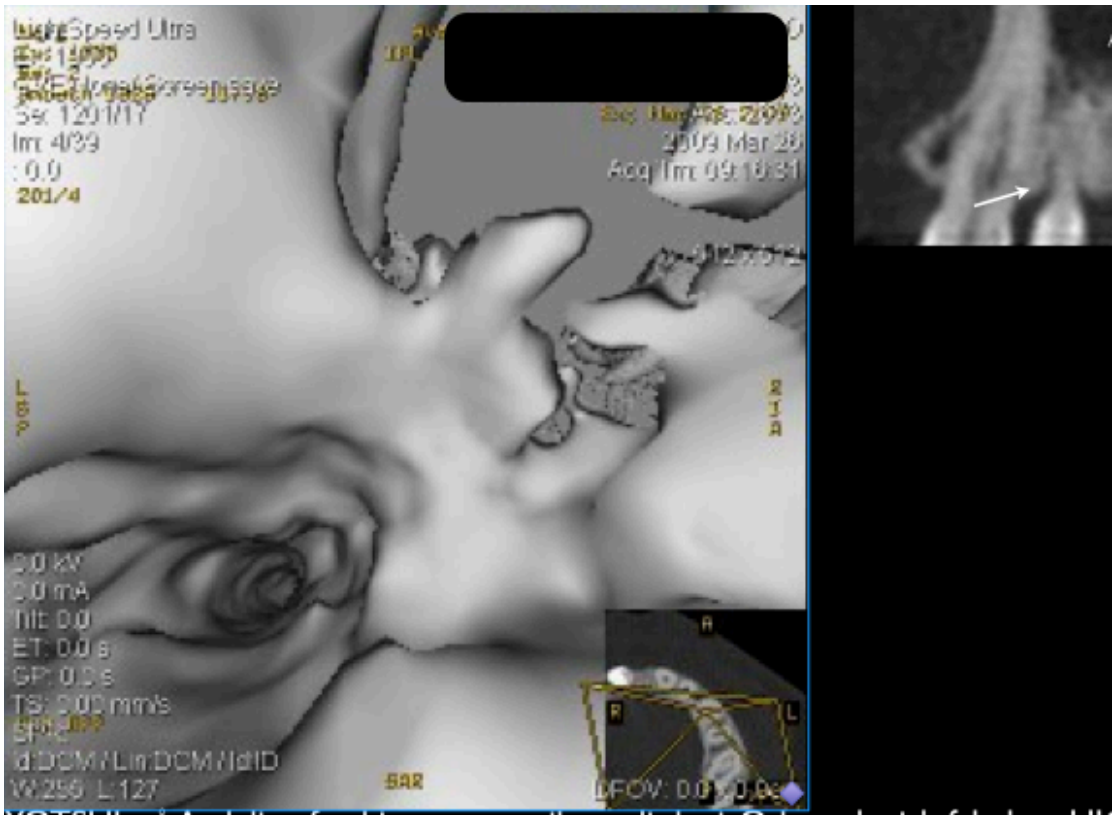
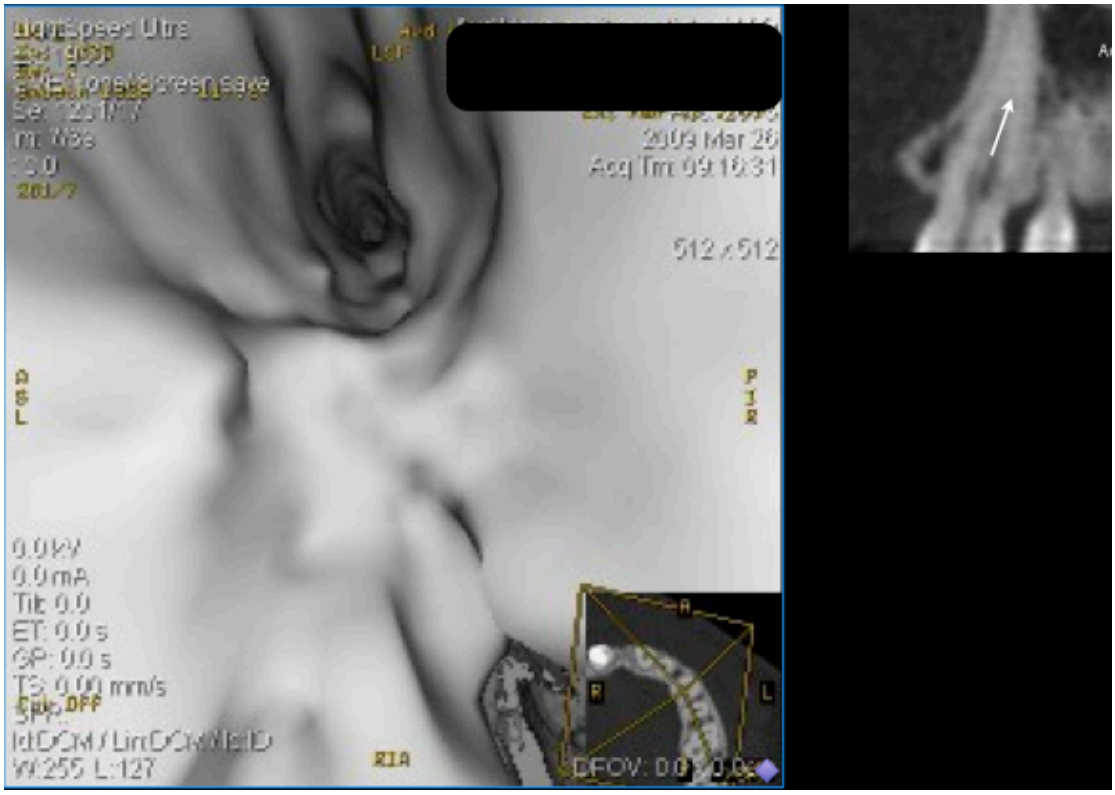


Fig. 14-16 Tooth 21: 3-D image conversion of the CT-scan. The small picture on the right side with the arrow, is indicating where inside the canal the image is representing.









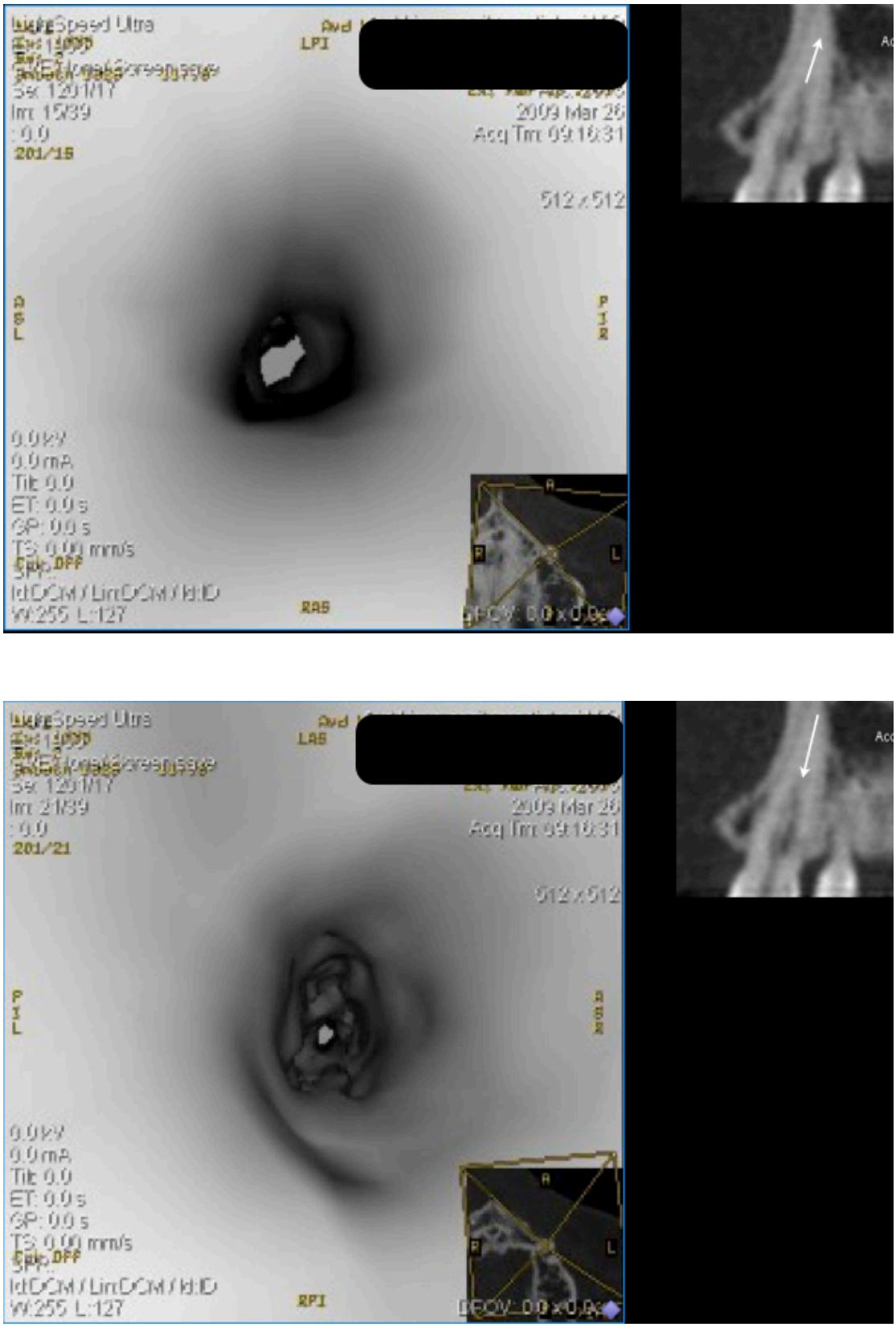


Fig 17-22. Tooth 23; 3-D image conversion of the CT-scan. The small picture on the right side with the arrow, is indicating where inside the canal the image is representing.

Translation of answer from CT-scan:

Since last CT-examination in September 2007, a new rootdefect with associated bone defect at the mesial aspect of tooth 21, located apically to

the cervical area, and a cervical rootdefect at the mesiopalatal aspect of tooth 23. Both of the defects seems to penetrate into the pulp. It can not be seen a new defect at tooth 11.
The defects at tooth 16 and 26 seems unchanged since 2007. Tooth 13 seems normal, but with a diffuse dentine structure in the palatal area, and unchanged since 2007.

Diagnosis

Tooth 21:
Tooth: Root resorption (K03.3)
Pulpal: Necrotic pulp (K04.11)
Periapical: Chronic apical/lateral periodontitis (K04.5)
Marginal: Within normal limits

Tooth 23:
Tooth: Cervical root resorption (K03.3)
Pulpal: Within normal limits
Periapical: Within normal limits
Marginal: Within normal limits

Treatment plan

Orthograde endodontic treatment of tooth 21 and 23. Obturate the resorption area with MTA.

Treatment
8. September 2009

Clinical examination.Tooth 23 diagnosed with cervical root resorption. No communication between the oral cavity and the resorption, and the tooth was asymptomatic. Access cavity preparation. Rubber dam. Length of the canal was determined by apex locator(Root ZX®) and a periapical radiograph. Root canal preparation was done mechanically with K- and NiTi hand files in conjunction with Bio-Race.
One canal.
R70/26mm I
1% NaOCl and 17% EDTA were used for chemical root canal disinfection. With the use of LN-bur and diamond coated ultrasonic tips the resorptive tissue was located and removed. The resorption was widest in

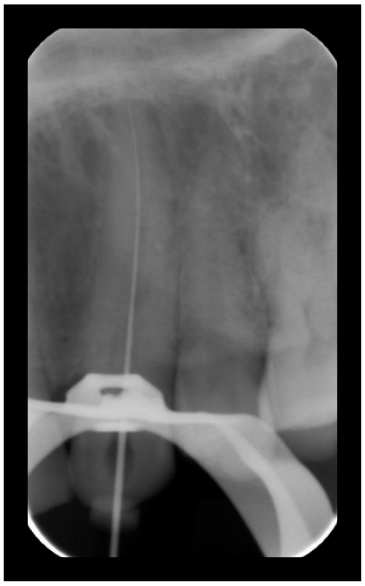


Fig. 23 Working length

buccopalatal direction toward the palatal. The canal was dried with paper points and filled with Ca(OH)2. Temporary sealed with IRM.

10. November 2009

The canals were rinsed with 1% NaOCl and 17% EDTA and dried with paper points. Irrisafe ultrasonic tip was used with the irrigants. Obturated with gutta percha and AH Plus to the apical extend of the resorption. Because of bleeding from the resortion area, the Ca(OH)2 was placed as an intracanal dressing. Temporary sealed with IRM.

Fig. 24 Master point

Fig. 25 Gp/Ah+

17. November 2009

The patient presented with no symptoms from tooth 23. Clinical examination showed no percussion or palpation sensitivity from the tooth. Rubber dam applied. The resorption defect was irrigated with 1% NaOCl. White Mineral Trioxide Aggregate (Pro Root, Dentsply) was applied with MAP-system® in the resorption. A wet cotton pellet was placed over the MTA. Temporary IRM filling applied.

8. December 2009

Permanent occlusal restoration was placed. Z250 3M.

Fig. 26 MTA

Fig. 27 Final radiograph

6. October 2009

Clinical examination.Tooth 21 diagnosed with root resorption. No communication between the oral cavity and the resorption, and the tooth was asymptomatic. Access cavity preparation. The pulp was confirmed necrotic. Rubber dam. Length of the canal was determined by apex locator (Root ZX®) and a periapical radiograph. Root canal preparation was done mechanically with K-and NiTi hand files in conjunction with Bio-Race.
One canal.
R70/20mm I
1% NaOCl and 17% EDTA were used for chemical root canal disinfection. With the use of irrisafe ultrasonic tips it was possible to resolve more of the resorptive tissue. The canal was dried with paper points and filled with Ca(OH)2. Temporary sealed with IRM.

Fig. 28 Working length

8. December 2009

The canal were rinsed with 1% NaOCl and 17% EDTA and dried with paper points. Obturated with Grey Mineral Trioxide Aggregate (Angelus, Brazil) applied with MAP-system® . Permanent occlusal restoration, Z250 3M.

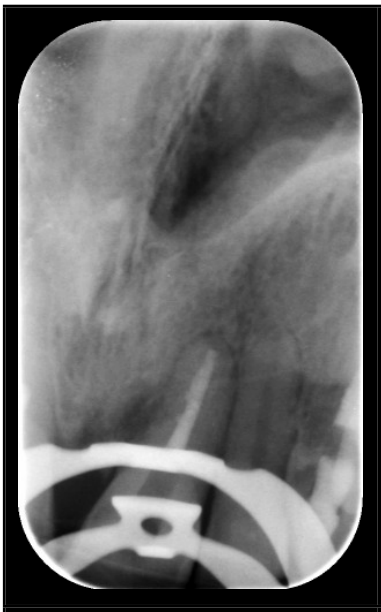


Fig. 29 MTA

Fig. 30 Final radiograph

Result

Fig. 31 Before treatment

Fig. 32 After treatment

Fig. 33 Before treatment

Fig. 34 After treatment

Evaluation

No complications during treatment. It is difficult to know if the resorption is completely removed since the treatment is done internally.

Prognosis

Endodontic: Uncertain
Tooth: Uncertain.

Follow-up examination

20. April 2010

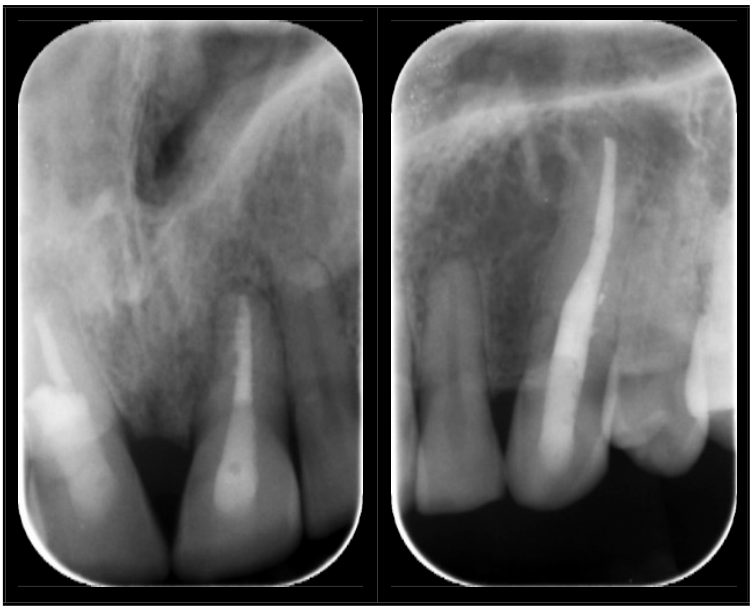


Fig. 35 Follow up radiograph tooth 21

Fig. 36 Follow up radiograph tooth 23

The patient experience no sensitivity to percussion or palpation. No further resorption process is visible at the radiographs

March 2010:

A probable detection of new resorptive lesions on tooth 13 and 33. The patient is referred back to the Department of Oral Radiology, UiO, for a new examination.

Fig 37. Periapical radiograph tooth 13

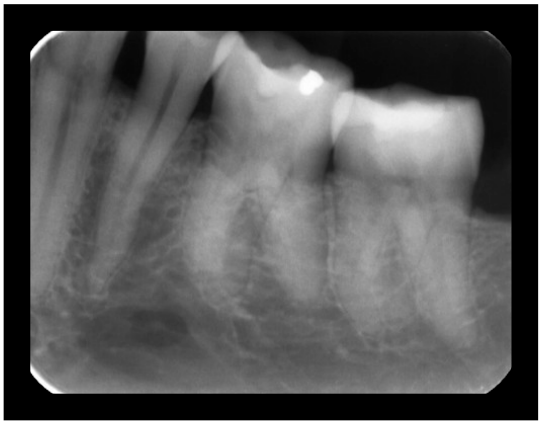


Fig 38. Periapical radiograph tooth 33

Discussion

Invariably, tooth resorption results from injuries to or irritation of the periodontal ligament and/or tooth pulp. It may arise as a sequela of traumatic luxation injuries, orthodontic tooth movement, or chronic infections of the pulp or periodontal structures(1).
There are many different types of external root resorption. External surface resorption, external infection-related resorption, external trauma-related replacement resorption(ankylosis), external spontaneous ankylotic resorption, external multiple sites of ankylosis or infection-related resorption, cervical invasive resorption(2).
In this case we have diagnosed the process on tooth 23 as cervical root resorption and tooth 21 as external root resorption. The process on tooth 21 is much similar to a external infected-related resorption.
The etiology of this infection related resorption represents a combined injury to the pulp and PDL and where bacteria, primarily located in the pulp space and in dentinal tubules, trigger osteoclastic activity on the root surface(2). In this case the patient has not experienced any injury as he can recall, so its difficult to see any relation to this resorption.
Currently, the etiology of invasive cervical resorption is poorly understood and this may explain some of the diversity in terminology as clinicians have applied varying interpretations of the underlying pathogenesis(3). There are some possible potential predisposing factors. Heithersay (1999) studied 222 patients with 257 teeth displaying varying degrees of invasive cervical resorption. The results are summarized in the figure below.

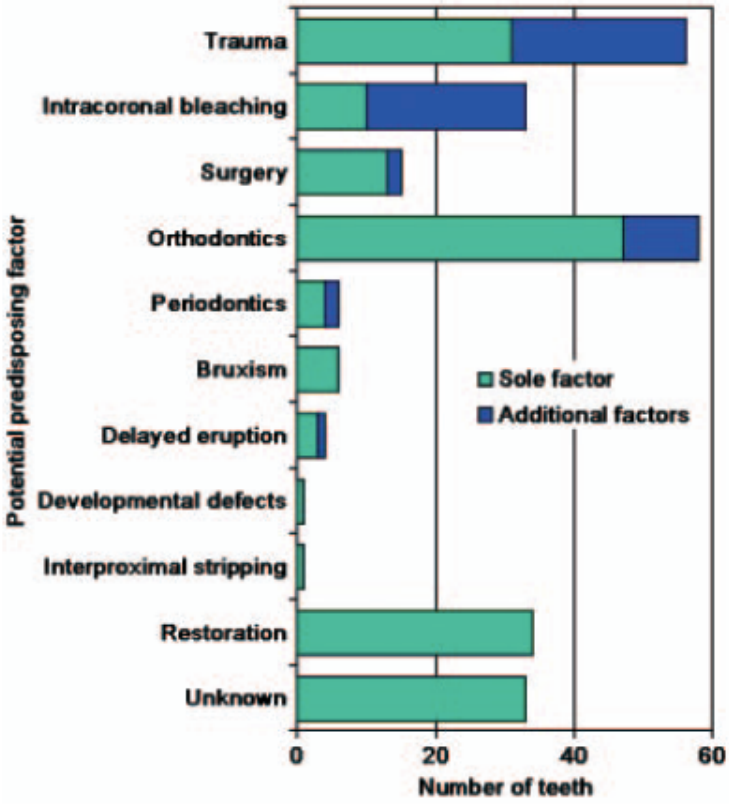


Fig 39. (3)

A clinical classification has been developed by Heithersay.

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(3)

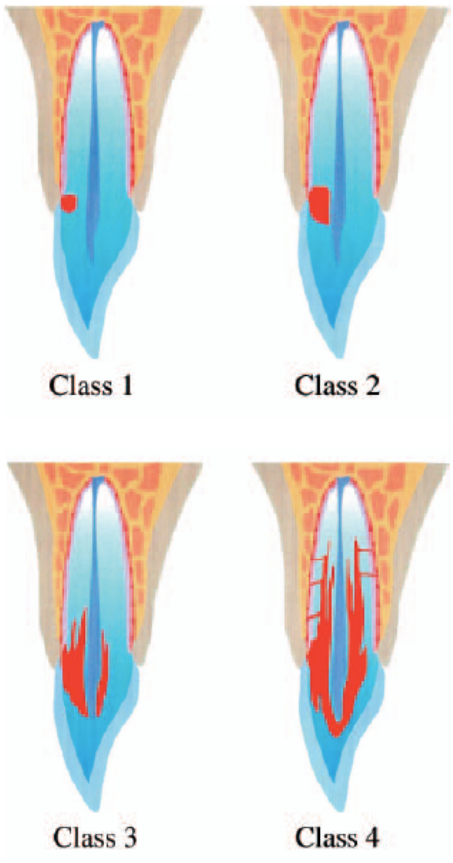


Fig 40. (3)

Treatment of these lesions can be difficult, especially when the resorption area are far below the bone margin. In these two cases, we filled the canal with MTA in the area of the resorption, after removal of the resorptive tissue. To my knowledge there are no reports on treatment like these.

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Case 10

Internal resorption in a maxillary molar

Introduction

28 year old white Northern European male

Fig.1 Frontal view

Chief complaint

28. January 2010

Non contributory

Medical history

Non contributory

Dental history

The patient was referred from his general dentist to an endodontist, for examination and treatment of two cervical resorptions. The endodontist referred the patient to the Department of Endodontics, UiO for examination and treatment of the left and right maxillary first molars.

Clinical findings

28. January 2010

Extra-oral examination: within normal limits

Intra-oral examination:

	25	26	27
EPT	29	27	30
Cold	+	+	+
Percussion	-	-	-
Palpation	-	-	-
PPD	2mm	2mm	2mm

Table 1. Clinical findings

Soft tissue: within normal limits.

Dental:

24: Sound tooth
25: Sound tooth
26: Sound tooth
27: MO composite filling

Fig. 2 Occlusal view

Radiographic findings
28. January 2010

Tooth: 27: Normal lamina dura. PAI 1. Normal marginal bone level. Radiopaque filling on the mesial and occlusal aspect of the crown

Tooth 26: Normal lamina dura. PAI 1. Normal marginal bone level. A radiolucent area in the distal part of crown of the tooth.

Tooth 25: Normal lamina dura.

PAI 1. Normal marginal bone level.

Fig. 3 Periapical radiograph

Fig. 4 Orthophantogram

Fig. 5 Axial CT Maxilla

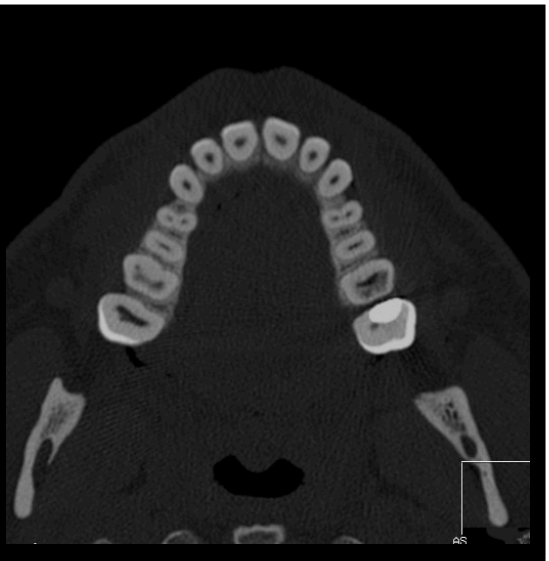


Fig. 6 Axial CT Maxilla

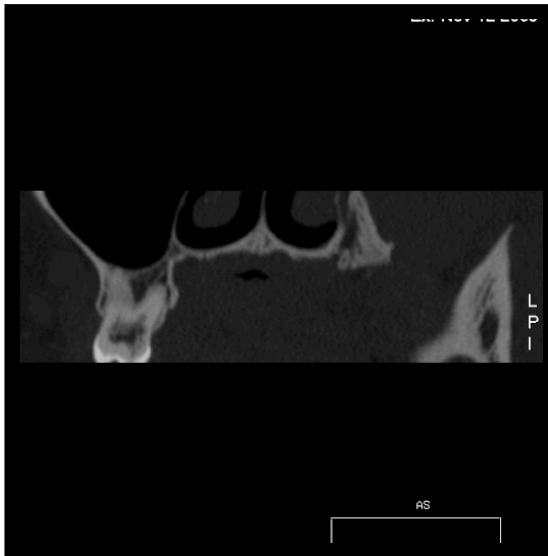
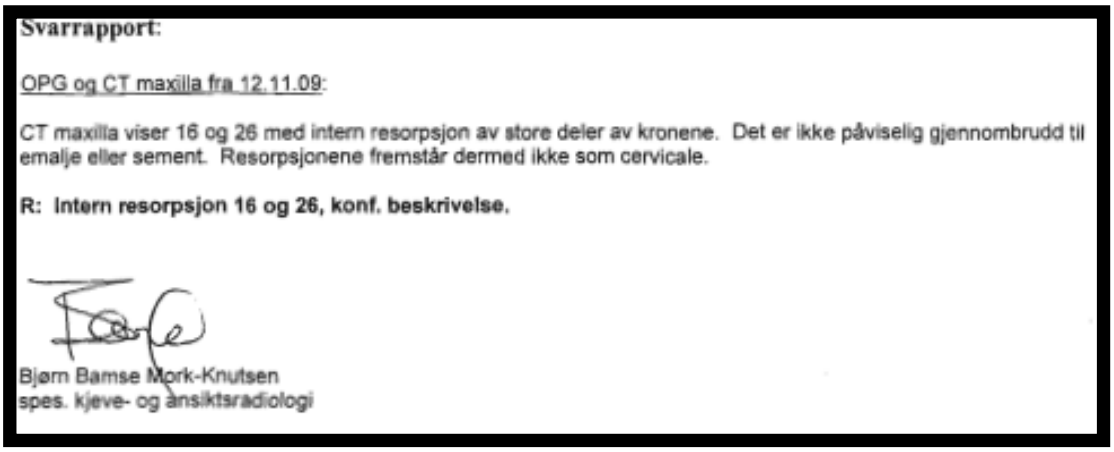


Fig. 7 Coronal plane. CT Maxilla

Fig. 8 Coronal plane. CT Maxilla



Svarrapport:

OPG og CT maxilla fra 12.11.09:

CT maxilla viser 16 og 26 med intern resorpsjon av store deler av kronene. Det er ikke påviselig gjennombrudd til emalje eller sement. Resorpsjonene fremstår dermed ikke som cervicale.

R: Intern resorpsjon 16 og 26, konf. beskrivelse.

Bjørn Bamse Mork-Knutsen
spes. kjeve- og ansiktsradiologi

Fig 9 Answer from specialist in oral radiology (in Norwegian)

Translation of answer from CT-scan:
CT maxilla show internal resorption tooth 16, 26 in major parts of the crown. There is no evident of communication to the enamel or cement. The resorptions is therefore not cervical.

Diagnosis

Tooth 26:
Pulpal: Internal root resorption (K03.31)
Periapical: Within normal limits
Marginal: Within normal limits

Treatment plan

Removal of the resorptive tissue using LN-burs and ultrasonic instruments. Standard non-surgical endodontic treatment.

Problem list

Difficult to completely remove the resorptive tissue, and possible communication to the cement.

Treatment
28. January 2010

Clinical examination.Tooth 26 diagnosed with internal resorption. 1.8 ml Septocaine ®. Access cavity preparation. Rubber dam. The palatal and distal part of the cavum had irregular dentin with sugar-like appearance. After removal of this dentin and the surrounding pulp-tissue, 3 root canals were localised. Because of the time limit, the instrumentation was postponed to the next session. The pulp cavum was filled with Ca(OH)2, and temporary sealed with IRM

1.8 ml Septocaine ®.
Instrumentation was done mechanically with K-and NiTi hand files and BioRace ® files. Root canal length was determined by radiographic image.
Three canals:
MB: R40/21mm
DB: R40/21mm
P: R60/21mm
1% NaOCL and 17% EDTA were used for chemical root canal disinfection. The canal was dried with paper points and filled with Epiphany and Resilon. A permanent restoration of Z250 3M was placed immediately after the root canal treatment.

Fig. 10 Working length radiograph

Fig. 11 Master point radiograph

Fig. 12 Final periapical radiograph

Result

Fig. 13 Before treatment

Fig. 14 After treatment

Evaluation

No complications during treatment. The root filling appeared dense and good, but a radiolucent area between the permanent filling and the root canal filling in the palatal canal can be seen.

Prognosis

Endodontic: good
Tooth: good

Follow-up examination

No follow-up examination because treatment was performed in February 2010.

Discussion

Internally, from the pulpal side, dentin is lined by the odontoblasts and predentin. The odontoblasts have no resorbing ability and, in combination with the unmineralized predentin, appear to form a barrier against dentin resorption (1,2). Internal resorption is preceded by chronic pulpal inflammation, a disappearance of the odontoblasts and predentin, and a pulpal invasion of macrophage-like resorbing cells(2,3). Damage to the organic sheath, predentin and odontoblast cells covering mineralized dentine inside the root canal must occur to expose the mineralized tissue to pulpal cells with resorbing potential. It is not known what kind of trauma or event is needed to initiate resorption, but some predisposing factors has been linked to internal resorption, e.g. pulpitis, trauma, pulpotomy, invagination, cracked tooth, tooth transplantation and orthodontic treatment(4).

Wedenberg and Lindskog (1985) suggested that internal resorption can be divided into two different types : 1. A transient type, similar to external root surface resorption, which developed in the absence of pulpal infection. This type of resorption may be caused by the disappearance of odontoblasts and predentin, thus exposing the dentin. 2. A progressive type, which required continuos stimulation by a bacterial inflammation, and which resembled external inflammatory resorption(2).

The prevalence of internal resorption varies, depending on the type of treatment the tooth has received. Cabrini et al. (5) reported internal root resorption in eight out of 28 teeth (28%) where pulpotomy in the coronal pulp and capping with calcium hydroxide (covered by zinc oxide eugenol) had been performed. Ahlberg et al found that the frequency of root resorption, both marginal and apical, in the transplanted teeth was about 75% while internal resorption was seen in 55% of the teeth(6). Haapasalo and Endal believe that the prevalence of internal resorptions is between 0,01-1% (6).

In most cases it is asymptomatic and detected on radiographic screening. Frequently, it is observed in the cervical region but may occur in all areas of the root canal system. If coronal, the tooth may demonstrate a pinkish hue because of the prolific capillaries in the pulpal inflammatory (granulomatous) tissue resorbing the coronal dentin and enamel(7). As soon as the coronal pulp becomes necrotic, it is likely that the original pink color will gradually change to a dark red/dark grey(4). Radiographically, it is possible to distinguish cervical resorptions from internal resorptions, as cervical resorptions in the crown area often have a more irregular outline and contain randomly shaped thin opaque

lines which are not seen in lesions of internal resorption. This opaque line is a 0,1-0,3mm of dentin which separates the cervical lesion from the pulp. Treatment of teeth with internal resorptions nonsurgical endodontic treatment. Intracanal medicaments are recommended to maximize the effect of the disinfection procedures(8). As long as the resorption has not perforated the tooth, the tooth has a good prognosis (9).

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Case 11

Chronic apical and lateral periodontitis - obturation with Resilon

Introduction

33 year old white Northern European male

Fig.1 Lateral view

Chief complaint

29. October 2008

The patient was referred to Department of Endodontics for examination and treatment of the right mandibular first molar.

Medical history

Non contributory

Dental history

Tooth 46:
Endodontically treated at the student clinic in 2001. The pretreatment pulpal diagnosis was asymptomatic pulpitits.

Fig 2. Periapical radiograph 2001

Clinical findings
29. October 2008

Extra-oral examination: within normal limits

Intra-oral examination:

	45	46	47
EPT	31	-	37
Cold	+	-	+
Percussion	-	-	-
Palpation	-	-	-
PPD	3mm	3mm	3mm

Table 1. Clinical findings

Soft tissue: within normal limits

Dental:

Tooth 45: Sound tooth
Tooth 46: Gold onlay
Tooth 47: Sound tooth

Radiographic findings
29. October 2008

Tooth 45: Normal lamina dura. No apical radiolucency. PAI 1.

Tooth 46: Discontinuous lamina dura. Apical and interradicular radiolucency. Endodontically treated tooth. PAI 5. Radiopaque restoration on the occlusal and distal aspect of the crown.

Tooth 47: Normal lamina dura. No apical radiolucency. PAI 1.

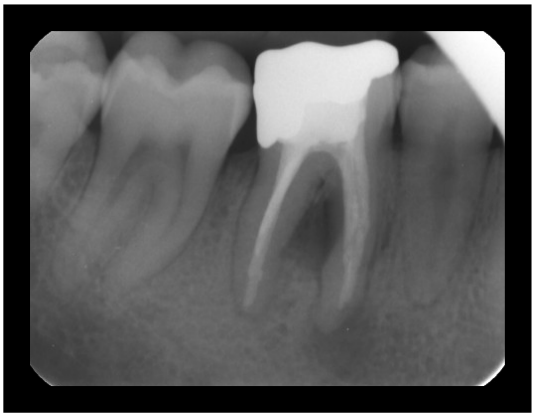

Fig. 3 Periapical radiograph

Diagnosis

Tooth 46:
Pulpal: Endodontically treated tooth (K04.19)
Periapical: Chronic apical periodontitis (K04.5)
Chronic interradicular periodontitis (kK04.51)
Marginal: Within normal limits

Treatment plan

Orthograde endodontic retreatment of tooth 46.

Treatment
29. October 2008

Clinical examination. Access cavity preparation. Rubber dam. Started removal of gutta-percha and sealer. No detection of perforation.

4. December 2008

Fig. 4 Orthopantomogram

11. December 2008

Rubber dam. Removal of gutta-percha and sealer. Length of the canal was determined by apex locator(Root ZX®) and a periapical radiograph. Root canal preparation was done mechanically with K-and NiTi hand files in conjunction with Bio-Race.
Three canals.
ML R45/21mm MLC
MB R45/21mm MBC
D R70/21mm DBC
1% NaOCl, 17% EDTA and 2% CHX were used for chemical root canal disinfection in conjunction with irrisafe. The canal was dried with paper points and filled with Ca(OH)2. Temporary sealed with IRM.

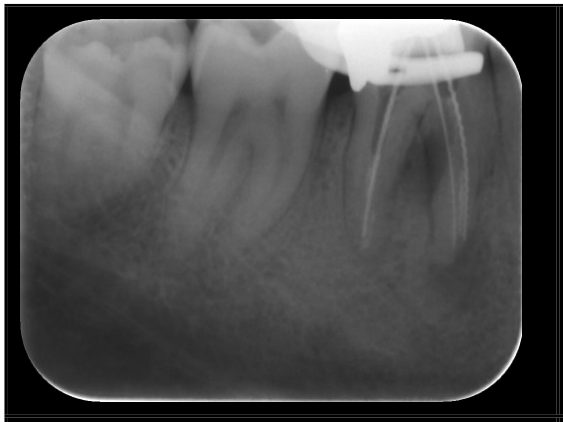

Fig. 5 Working length radiograph

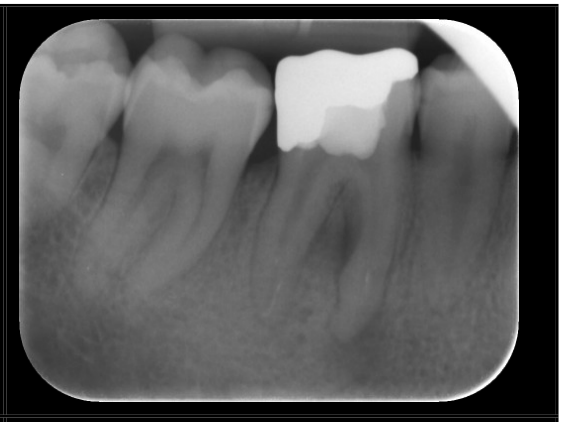

Fig. 6 Removal of gutta-percha

15. January 2009

The patient was asymptomatic from tooth 46. The tooth was not sensitive to percussion or percussion. Rubber dam. Removal of temporary filling. Root canal disinfection was done with with 1% NaOCl, 17% EDTA and 2% CHX. The canals were filled with Epiphany® and Resilon®.
Temporary sealed with IRM.

Fig 7. Master point

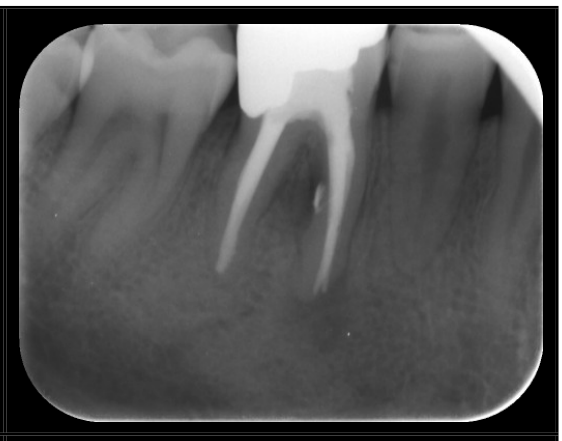

Fig. 8 Final radiograph

Result

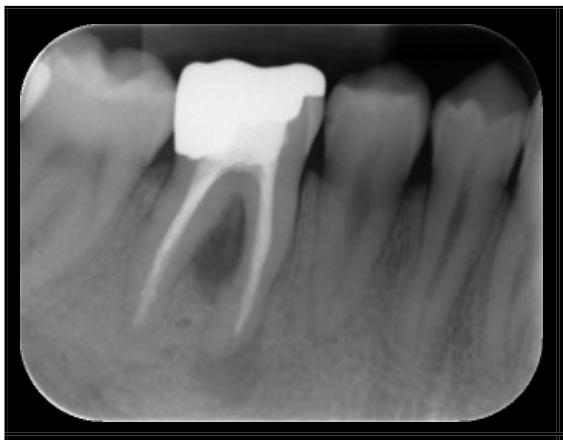

Fig. 9 Before treatment

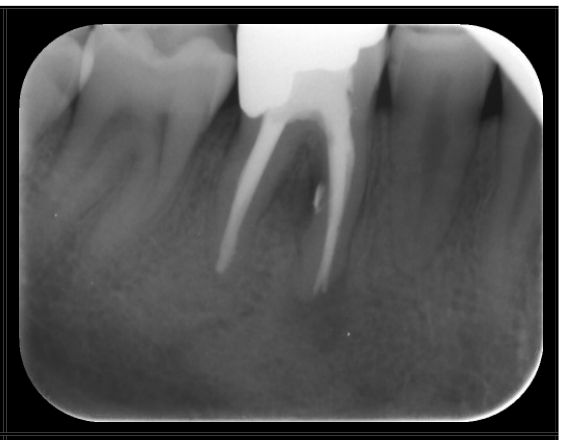

Fig. 10 After treatment

Evaluation

No complications during treatment. The root filling appeared dense and good.

Prognosis

Endodontic: Uncertain
Tooth: good.

Follow-up examination

5. January 2010

Extra-oral examination: within normal limits

The patient was asymptomatic and experienced no sensitivity to percussion or palpation tests

The radiograph showed apical healing on the mesial root and healing in the interradicular area.

Fig. 11 Follow up radiograph

Discussion

Accessory and lateral canals extend from the pulp to the periodontium. An accessory canal is any branch of the main pulp canal or chamber that communicates with the external surface of the root. A lateral canal is an accessory canal located in the coronal or middle third of the root, usually extending horizontally from the main root canal(1). They occur 73.5% of the time in the apical third, 11.4% of the time in the middle third and 6.3% of the time in the cervical third of the root(2).

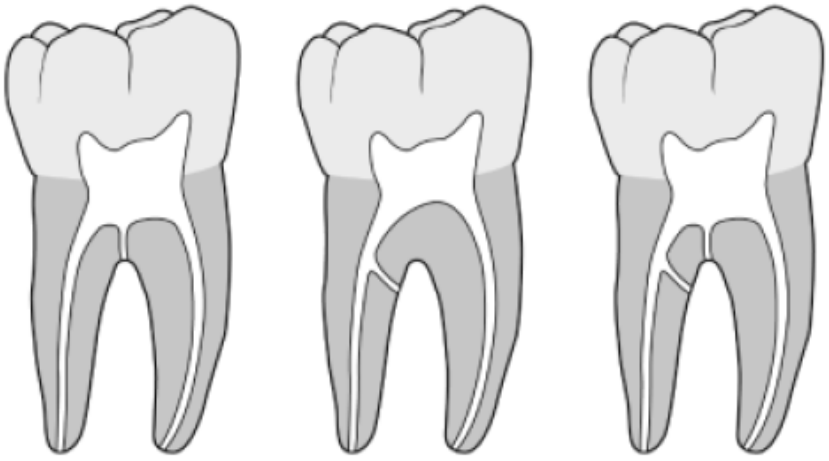

Fig. 9. Accessory canals occur in three distinct patterns in mandibular first molars(1).

To eliminate microorganisms in lateral canals can be complicated, especially since the canal is often undetectable and unreachable for mechanical instrumentation. With the use of different irrigation solutions and intracanal medication, one can eliminate a larger portion of the microorganisms. Chlorhexidine (CHX) is used widely as an endodontic irrigant and medicament, CHX is a positive charged molecule that interact with the negatively charged cell wall. It increases the permeability and CHX penetrate in to the bacteria. This changes the osmotic pressure inside the bacteria, which leads to other substances will leak out of the cell and can result in cell death(3).
Mohammadi and Abbot (2009) reviewed the literature regarding CHX and made some conclusions.

1. The antibacterial effect of CHX and NaOCl in both ex vivo and in vivo are similar
2. CHX is an effective antifungal agent, but its efficacy is significantly less than NaOCl.
3. The effect of CHX on microbial biofilms is significantly less than that of NaOCl.
4. CHX has antibacterial substantivity in dentine for up to 12 weeks.
5. Dentine, dentine components (HA and collagen), killed microorganisms and inflammatory exudate in the root canal system may reduce or inhibit the antibacterial activity of CHX.
6. CHX has little to no ability to dissolve organic tissues
7. Mixing CHX with Ca(OH)2 may enhance its antimicrobial activity.
8. CHX can significantly improve the integrity of the hybrid layer and resin–dentine bond stability.
9. Combination of NaOCl and CHX causes colour changes and formation of a precipitate, which may interfere with the seal of the root filling.
10. The biocompatibility of CHX is acceptable.

(3)

With these conclusions the use of CHX in this case, can have contributed with the positive result.

Sharifian et al evaluated the effect of a final rinse with 2% chlorhexidine (CHX). They found that the group with a final rinse of 2% chlorhexidine (CHX) tended to

be more resistant to saliva leakage; however, the difference was not significant (P > 0.05). They suggested that 2% CHX is a good conditioner for root canal dentin before use of Resilon/Epiphany SE(4).

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Case 12

Three rooted maxillary premolar filled with warm vertical compaction of Resilon

Introduction

83 year old white Northern European male

Fig.1 Frontal view

Chief complaint

7. October 2009

Some lingering pain from maxillary left second premolar.
The patient was referred to Department of Endodontics for examination and treatment of the left maxillary second premolar. Further treatment plan for tooth 25 is an abutment for a new bridge.

Medical history

Non contributory

Dental history

Tooth 25:
The referring dentist had started endodontic treatment. Because obliteration of the root canals the dentist was not able to locate the canals.

Clinical findings
7. October 2009

Extra-oral examination: within normal limits

Intra-oral examination:

Dental:

Tooth 24: Porcelain fused to metal crown
Tooth 25: Acryl fused to metal bridge
Tooth 27: Acryl fused to metal bridge

Fig. 2 Occlusal view

	24	25	27
EPT	-	-	-
Cold	-	+	-
Percussion	-	+	-
Palpation	-	-	-
PPD	3mm	3mm	3mm

Table 1. Clinical findings

Soft tissue: within normal limits

Radiographic findings
7. October 2009

Tooth 25: Normal lamina dura. No apical radiolucency. PAI 2. Radiopaque restoration on the occlusal aspect of the crown.

Tooth 27: Normal lamina dura. Surplus of endodontic sealer at the MB and DB root. PAI 2. Radiopaque restoration on the occlusal aspect of the crown.

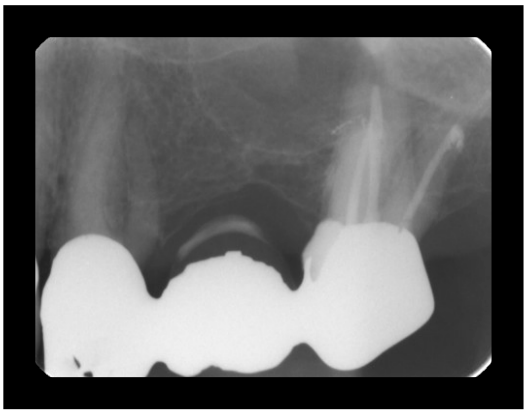

Fig. 3 Periapical radiograph

Diagnosis

Tooth 25:

Pulpal: Chronic irreversible pulpitis (K04.3)
Periapical: Within normal limits
Marginal: Within normal limits

Treatment plan

Orthograde endodontic treatment of tooth 25.

Treatment
7. October 2009

Clinical examination. Tooth 25 diagnosed with chronic irreversible pulpitis. Access cavity preparation. Rubber dam. Located the buccodistal and palatal canal.Length of the canals was determined by apex locator(Root ZX®) and a periapical radiograph. The mesiobuccal canal was very obliterated and non-negotiable at that time.

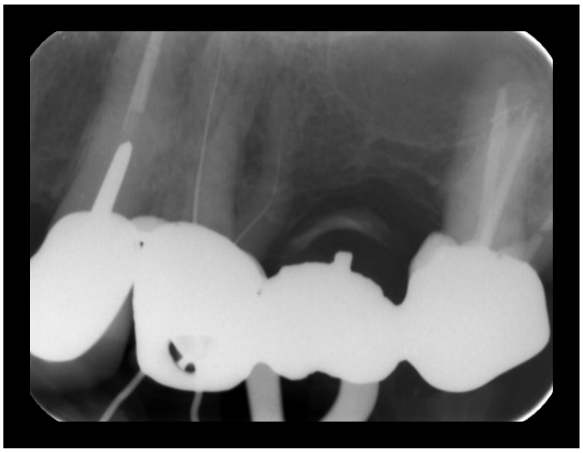

Fig. 4. Working length radiograph

15. October 2009

The MB canal was located and negotiated. Root canal preparation was done mechanically with K-and NiTi hand files
in conjunction with Bio-Race.
Three canals.
MB R40/23mm BC
DB R40/22mm BC
P R40/24mm PC
1% NaOCl and 17% EDTA were used for chemical root canal disinfection. The canal was dried with paper points and filled with Ca(OH)2. Temporary sealed with IRM.

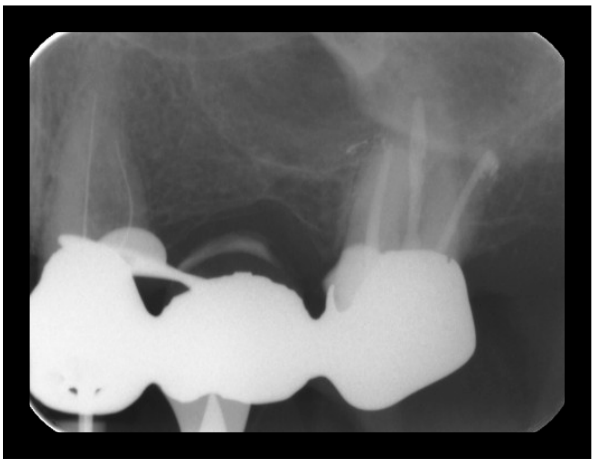

Fig 5. Working length radiograph

29. October 2009

The canals were rinsed with 1% NaOCl and 17% EDTA and dried with paper points. The MB and DB canal was obturated and laterally compacted with Resilon and Epiphany. The P canal was obturated with warm vertical compaction of Resilon and Epiphany. The Hottip cordless warm vertical compaction device was used in combination with the HotShot cordless backfill obturation device. Epiphany was applied to the walls of the canal, and the masterpoint was inserted to working length. The Hottip at 180C was inserted until 4mm from the apex, and cut off the masterpoint. The canal was backfilled with the backfill obturation device. Temporary sealed with IRM.

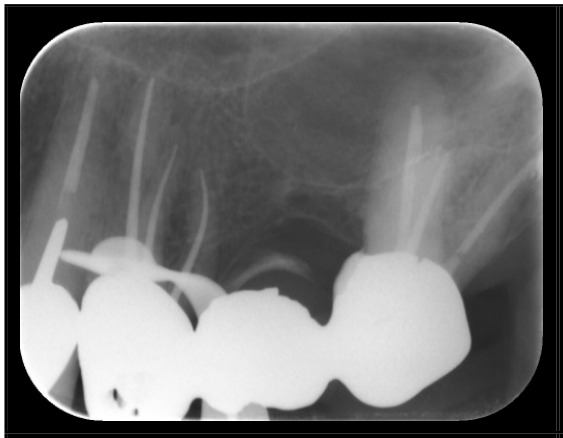

Fig. 6 Master point

Fig. 7 Final radiograph

Result

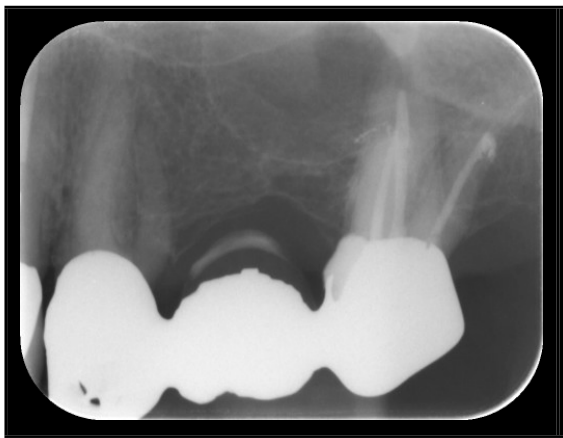

Fig. 8 Before treatment

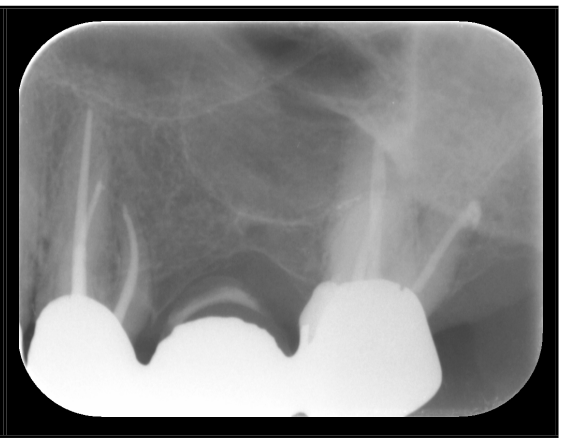

Fig. 9 After treatment

Evaluation

No complications during treatment. The root filling appeared dense and good.

Prognosis

Endodontic: good
Tooth: good.

Follow-up examination

The patient was unable to come for a follow up.

Discussion

To treat a tooth endodontically, the knowledge of morphology is essential. And also the ability to examine an radiograph. In this case it was quite easy to see at the radiograph that tooth 25 had an unusual morphology.
Kartal et al(1) used six hundred recently extracted maxillary first and second premolar teeth. One-half of the teeth were maxillary first premolars, the other half were maxillary second premolars. They found that approximately 50% of the maxillary second premolars had one root and one canal and approximately 30% had two roots and two canals. That is Vertuccis classification type 1 and type 4, receptively. And only 0,66% of the maxillary second premolars had three roots. Vertucci (1974) found that 75% of 200 second maxillary premolars had one apex apically, and only 1% had three apices(2).

Table 1 Percent of maxillary second premolars with three root canals reported in studies retrieved from English language papers available in the PubMed database

Authors	Number of teeth	Three canals (%)
Hess (2)	260	2
Pineda and Kuttler (3)	282	0
Green (4)	50	0
Vertucci *et al.*(5)	200	1
Kerekes and Tronstad (6)	20	0
Vertucci and Gregauff (7)	200	1
Bellizi and Hartwell (8)	398	0.3
Bellizi and Hartwell (9)	630	1.1
De Deus (10)	108	0
Pécora (11)	300	0.3
Çaliskan *et al.* (12)	100	0
Kartal *et al.* (13)	300	0.66

Table 2 (3)

The data summarised in Table 2 show that the occurrence of three root canals in maxillary second premolars is very rare. Five out of the 12 studies mentioned in Table 2 did not refer to this anatomic variation and the frequency of teeth with this abnormal root canal anatomy was very low (only 0.69%)(3).

Krasner and Rankow in a study of 500 pulp chambers, determined that the cemento-enamel junction was the most important anatomic landmark for

determining the location of pulp chambers and root canal orifices. They demonstrated that specific and consistent pulp chamber floor and wall anatomy exists and proposed laws for assisting clinicians identify canal morphology. The relationships expressed in these laws are particularly helpful in locating calcified canal orifices.

These laws are:

1. Law of symmetry 1: Except for maxillary molars, the orifices of the canals are equidistant from a line drawn in a mesiodistal direction through the pulpchamber floor.'

2. Law of symmetry 2: Except for maxillary molars, the orifices of the canals lie on a line perpendicular to a line drawn in a mesiodistal direction across the center of the floor of the pulp chamber.'

3. Law of color change: The color of the pulp chamber floor is always darker than the walls.'

4. Law of orifices location 1: the orifices of the root canals are always located at the junction of the walls and the floor.'

5. Law of orifices location 2:The orifices of the root canals are located at the angles in the floor–wall junction.'

6. Law of orifices location 3: The orifices of the root canals are located at the terminus of the root developmental fusion lines.'

The above laws were found to occur in 95% of the teeth examined(4).

The pulp cavity generally decreases in size as an individual ages. Dentine formation is not uniform throughout life and is more rapid on the roof and floor than on the walls of pulp chambers of posterior teeth. Such calcifications result in a flattened pulp chamber(5).

The term monoblock, literally meaning a single unit, has become familiar in the endodontic literature with recent interest in the application of dentin adhesive technology to endodontics. Replacement monoblocks created in the root canal spaces may be classified as primary, secondary, or tertiary depending on the number of interfaces present between the bonding substrate and the bulk material core (fig. 10). Resilon (Resilon Research LLC, Madison, CT) is the only bondable root filling material that may be used for either lateral or warm vertical compaction techniques(6).

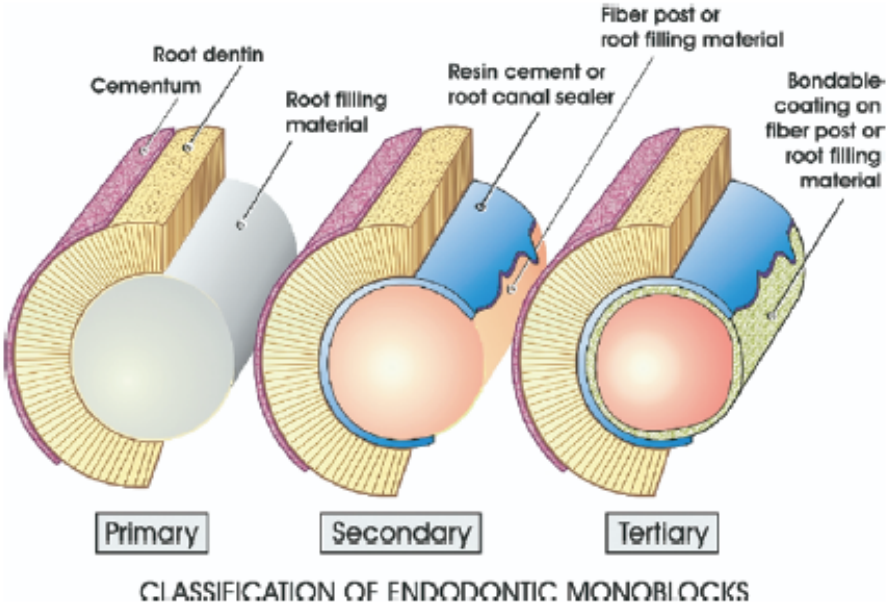

Fig. 10. (6).

Shipper et al did (2004) a evaluation of microbial leakage in roots filled with Resilon/ Epiphany and Gutta-Percha/AH 26 and Gutta-percha/Epiphany. Resilon groups were found to be superior to the gutta-percha groups with respect to the number and rate that the specimens in each group leaked(7). While Williamson et al (2009) showed no evidence of a difference in days to leakage(8).

Wedding et al found that canals obturated with Resilon and Epiphany sealer leaked statistically less than canals obturated with gutta-percha and AH 26 sealer, and that Resilon is a suitable replacement for gutta-percha as a root canal filling material on the basis of its increased resistance to fluid microleakage(9).

Raina et al(2007) compared the sealing ability of Resilon/ Epiphany and Gutta-Percha/AH+. If Resilon-/Epiphany-filled canals were truly adhesive throughout the length of the root canal, then sequential shortening of the root length from the apical end should not lead to any increase in microleakage. They found that before removal of any of the length of the filled roots, statistical comparisons revealed that there were no significant differences in fluid leakage between the Resilon/Epiphany and GP/AH Plus groups. However, the fluid filtration results indicated that Resilon-/Epiphany-filled canals leaked about as much as did the gutta-percha– and AH Plus–filled canals. So they also concluded with that, Resilon/ Epiphany does not create a monoblock root filling that does not leak (10).

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Case 13

Trauma

Introduction

35 year old white northern european female

Fig. 1-4 Clinical pictures 17. days after injury.

Chief complaint

16. September 2009

The patient was in a bicycle accident 30.08.2009 and treated at the Ullevål University Hospital. Teeth 33-41 and tooth 21 was extracted, and maxilla was fixated because of fracture. The patient was then referred to Department of Prosthodontics for evaluation and treatment. Then referred to Department of Endodontics.

Medical history

Non contributory

Clinical findings
16. September 2009

Extra-oral examination: Rubour in the area between upper lip and nose left side. Swollen lips. Bruises on the lower lip.

Intra-oral examination:

	12	11	22	23	34	43
EPT	41	-	-	39	45	28
Cold	+	-	-	+	+	+
Percussion	-	+	+	+	-	-
Palpation	-	+	+	-	-	-
PPD	2 mm	2mm	2mm	2mm	2mm	2mm

Table 1. Clinical findings

Soft tissue: Plaque formation in the area around the fixation splint in maxilla. Sutures and rubour in the area 34-43.

Dental:

Tooth 11: Color change. Red to grey in the crown
Tooth 22: No color change. Horizontal crack line in the crown visible with ultraviolet light

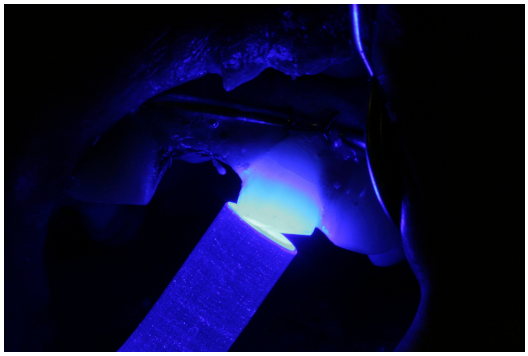

Fig. 5 UV light indicating horizontal crack line

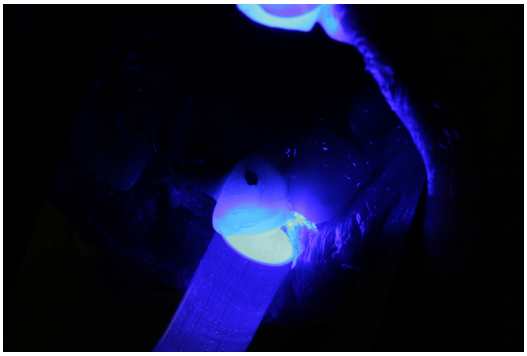

Fig. 6 UV light indicating horizontal crack line

Radiographic findings
16. September 2009

Fig. 7 Periapical radiograph

Fig. 8 Periapical radiograph

Tooth 11: Widended lamina dura. PAI 2 Fixation splint in the coloumn area.

Tooth 12: Normal lamina dura. No apical radiolucency. PAI 1. Fixation splint in the column area.

Tooth 22: Discontinous lamina dura. Apical radiolucency. PAI 3. Radiopaque restoration on the palatal aspect of the crown. Fixation splint in the column area.

Diagnosis

Tooth 11:
Pulpal: Vital pulp (K04.a)
Periapical: Within normal limits
Marginal: Within normal limits

Classification of dental trauma: Concussion

Tooth 22:
Pulpal: Necrotic pulp(K04.1)
Periapical: Extrusion (S03.21A)
Marginal: Within normal limits

Classification of dental trauma: Extrusive luxation with infractions.

Treatment plan

Fig. 8 X-ray holder with individual bite marks.

Follow up control in two weeks. Use the x-ray holder with individual bite marks(Fig. 8).

30. September 2009

Fig. 9 Frontal view

Dental:
Tooth 11: Color change. Grey in the gingival third of the crown
Tooth 22: No color change

Intra-oral examination:

	11	22
EPT	70	-
Cold	-	-
Percussion	+	+
Palpation	+	+
PPD	2mm	2mm

Table 2. Clinical findings

Soft tissue: Fixation splint is removed.

Radiographic findings

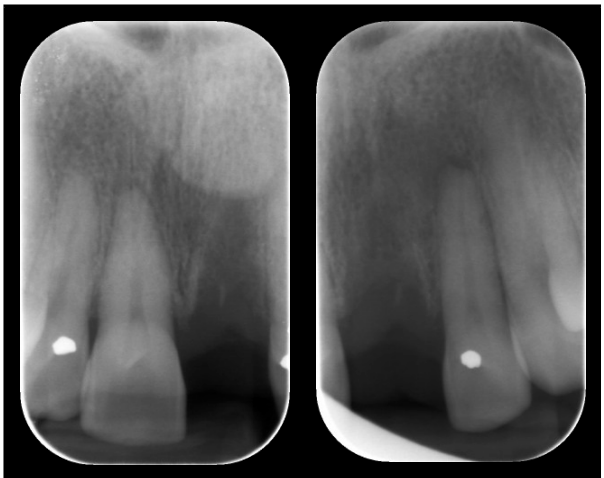

Fig. 10 Periapical radiograph 30092009

Fig. 11 Periapical radiograph 30092009

Tooth 11: Discontinuous lamina dura. Periapical radiolucency. PAI 3

Tooth 12: Normal lamina dura. No apical radiolucency. PAI 1.

Tooth 22: Discontinuous lamina dura. Periapical radiolucency. PAI 3. Radiopaque restoration on the palatal aspect of the crown.

Treatment

30. September 2009

Clinical examination. Sign of pulp sensitivity tooth 11. Wait with any treatment.
Tooth 22 diagnosed with chronic apical periodontitis. Access cavity preparation. Necrotic pulp. Rubber dam. Length of the canal was determined by apex locator(Root ZX®) and a periapical radiograph. Root canal preparation was done mechanically with K-and NiTi hand files in conjunction with Bio-Race.
One canal.
R50/21mm I
1% NaOCl and 17% EDTA were used for chemical root canal disinfection. The canal was dried with paper points and filled with Ca(OH)2. Temporary sealed with IRM.

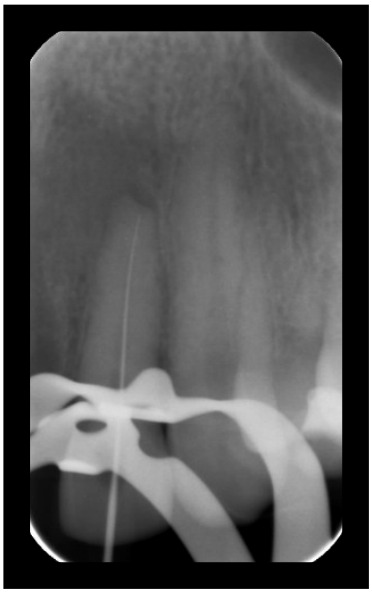

Fig.12 Working length

20. October 2009

Fig. 13 Frontal view

Dental:

Tooth 11: Color change. Grey in the middle third of the crown

Intra-oral examination:

	11	22
EPT	48	-
Cold	-	-
Percussion	+	+
Palpation	-	-
PPD	2mm	2mm

Table 3. Clinical findings

Soft tissue: Within normal limits

Treatment

Wait with any treatment tooth 11. Positive sensitivity reaction, and the grey color in the crown of the tooth is less prominent. The tooth is less sensitive to percussion.

27. October 2009

Tooth 22:

The canal was rinsed with 1% NaOCl and 17% EDTA and dried with paper points. Obturated with gutta percha and AH Plus. Temporary sealed with IRM.

Fig. 14 Master point

Fig. 15 Final radiograph

Result

Fig. 16 Before treatment

Fig. 17 After treatment

24. November 2009

Dental:

Tooth 11: Color change: Grey in the middle third of the crown

Fig. 18 Frontal view

Intra-oral examination:

	11	22
EPT	71	-
Cold	-	-
Percussion	+	+
Palpation	-	-
PPD	2mm	2mm

Table 4. Clinical findings

Soft tissue: Within normal limits

Radiographic findings:

Fig. 19 Periapical radiograph

Tooth 11: Widened lamina dura. PAI 2

Treatment

Wait with any treatment tooth 11. Positive sensitivity reaction to the EPT but still not responding to the cold test. The grey color in the crown of the tooth is less prominent. The tooth is still sensitive to percussion.

6. January 2010

Dental:

Tooth 11: Color change: Grey in the middle third of the crown

Fig. 20 Frontal view

Intra-oral examination:

	11	22
EPT	67	-
Cold	+	-
Percussion	-	-
Palpation	-	-
PPD	2mm	2mm

Table 5. Clinical findings

Soft tissue: Within normal limits

Radiographic findings:

Fig.21 Periapical radiograph

Tooth 11: Normal lamina dura. PAI 2

Treatment

Wait with any treatment tooth 11. Positive sensitivity reaction to both EPT and the cold test. The grey color in the crown of the tooth is less prominent. The tooth is no longer sensitive to percussion.

2. March 2010

Dental:

Tooth 11: Color change: Grey in the middle third of the crown

Fig. 22 Frontal view

Intra-oral examination:

	11	22
EPT	47	-
Cold	+	-
Percussion	-	-
Palpation	-	-
PPD	2mm	2mm

Table 6. Clinical findings

Soft tissue: Within normal limits

Radiographic findings

Fig.21 Periapical radiograph

Tooth 11: Normal lamina dura. PAI 2

Possible root canal calcification

Treatment

Wait with any treatment tooth 11. Positive sensitivity reaction, and the grey color in the crown of the tooth is less prominent. The tooth is no longer sensitive to percussion.

Evaluation

The tooth is discolored, but vital. The tooth has a good prognosis but the discoloration will probably not vanish.

Prognosis

Endodontic: Good
Tooth: Good.

Discussion

Almost all treatment procedures used for dental traumas are still today not evidence-based, a fact, which makes it difficult to analyze the long-term outcome of healing and its relationship to treatment(1). Traumatic dental and maxillofacial injuries are common occurrences, and affect worldwide approximately 20% to 30% of the permanent dentition(2). And luxation injuries with displacement are relatively common injuries occurring with a frequency of 8–20% among the injuries. In case of luxation injuries, the accepted treatment principles appear to be anatomically correct repositioning, stabilization with a splint and sometimes antibiotic coverage. In clinical studies, these principles could not be proven to optimize either periodontal or pulpal healing. The repositioning procedure by it self, because of the necessary force used may injure the PDL and pulp, especially in case of lateral luxation and intrusion. Such an extra damage to the PDL cells on the root surface and pulp cells at the apical foramen may explain the added risk of pulp necrosis, root resorption and marginal healing complications(1).
The American Association of Endodontics wrote in 2006 that the current concept of stabilizing traumatized teeth(luxation injuries, root fractures and avulsions) is to use dental splints that permit some mobility of the injured teeth. The terms «functional and nonrigid» describe splint that allow some mobility, which encourages healing of damaged periodontal ligament fibers and results in less resorption than when rigid splints are used(4). This is very much in agreement with other guidelines(5). Treatment of extrusive luxation injuries is to reposition the tooth by gently re-inserting it into the tooth socket. Stabilize the tooth for 2 weeks using a flexible splint. Monitoring the pulpal condition is essential to diagnose root resorption(5).
With the exception of concussion injuries, luxation injuries frequently result in pulp necrosis requiring root canal treatment(4).
Robertsson(1997) studied a total of 198 patients with 488 injured permanent teeth that were available for clinical examination with a 15 year follow up. She also followed 82 permanent incisors presenting with pulp canal obliteration for a period of 7 to 22 years (mean 16 yr.). Pulp canal obliteration was found in all luxation categories, and according to the survival curve, the 20-year pulp survival rate diagnosed with X-ray was 84%. Although the risk for pulp necrosis increased with time, routine endodontic intervention of teeth with ongoing pulp canal obliteration of the root canal did not seem justified(6).
The fact that diagnosis of pulp necrosis following pulp canal obliteration can in most cases only be based on radiographic findings of a periapical radiolucency, as conventional diagnostic criteria for pulpal status (coronal discoloration, EPT) are

not reliable, may cause diagnostic problems. The crowns of teeth with pulp canal obliteration often had a yellowish appearance(7).

In this case the treatment procedures has followed the guidelines, and according to the table below, further treatment for tooth 11 is follow up for one year.

Follow-up procedures for luxated permanent teeth

Time	Up to 2 weeks	4 weeks	6–8 weeks	6 months	1 year	Yearly for 5 years
Concussion/subluxation		C(1)	C(1)		C(1)	NA
Extrusive luxation	S+C (2)	C(3)	C(3)	C(3)	C(3)	C3)
Lateral luxation	C(3)	S	C(3)	C(3)	C(3)	C(3)
Intrusive luxation	C(4)		C(4)	C(4)	C(4)	C(4)

S, splint removal.
C, clinical and radiographic examination.
NA, not applicable.

Table 6 (5).

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Case 14

Apicoectomy with submarginal incision

Introduction

36 year old female originally from Pakistan

Fig.1 Frontal view

Chief complaint

2. September 2008

None

The patient was referred to Department of Endodontics for evaluation and treatment of maxillary right lateral incisor.

Medical history

Non contributory

Dental history

Tooth 12: Endodontically treated and bridge formation in 2005.

Clinical findings

2. September 2008

Extra-oral examination: within normal limits

Intra-oral examination:

	13	12	22
EPT	35	-	-
Cold	+	-	-
Percussion	-	+	-
Palpation	-	+	-
PPD	3mm	3mm	3mm

Table 1. Clinical findings

Soft tissue: within normal limits

Dental:

Tooth 12: porcelain fused to metal bridge
Tooth 13: sound tooth
Tooth 22: porcelain fused to metal bridge

Radiographic findings

2. September 2008

Tooth 12: Discontinuous lamina dura. Apical radiolucency. Endodontically treated. Radiopaque material on the mesial, occlusal, and distal aspects of the crown tooth. PAI 5.

Tooth 13: Normal lamina dura. No apical radiolucency. PAI 1

Fig. 2 Periapical radiograph

Diagnosis

Tooth 12:

Pulpal: Endodontically treated tooth (K04.19)
Periapical: Chronic apical periodontitis (K04.5)
Marginal: Within normal limits

Treatment plan

Apicoectomy with retrograde filling tooth 12

Problem list

Gingival recession of gingiva

Treatment
16. September 2008

Pre-operative procedure. Septocaine® 3 x 1.8 ml. Submarginal incision from the mesial aspect of tooth 13 to the distal aspect of tooth 21. Vertical releasing incision on the mesial aspect of tooth 13 and mesial aspect of tooth 22, approximately 3cm. Elevation of full mucoperiostal flap. No pathologic fenestration of the buccal cortical bone was observed. Osteotomy. Curettage of granulation tissue. Root-end resection. Root-end preparation with diamond coated ultrasonic tip. Stryphnon gauze and ferric sulfate were used for hemorrhage control. White MTA (ProRoot® MTA) was applied as retrograde filling material. The operation site was inspected and carefully rinsed with sterile saline. Suturing with five 4-0 silk sutures. Post-operative instructions. Patient was given six tablets of 400 mg Ibuprofen to take one tablet every fourth hour the first day after surgery.

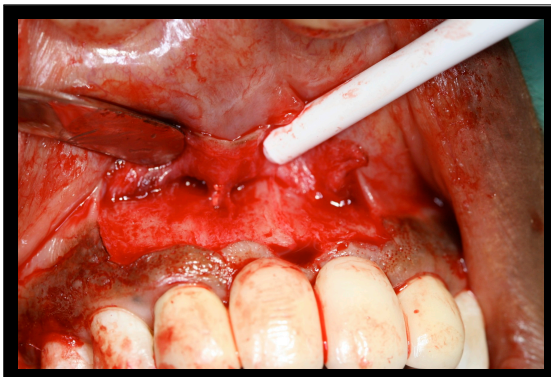

Fig. 3 Full mucoperiostal flap elevated

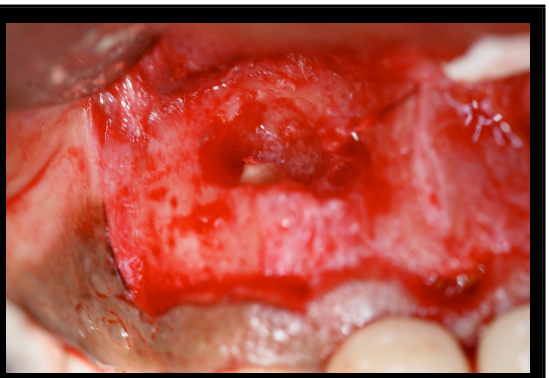

Fig. 4 After osteotomy

Fig. 5 Apical root-resection

Fig. 6 Retrograde filling

Fig. 7 Flap sutured

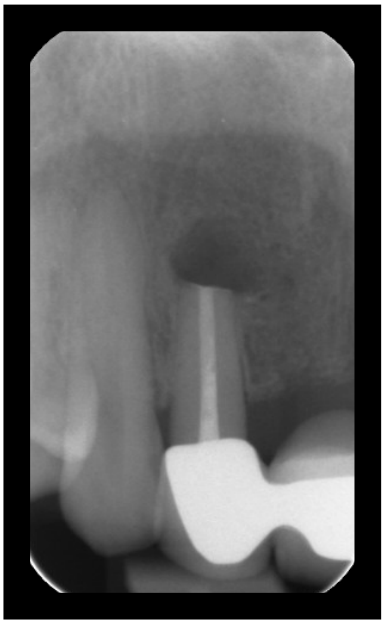

Fig. 8 Post treatment radiograph

17. February 2009

Suture removal. Good soft tissue wound healing. Patient had experienced no discomfort after the surgery

Fig. 9 Before removal of sutures

Fig. 10 After removal of sutures

Result

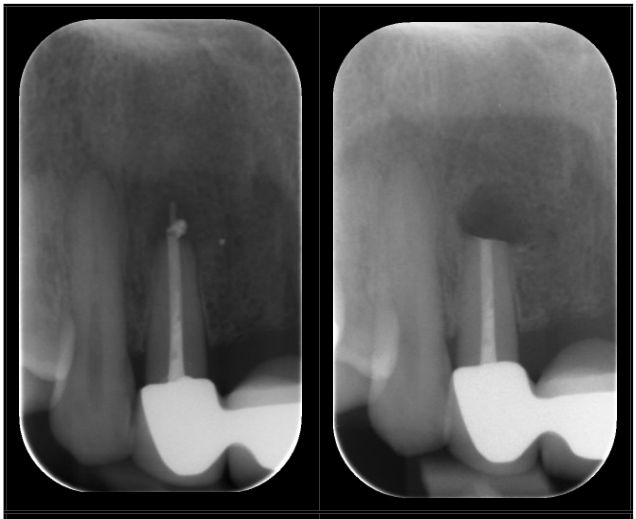

Fig. 11 Before treatment

Fig. 12 After treatment

Evaluation

No complications during treatment. The retrograde filling appeared dense and good.

Prognosis

Endodontic: Good
Tooth: Good.

Follow-up examination

5. January 2010

Fig. 13 Before surgery

Fig. 14 One week after surgery

Fig. 15 Four week after surgery

Fig. 16 One year after surgery

Fig. 17 One year after surgery

The radiograph showed evidence of apical healing .

Discussion

To prevent the marginal recession of the gingiva, a submarginal incision was suggested by Luebke in 1974. This incision is made within the attached gingiva parallel to the marginal contour of the gingiva. The submarginal flap is advocated when there is a broad band of attached gingiva and the expected apical lesion or surgical bony access will not extend to the incision line. In maxillary anterior areas the submarginal incision is preferred in situations with subgingivally placed margin of crowns and bridgework(1). The main disadvantages of the submarginal incision are the scar formation due to flap shrinkage, delayed healing and possible marginal tissue necrosis, when an insufficient blood supply is present(2).

Von Arx et al did a prospective clinical study of three incision techniques, intrasulcular incision, papilla base incision and submarginal incision, and compared the changes of periodontal parameters following apical surgery. Periodontal parameters were recorded at baseline and 1 year following apical surgery. The study included one hundred and eighty-four teeth. They found significant differences between the intrasulcular and submarginal incisions. Intrasulcular incision had a mean recession of 0.42 mm at buccal sites while the submarginal incision had a gain of 0.05 mm(3). Another study from 2009 evaluated gingival recession 1 year following apical surgery of 70 maxillary anterior teeth (central and lateral incisors, canines, and first premolars)(4). The submarginal incision showing considerably less gingival recession compared with the intrasulcular incision, papilla-base incision or papilla-saving incision.

Kreisler et al did a study on ninety-eight teeth. In 65 cases, surgical access was achieved by means of a sulcular incision technique without the involvement of the adjacent periodontia and the interproximal papillae and in 33 cases by means of a submarginal trapezoidal technique. Periodontal parameters (probing pocket depth, gingival recession, clinical attachment loss, and tooth mobility [periotest]) were recorded at baseline and after 6 months. No significant changes in the attachment level and no loss of papilla height were found in either group. A slight gingival recession (0.2 0.4 mm) corresponding to the decrease in pocket depths occurred on the buccal aspect with the sulcular incision(5).

In this case the patient had a porcelain fused to metal bridge from tooth 12 to tooth 22. The metal from the bridge would probably become visible with a gingival recession. So here the submarginal incision was a suitable choice.

Reference list

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Case 15

Apicoectomy with papilla base incision

Introduction

39 year old white Norwegian female

Fig.1 Frontal view

Chief complaint

27. October 2009

The patient felt sometimes discomfort form tooth 12..
The patient was referred to Department of Endodontics for evaluation and treatment of maxillary right lateral incisor.

Medical history

Non contributory

Dental history

Tooth 12:
Endodontically treated at the student clinic in may 2007. Pre treatment diagnosis was acute irreversibel pulpitis

Clinical findings

27. October 2009

Extra-oral examination: within normal limits

Intra-oral examination:

	13	12	11
EPT	35	-	29
Cold	+	-	+
Percussion	-	+	-
Palpation	-	+	-
PPD	2mm	2mm	2mm

Table 1. Clinical findings

Soft tissue: within normal limits

Dental:

Tooth 13: Composite filling at the buccal aspect of the crown
Tooth 12: Composite filling at the mesial and palatal aspect of the crown
Tooth 11: Composite filling at the buccal aspect of the crown

Radiographic findings
27. October 2009

Tooth 12: Discontinuous lamina dura. Apical radiolucency. Endodontically treated. Radiopaque material on the mesial aspect of the crown. PAI 5.

Tooth 13: Normal lamina dura. No apical radiolucency. PAI 1

Fig. 2 Periapical radiograph

Diagnosis

Tooth 12:

Pulpal: Endodontically treated tooth (K04.19)
Periapical: Chronic apical periodontitis (K04.5)
Marginal: Within normal limits

Problem list

Gingival recession.

Treatment plan

Apicoectomy with papilla base incision and retrograde filling tooth 12

Treatment
18. November 2009

Pre-operative procedure. Septocaine® 3 x 1.8 ml. Papilla base incision from the distal aspect of tooth 13 to the distal aspect of tooth 21. Vertical releasing incision on the distal aspect of tooth 13 approximately 3cm. Elevation of full mucoperiostal flap. No pathologic fenestration of the buccal cortical bone was observed. Osteotomy. Curettage of granulation tissue. Biopsy. Root-end resection. Root-end preparation with diamond coated ultrasonic tip. Stryphnon gauze and ferric sulfate were used for hemorrhage control. White MTA (ProRoot® MTA) was applied as retrograde filling material. The operation site was inspected and carefully rinsed with sterile saline. Suturing with nine 6-0 Supramide® sutures. Post-operative instructions. Patient was given six tablets of 400 mg Ibuprofen to take one tablet every fourth hour the first day after surgery.

Fig. 3 Papilla base incision

Fig. 4 Full mukoperiostal flap elevated

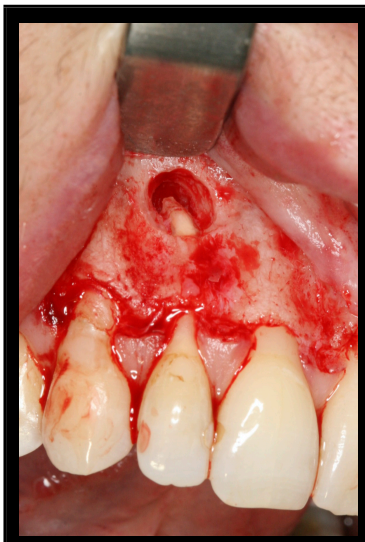


Fig. 5 Osteotomy

Fig. 6 Biopsi

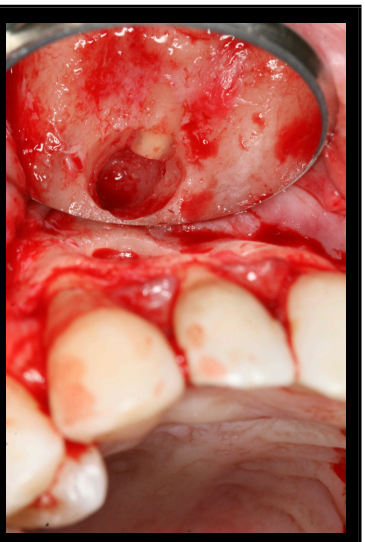


Fig. 7 Root-end resection

Fig. 8 Root-end preparation

Fig. 9 Retrograde filling MTA

Fig. 10 Post treatment radiograph

Fig. 11 Flap sutured

25. November 2009

Suture removal. Good soft tissue wound healing. Patient had experienced discomfort for two days after the surgery

Fig. 12 Before removal of sutures

Fig. 13 After removal of sutures

Result

Fig. 14 Before treatment

Fig. 15 After treatment

Biopsy diagnosis: Granulation tissue and fibrous connective tissue with moderate chronic inflammation

Evaluation

No complications during treatment. The retrograde filling appeared dense and good.

Prognosis

Endodontic: Good
Tooth: Good.

Follow-up examination

5. January 2010

Fig. 16 Before surgery

Fig. 17 One week after surgery(251109)

Fig. 18 Three and a half months after surgery (9032010)

The pictures show good preservation of the periodontal condition. The scar formation is almost invisible.

Fig. 19 9032010

The radiograph showed evidence of apical healing .

Discussion

The ultimate goal in surgical endodontics is not only the eradication of periapical pathosis but also preservation of periodontal conditions using suitable surgical techniques. Acceptable treatment outcomes are no longer possible without consideration of esthetic consequences for all involved dentoalveolar structures(1).

The papilla base incision (PBI) for the marginal mucoperiosteal flap was suggested to prevent loss of interdental papilla height (2). This incision allows the preservation of the entire papilla, thus eliminating any substantial loss of height as a result of the surgical or healing process. A short term (1- and 3-month) comparison of papilla healing when the PBI or standard papilla elevation

was performed, found marked recession of the papilla in completely elevated papilla sites (3).

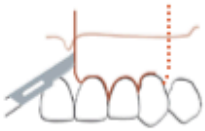
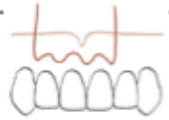
Flap Design	Advantages	Disadvantages
 Semilunar flap		•Limited access. •Incision over defect •Sever majority of blood vessels •Difficult in re-approximating margins
 Trangular/ Rectangular flap	•Minimal disruption of blood supply •Easy repositioning	•Risk of recession
 Submarginal flap	•Low risk of recession	•Possible scar tissue formation •Close proximity to the bony defect
 Papilla based incision	•Low risk of recession •More esthetic results	•Technique sensitive

Table 2. (2) A short summary of the chapter in Endodontic topics 2005, by Velvart et al listed in the table.

In 2004 Velvart et al did a follow up study of the patients evaluated in the previous study in 2003. The PBI incision showed significantly less shrinkage than total mobilization of the papilla at all recall appointments compared with the preoperative levels. The mean recession for the PBI measured between a reference point and the most coronal point of the papilla comparing the preoperative and the recall at 1 month was 0.07 ± 0.09, 0.10 ± 0.15 mm at 3 months and)0.06 ± 0.21 mm at 12 months. For the total papilla mobilization of the papilla the readings were 1.10 ± 0.72 mm at 1 month, 1.25 ± 0.81 mm at 3 months and 0.98 ± 0.75 mm at 12 months. The main vertical loss of height occurs during the initial healing phase in the first month following the surgical procedure. Changes between the 3- and 12-month visit were in general small(4).

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Case 16

Root resection

Introduction

56 year old white Norwegian male

Fig.1 Frontal view

Chief complaint

28. May 2009

None

The patient was referred to Department of Endodontics for evaluation and treatment of maxillary right second molar.

Medical history

Non contributory

Dental history

Non treated tooth

Clinical findings

28. May 2009

Extra-oral examination: within normal limits

Intra-oral examination:

	17
EPT	48
Cold	+
Percussion	-
Palpation	-
PPD	12 mm

Table 1. Clinical findings

Soft tissue: within normal limits

Dental:

Tooth 17: Massive tooth wear.

Radiographic findings

28. May 2009

Tooth 17: Widened lamina dura palatal root. Normal lamina dura mesiobuccal root. Loss of bone support distobuccal root. Massive tooth wear at the occlusal aspect of the crown.

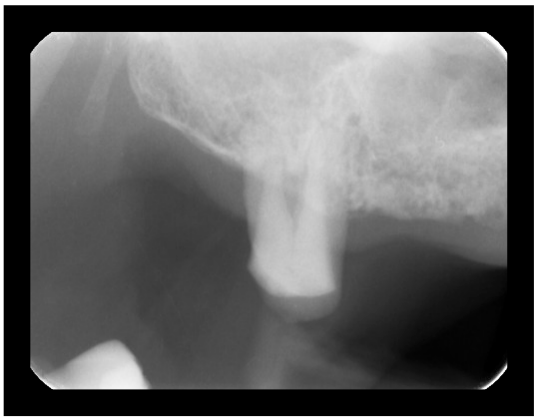

Fig. 2 Peripaical radiograph

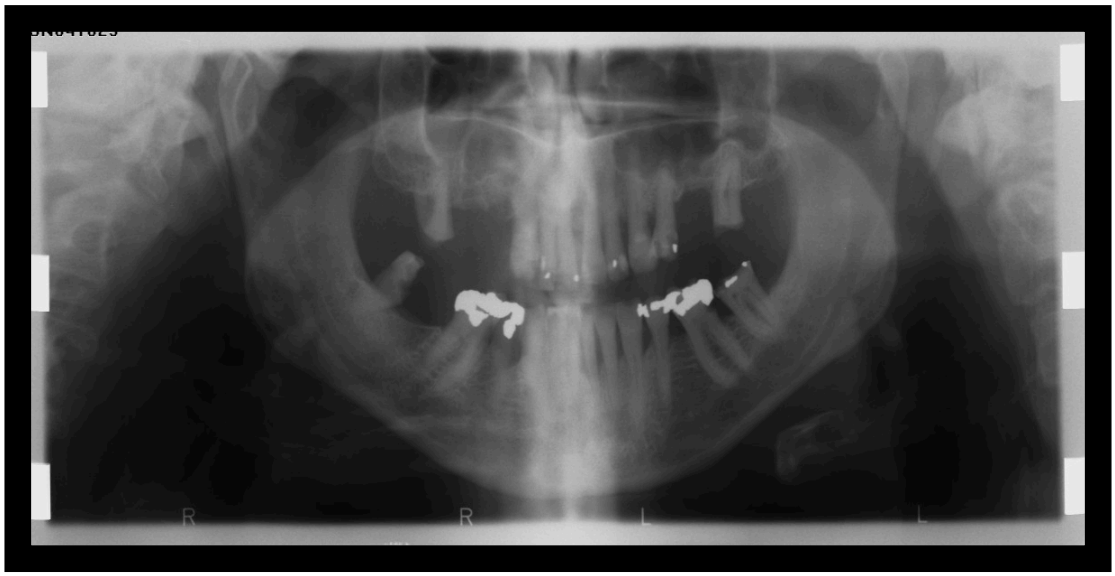

Fig. 3 Orthophantogram

Diagnosis

Tooth 17:

Pulpal: Vital pulp(K04.a)
Periapical: Within normal limits
Marginal: Within normal limits

Treatment plan

Orthograde endodontic treatment, prior to root resection of the distobuccal root. Further treatment plan is an abutment for a bridge.

Treatment

28. May 2009

Clinical examination. Tooth 17 diagnosed with vital pulp. Access cavity preparation. Rubber dam. Located the buccodistal and palatal canal.Length of the canals was determined by apex locator(Root ZX®) and a periapical radiograph. Root canal preparation was done mechanically with K-and NiTi hand files in conjunction with Bio-Race.
Three canals.
MB R40/23mm BC
DB R40/22mm BC
P R40/24mm PC
1% NaOCl and 17% EDTA were used for chemical root canal disinfection
The canals was obturated with lateral compacted gutta percha and Ah+.
The three coronal mm of the distobuccal canal was cleaned, dried and ready for a composite filling, prior to the root resection. Phosphoric acid, Adper Scotchbond, Filtek Supreme A1. Temporary sealed with IRM.

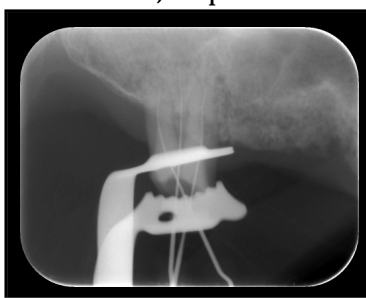

Fig. 4 Working length

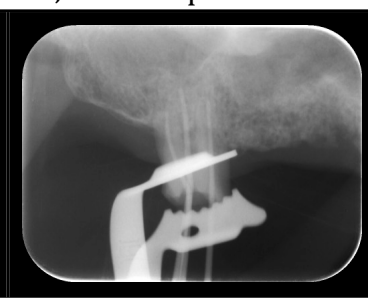

Fig. 5 Master point

Fig. 6 Final radiograph

22. October 2009

Pre-operative procedure. Septocaine® 2 x 1.8 ml. Intra sulcular incision from regio 16 to the distal aspect of tooth 27. Vertical releasing incision on the distal aspect of tooth 17 approximately 3cm. Elevation of full mucoperiostal flap. Osteotomy. Root resection. Curettage of granulation tissue. The operation site was inspected and carefully rinsed with sterile saline. Suturing with four 4-0 Supramide® sutures. Post-operative instructions. Patient was given six tablets of 400 mg Ibuprofen to take one tablet every fourth hour the first day after surgery.

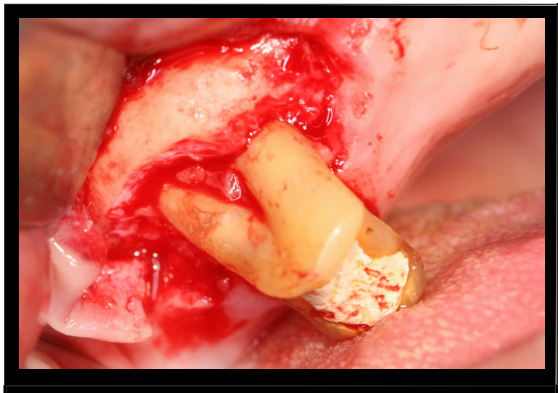

Fig. 7 Full mucoperiostal flap

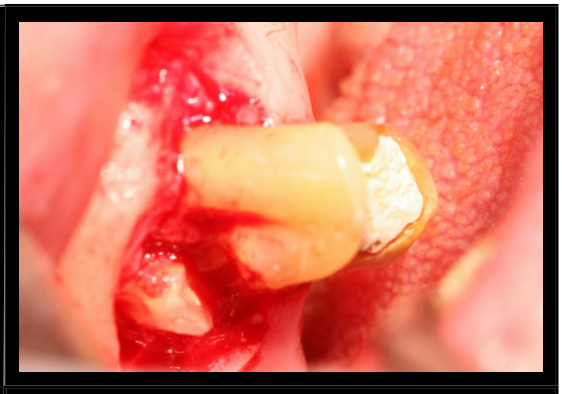

Fig. 8 Root resection

Fig. 9 Root resected

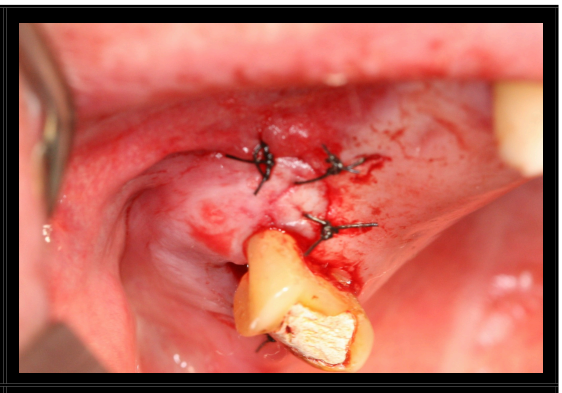

Fig. 10 Flap sutured

28. October 2009

Suture removal. Good soft tissue wound healing.

Fig. 11 Before removal of sutures

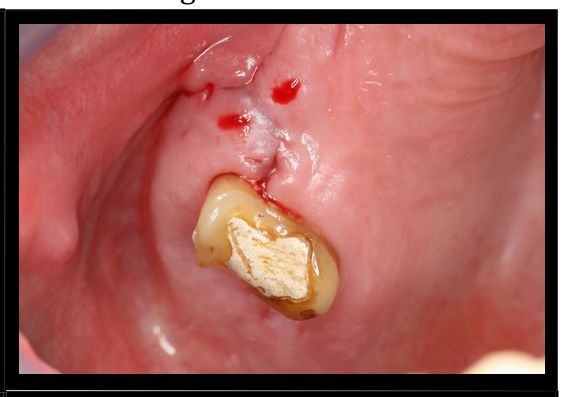

Fig. 12 After removal of sutures

Result

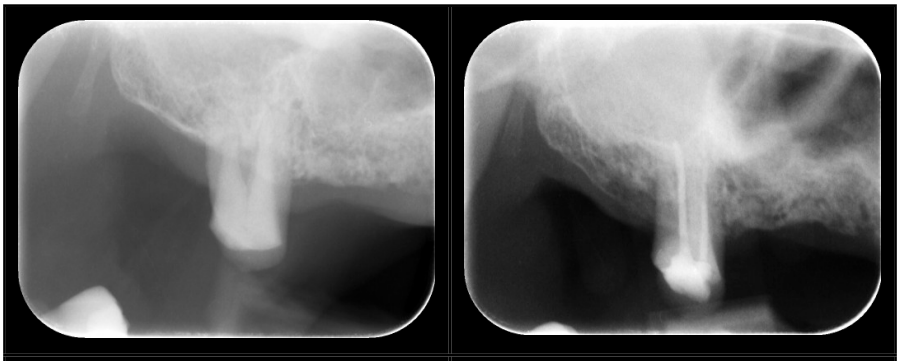

Fig. 13 Before treatment

Fig. 14 After treatment

Evaluation

No complications during treatment.

Prognosis

Endodontic: Good
Tooth: Good.

Follow-up examination

9. December 2009

Fig. 15 Before treatment

Fig. 16 After final restoration

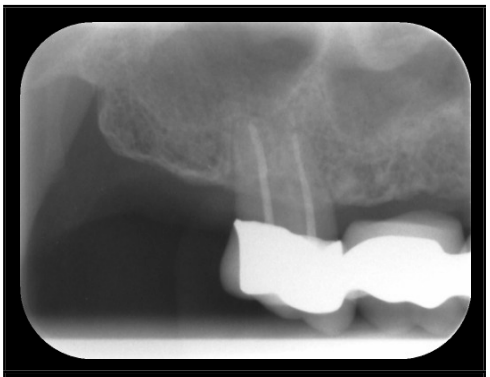

Fig. 17 Follow up radiograph

The patient was asymptomatic and very pleased with his new teeth.

Discussion

Root resection is a good alternative in a multirooted tooth when one or more roots can be saved, while the other cannot(1). Through root-resection therapy, furcation-involved molars can be converted to non-furcated single-root teeth and provide a favorable environment for oral hygiene for patients and clinicians(2). Contraindications are: deeply placed furcation, or fused roots, inability to restore the remaining tooth, remaining root canals are non-negotiable, or remaining roots are short or have little attachment(1).
Fugazzotto compared the success of root resected molars with implants in the molar position. He found that Root resected molars and molar implants demonstrated the highest degree of failure when they were lone standing terminal abutments(3). But still success up to 75%.
Zafiropoulos et al found that root resected molars were at a significantly greater risk for complications than implants. Although approximately 80% of root resected mandibular molars were retained overall, and almost 70% of root resected mandibular molars remained complication free for an average of 5 years (4). Bühler did a 10-year review of 28 root-resection cases, which mainly had been used as bridge abutments. He evaluated the periodontal, prosthetic, and endodontic problems. No failures were observed in the first four years. After ten years nine teeth had failed, and five of them due to endodontic or endodontic-periodontic combined reason(5).

The success of these procedures is dependent on good diagnosis, well-executed root canal treatment, carefully performed periodontal surgery, well contoured crowns, and good oral hygiene by the patient(1).

This patient wanted fixed teeth in the first quadrant. So the alternatives where either to keep the tooth and use it as a bridge abutment, or extract it an replace it with implants. In this case the tooth was non-mobile, and the bone support around the mesiobuccal and palatal root was good. The patient was eager to keep a good oral hygiene, and had quit smoking. So the prognosis for this tooth seems to be good.

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Case 17

Endodontic-periodontal lesion

Introduction

61 year old white northern european female

Fig.1 Frontal view

Chief complaint

7. October 2009

Tenderness upper right region.
The patient was referred to Department of Endodontics for evaluation and treatment of maxillary first and second left molar

Medical history

Non contributory

Dental history

Tooth 26: Endodontically treated in a private clinic by a postgraduate student July 2008. Pretreatment periapical diagnosis was endodntically treated tooth with chronic apical periodontitis(K04.5)

Tooth 27: Endodontically treated in a private clinic by a postgraduate student July 2008. Pretreatment periapical diagnosis was chronic apical periodontitis with sinus tract to the oral cavity(K04.62).

Fig. 2 Orthophantogram

Fig. 3 July 2009

Clinical findings
7. October 2009

Extra-oral examination: within normal limits

Intra-oral examination:

	25	26	27
EPT	-	-	-
Cold	-	-	-
Percussion	-	+	+
Palpation	-	+	+
PPD	2 mm	12mm	14mm

Table 1. Clinical findings

Soft tissue: sinus tract

Dental:

Tooth 27: Porcelain fused to metal crown
Tooth 26: Porcelain fused to metal crown
Tooth 25: Gold onlay

Fig. 4 Lateral view

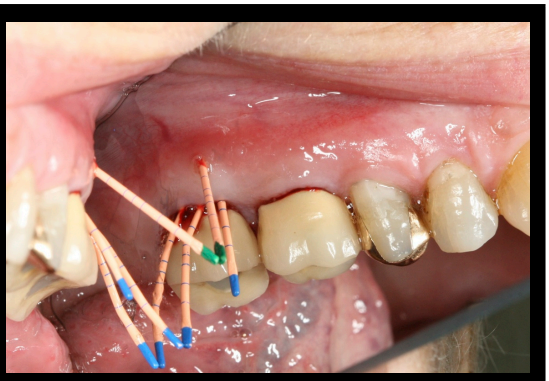


Fig. 5 Master points in perodontal pocket and sinus tract

Radiographic findings
7. October 2009

Fig. 6 Pretreatment radiograph

Fig. 7 Fistulogram

Tooth 27:Discontinuous lamina dura. Apical and interradicular radiolucency. Endodontically treated. Radiopaque material on the occlusal aspect of the crown. PAI 5.

Tooth 26: Discontinuous lamina dura. Apical radiolucency. PAI 5. Radiopaque restoration on the occlusal aspect of the crown.

Tooth 25: Normal lamina dura. No apical radiolucency. PAI 2. Radiopaque restoration on the occlusal aspect of the crown.

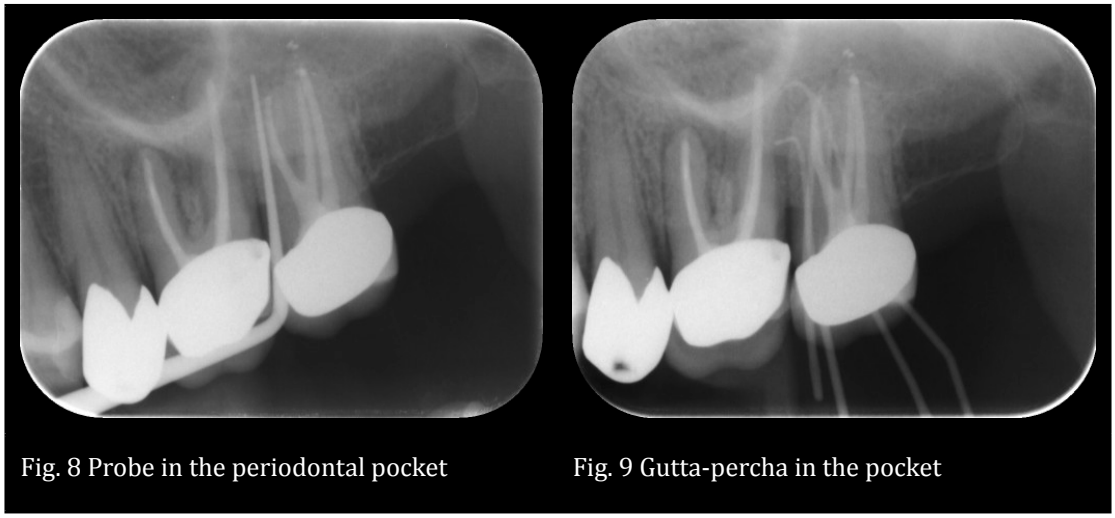


Fig. 8 Probe in the periodontal pocket

Fig. 9 Gutta-percha in the pocket

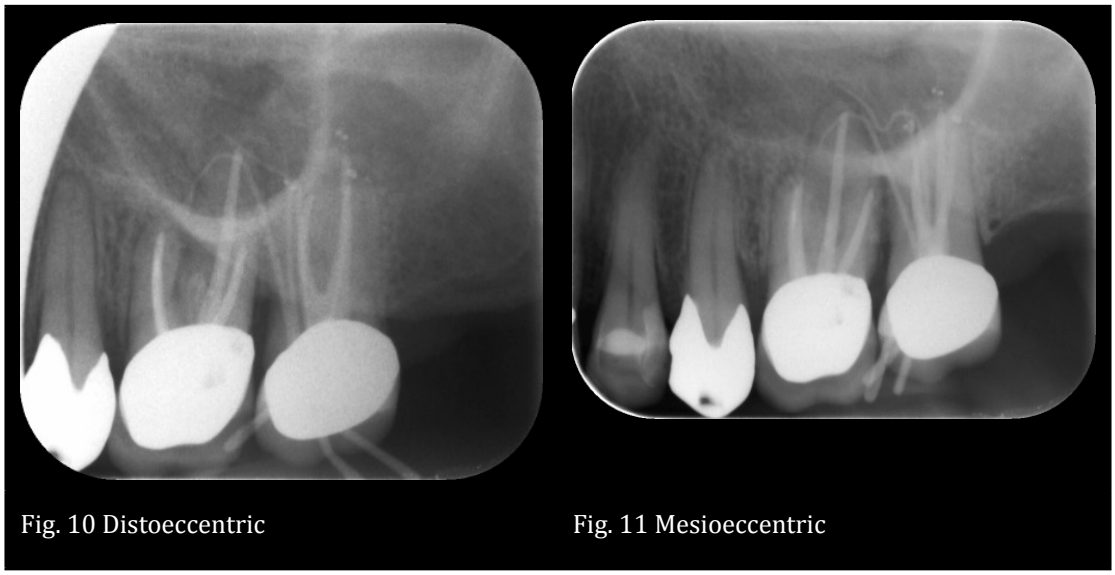


Fig. 10 Distoeccentric

Fig. 11 Mesioeccentric

Fig. 10 and 11 is taken with a changed angle of the x-ray. It shows that the GP curved on the palatal root of tooth 26 is buccal to the palatal root.

Diagnosis

Tooth 26:

Pulpal: Endodontically treated tooth (K04.19)
Periapical: Chronic apical periodontitis with sinus tract(K04.62)
Marginal: Chronic marginal periodontitis (K05.3)

Tooth 27:

Pulpal: Endodonticaly treated tooth (K04.19)
Periapical: Chronic apical periodontitis with sinus tract(K04.62)
Marginal: Chronic marginal periodontitis (K05.3)

Treatment plan

Exploratory surgery
If possible; apicoectomy with root-end filling

Problem list:

Vertical root fracture?

Treatment

4. November 2009

Pre-operative procedure. Septocaine® 3 x 1.8 ml. Intra sulcular incision from the mesial aspect of tooth 25 to the distal aspect of tooth 27. Vertical releasing incision on the mesial aspect of tooth 25 approximately 3cm. Elevation of full mucoperiostal flap. Curettage of granulation tissue. Wide vertical bone defect. Osteotomi. Extraction of tooth 27. Granulation tissue sent for 3D scanning with electron microscope. Root resection of distobuccal root tooth 26. Root-end preparation with diamond coated ultrasonic tip. Stryphnon gauze and ferric sulfate were used for hemorrhage control. Composite Z250 3M was applied as retrograde filling material. The operation site was inspected and carefully rinsed with sterile saline. Suturing with five 4-0 Supramide® sutures. Post-operative instructions. Patient was given six tablets of 400 mg Ibuprofen to take one tablet every fourth hour the first day after surgery.

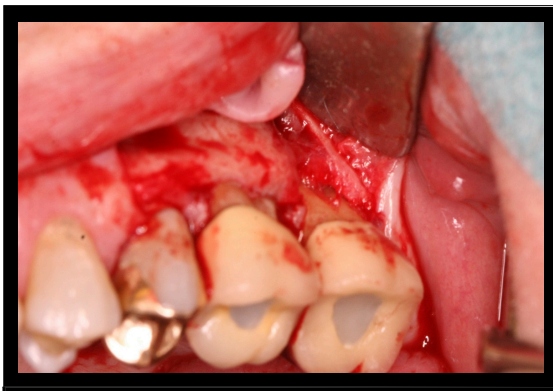


Fig. 11 Full mucoperiostal flap

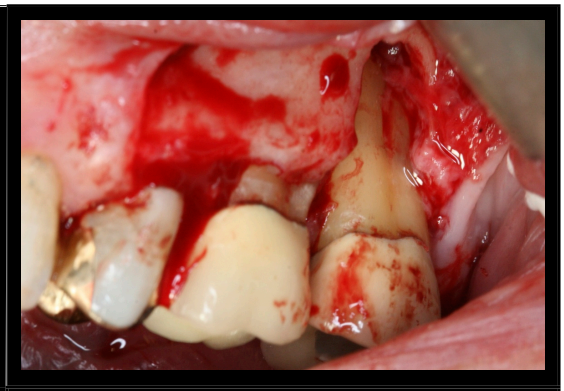


Fig. 12 Wide vertical bone defect

Fig. 13 Granulation tissue sendt for 3D scanning EM

Fig. 14 Rootresection tooth 26 DB root

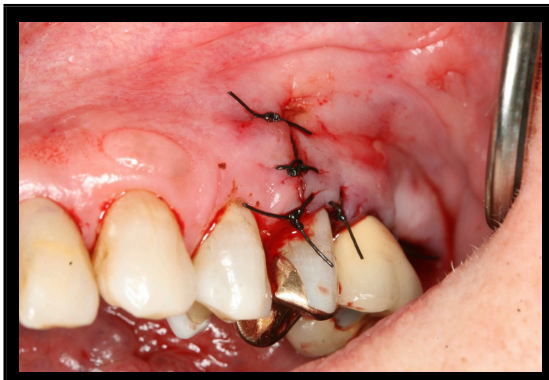


Fig. 15 Flap sutured

Fig. 16 Post treatment radiograph

12. November 2009

Suture removal. Good soft tissue wound healing.

Fig. 17 Before removal of sutures

Fig. 18 Before removal of sutures

Fig. 19 After removal of sutures

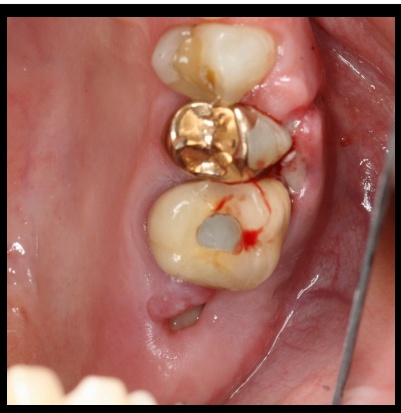


Fig. 20 After removal of sutures

Result

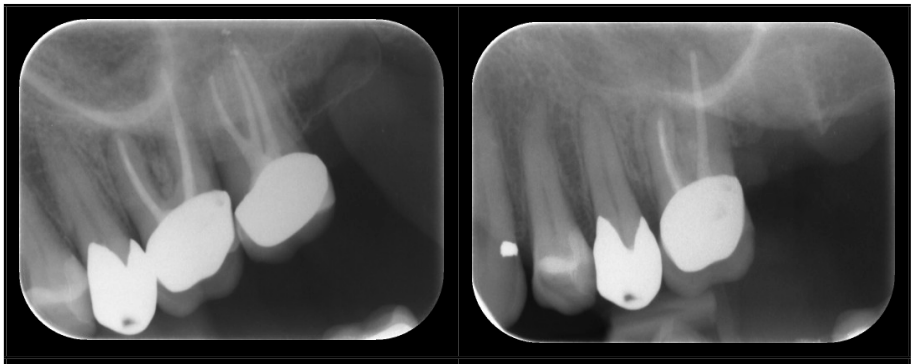
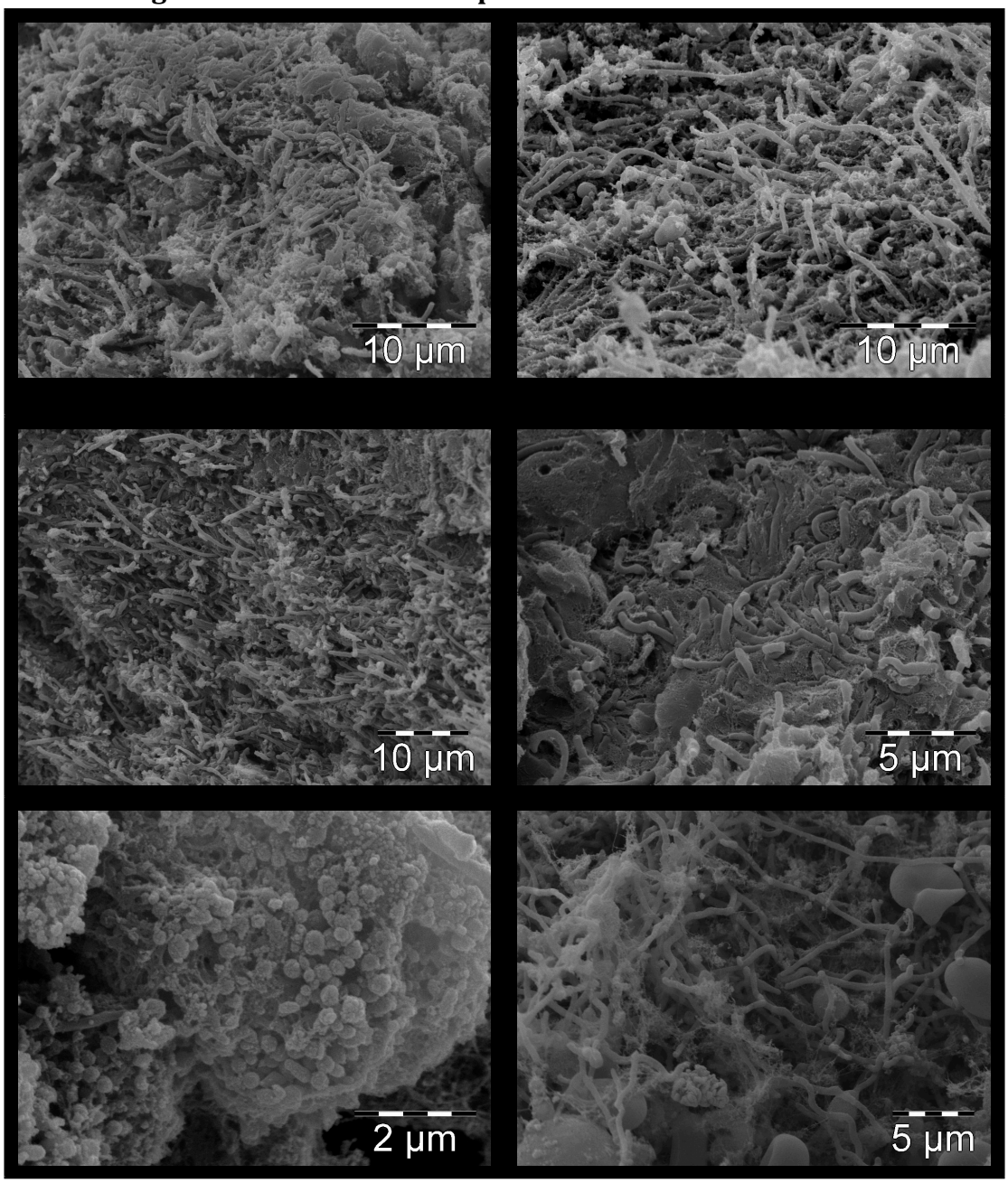


Fig. 21 Before treatment

Fig. 21 After treatment

3D scanning with electron microscope



The morphology of the structures are compatible with rods, cocci and spirochete-like bacteria. In between the bacteria-like structures, extracellular matrix can be seen.

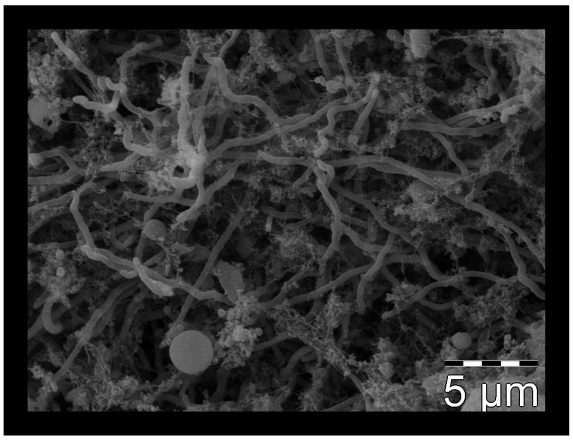


Fig. 22-28 3D scanning with electron microscope

Evaluation

No complications during treatment.

Prognosis

Endodontic: Good
Tooth: Uncertain.

Follow-up examination

22. April 2010

Extra-oral examination: within normal limits

Intra-oral examination:

Fig. 29-31 Clinical photos showing gingival healing. No periodontal pocket.

The patient was asymptomatic and experienced no sensitivity to percussion or palpation tests on tooth 26.
The radiograph showed evidence of healing.

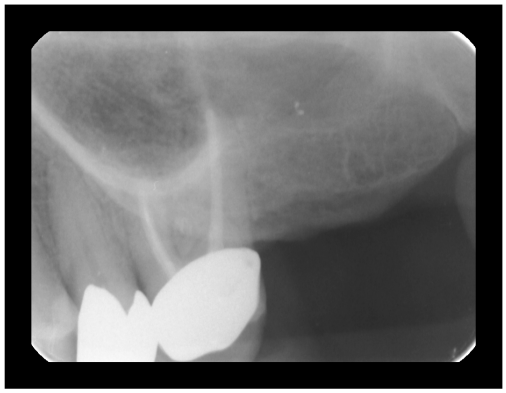


Fig 32. Follow up radiograph

Discussion

The interrelationship between periodontal and endodontic disease has aroused much speculation, confusion, and controversy. Pulpal and periodontal problems are responsible for more than 50% of tooth mortality today. Diagnosis is often difficult since these diseases have been studied primarily as separate entities(1). But establishing the correct diagnosis and subsequently the correct treatment sequence is necessary for a satisfactory prognosis. Clinical diagnostic procedures include a wide variety of tests. Pulp vitality testing including hot, cold, electric, and where indicated, test cavity preparation should be conducted to establish the lack of vitality(2).
Despite our substantial understanding of the etiology of periodontal and endodontic disease, we are frequently at a loss to explain how one process occurring primarily in the pulpal or periodontal tissues might affect the other process(3).

In this case the teeth that were affected were already endodontically treated and the general marginal bone support was within normal limits. But both tooth 26 and 27 had furcation involvement and narrow deep pockets. It is difficult to decide wether this was primarily an endodontic lesion or and periodontal lesion, but since the rest of the periodontium is within normal limits, this might be a primarily endodontic lesion.

Gram-negative bacteria are common members of primary infection but not commonly found in post-instrumentation or post-medication samples. The most prevalent group of the bacterial flora of an persistent endodontic lesion is gram-positive facultatives and include Streptococcus species, P.micra, Actinomyces species, Proprionibacterium species, P. alactolyticus, Lactobacillus species, Enterococcus faecalis and O.uli. Approximately 40% of the taxa found in post-treatment samples are as-yet-uncultivated phylotypes (4).
Traditionally it has been held that the microorganisms are present in necrotic tissue in the root canal system and in tubules of the root dentin whereas the periapical tissues are free of bacteria(5). In 1959 Grossman(6) studied the bacteriological status of periapical tissue in 150 cases of infected pulpless teeth. He did not find bacteria in the periapical tissue in 85,3% of the cases. So his opinion was that bacteria in abundance were always found within the root canal but granulation tissue and cysts attached to the apices of these teeth were often free from microorganisms, and that a granuloma is not an area in which bacteria live, but in which they are destroyed(7). Nair studied the root canal flora and periapical lesions. He concluded with his study in 1987 that only a small fraction of the periapical lesions reveals bacteria within the body of the lesions(8). Sunde et al did a methodological study on extraradicular infection. They found that most organisms detected in the periapical lesions were clearly different from the bacteria present at neighboring sites and appeared to have been there before sampling. And with that study revealed the unsureness of the contaminant theory (9).
Some studies on extraradicular endodontic infections using molecular techniques have confirmed previous findings from culture studies. Sunde et al (2000) used the “checkerboard” DNA-DNA hybridization technique to identify

bacteria in periapical endodontic lesions of asymptomatic teeth . Bacterial DNA was identified in all samples and the number of species per lesion ranged from 11
to 34 in the group that a submarginal incision was made. Were a marginal incision was made the number of species ranged from 26-39. Much more bacteria were detected in periapical lesion after a marginal lesion(10). Similar findings were observed by Ghatti et al(11). The "red complex" was detected in 70% of the lesions. P. endodontalis occurred in approximately 50% of the cases. Gram-positive anaerobes, including Actinomyces, Propionibacterium, Peptostreptococcus and Eubacterium species were also frequently detected. Sunde et al (2003) did a study using the FISH technique for direct visualization of bacteria in periapical lesion of asymptomatic rootfilled teeth. Bacteria were observed in 20 of 39 lesions. Bacteria were present in localized areas of the lesions and no bacteria were observed at the borders of the lesions, indicating that contamination had been prevented. Other parts of the lesions appeared to be free of bacteria. A variety of different bacterial morphotypes was visualized, including cocci, rods and spirilla . Rods and especially spirochete-like bacteria were present between cells and fibers in the tissue (12).

Species associated with adult periodontitis include Bacteroides forsythus, Porphyromonas gingivalis, Prevotella intermedia, A. actinomycetemcomitans, and Wolinella recta(13).

In this case we cyretted a sample of granulation tissue containing bacteria as seen in the 3D images. We can probably see rods, cocci and spirochetes. All these can be associated with the species both in adult periodontitis and extra radicular infections associated with apical periodontitis.

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Case 18

Endo-perio lesion treated with Bio-oss

Introduction

70 year old white Norwegian male

Fig.1 Frontal view

Chief complaint

2. April 2009

None
The patient was referred to Department of Endodontics for evaluation and treatment of mandibular second left molar

Medical history

Non contributory

Dental history

Tooth 37: Endodontically treated at the student clinic November 2008. Pretreatment periapical diagnosis was chronic apical periodontitis and chronic lateral/interradicular periododontitis.

Fig. 2 6062008 Fig. 3 12112008

Clinical findings
2. April 2009

Extra-oral examination: within normal limits

Intra-oral examination:

	37	36	35
EPT	-	-	37
Cold	-	-	+
Percussion	+	-	-
Palpation	+	-	-
PPD	12 mm	2mm	2mm

Table 1. Clinical findings

Soft tissue: within normal limits

Dental:
Tooth 37: Porcelain fused to metal crown
Tooth 36: Porcelain fused to metal crown

Radiographic findings
2. April 2009

Tooth 37:Discontinuous lamina dura. Apical and interradicular radiolucency. Endodontically treated. Radiopaque material on the occlusal aspect of the crown. PAI 5.

Fig. 4 Periapical radiograph

Tooth 36: Normal lamina dura. No apical radiolucency. PAI 2. Radiopaque restoration on the occlusal aspect of the crown.

Diagnosis

Tooth 37:

Pulpal: Endodontically treated tooth (K04.19)
Periapical: Chronic apical periodontitis with sinus tract(K04.62)
Chronic lateral/interradicular periododontitis (K04.51)
Marginal: Chronic marginal periodontitis (K05.3)

Treatment plan

Exploratory surgery

Problem list

Vertical root fracture?

Treatment
2. April 2009

Pre-operative procedure. Septocaine® 3 x 1.8 ml. Intra sulcular incision from the mesial aspect of tooth 36 to the distal aspect of tooth 37. Vertical releasing incision on the mesial aspect of tooth 36 approximately 3cm. Elevation of full mucoperiostal flap. Curettage of granulation tissue. Wide bone defect. Defect filled with Geistlich Bio-Oss®. The operation site was inspected and carefully rinsed with sterile saline. Suturing with four 6-0 Supramide® sutures. Post-operative instructions. Patient was given six tablets of 400 mg Ibuprofen to take one tablet every fourth hour the first day after surgery.

Fig. 5 Full mucoperiostal flap

Fig. 6 Geistlich Bio-Oss®

Fig. 7 Defect filled with Geistlich Bio-Oss®

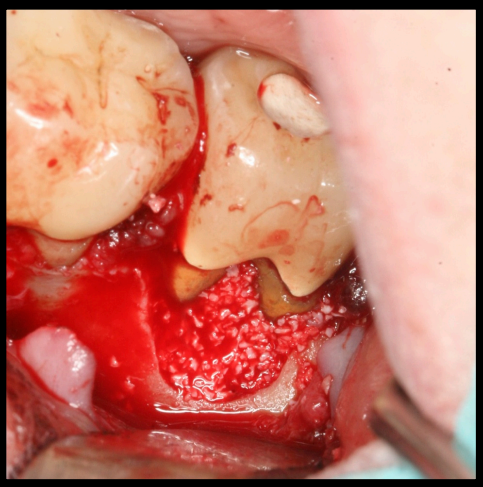

Fig. 8 Defect filled with Geistlich Bio-Oss®

Fig. 9 Flap sutured

Fig. 10 Post treatment radiograph

16. April 2009

Suture removal. Good soft tissue wound healing.

Fig. 11 Before removal of sutures

Fig. 12 After removal of sutures

Result

Fig. 13 Before treatment

Fig. 14 After treatment

Evaluation

No complications during treatment.

Prognosis

Endodontic: Good
Periodontal: Uncertain
Tooth: Uncertain.

Follow-up examination

1. September 2009

Extra-oral examination: within normal limits

Intra-oral examination:

Fig. 15 Exostosis buccaly tooth 37

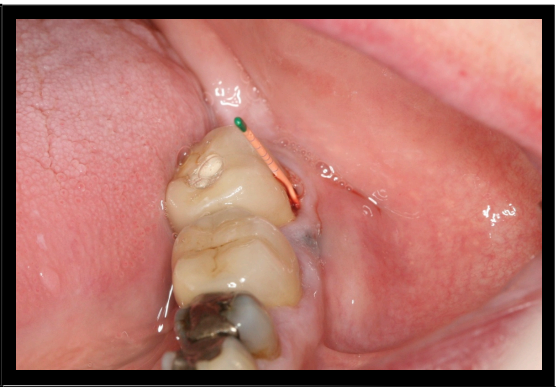

Fig. 16 Gutta-percha in the narrow pocket

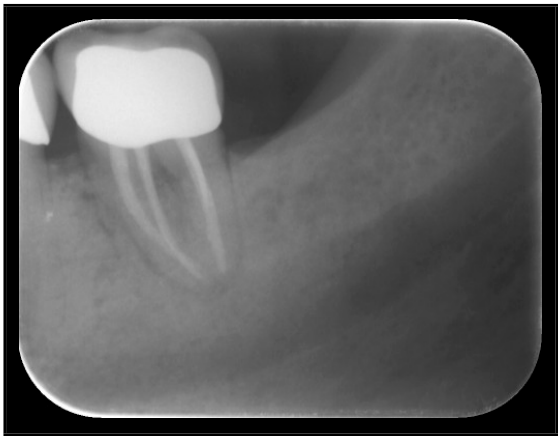

Fig. 17 1092009

Fig. 18 1092009

11. February 2010

Extra-oral examination: within normal limits

Intra-oral examination:

Fig. 19 Exostosis buccaly tooth 37

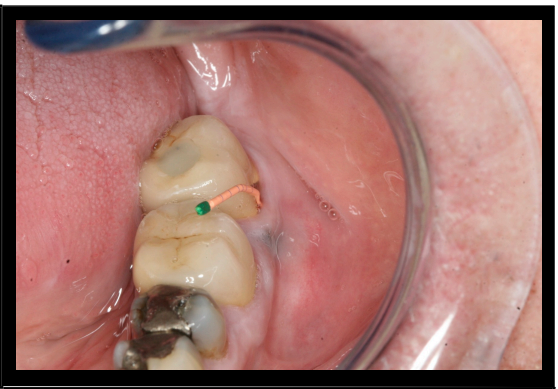

Fig. 20 Gutta-percha in the narrow pocket

Fig. 21 11022010

Fig. 22 11022010

Discussion

The morphology of the periodontal lesion is an important diagnostic factor. In general, periodontitis is characterized by horizontal bone loss and is often generalized in the mouth with evident plaque and calculus formation. In contrast, the presence of a vertical bony lesion (deep narrow pocket) should lead the clinician to suspect an endodontic origin of the lesion, and the presence of a fractured root should be evaluated in these cases(1).

Several tooth-related factors have been shown to influence the prognosis of periradicular surgery, among them the amount and location of bone loss(2). Two retrospective studies indicated that the prognosis is substantially reduced in teeth with a localized total loss of marginal bone(3,4).

Bone regeneration grafts (BRG) are widely used in the treatment of osseous defects and oral surgery. The various techniques and associated success rates of bone augmentation require evaluation by systematic review and meta-analysis of eligible studies(5).

Although apicomarginal defects are relatively rare, they constitute a significant challenge to the oral surgeon. Dietrich et al studied 23 defects in 22 patients for whom follow-up data were available. The defects were classified according to their pathogenetic and morphologic criteria. This classification is divided into three groups, depending on if there is a bony bridge covering the periodontic-endodontic lesion. The root surface was carefully scaled with sonic tips (SONICflex; KaVo). Afterwards, the defect was augmented with inorganic bovine bone mineral (Bio- Oss spongiosa 0.5-1.0 mm particles; Geistlich Biomaterials, Wolhusen, Switzerland). Out of the 22 teeth 19 were considered clinically and radiographically successful, 2 were doubtful, and 2 were failures(2).
In a review article they concluded with that the difference in bone augmentation between Bio-Oss and autogenous bone graft was not significant. However, Bio-Oss may be considered superior to autogenous bone graft, because autogenous bone graft sometimes involves donor site surgery, complications and donor site morbidity(5).

In this case a periradicular healing is radiographically evident and the periodontal defect is minimized. The tooth still had a narrow pocket in the furcation area. The periodontal defect was not bleeding on probing and seemed to be in a silent stage.

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Case 19

Resurgery of chronic apical periodontitis

Introduction

55 year old white Northern European male

Fig.1 Frontal view

Chief complaint

11. November 2008

Tender on palpation region 23

The patient was referred to Department of Endodontics from Department of Oral Surgery for evaluation and treatment of maxillary left canine.

Medical history

Non contributory

Dental history

Tooth 23:

Car accident 1990. Possible fracture in both maxilla and mandible.

Endodontically treated in 1990. Crown and post.

March 2007: Periapical surgery at the Department of Oral Surgery, UiO

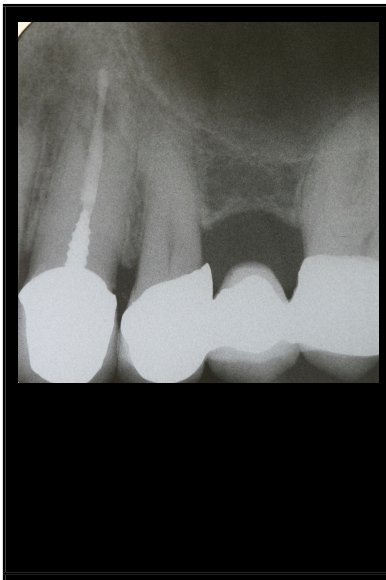

Fig. 2 Before periapical sugery 2007

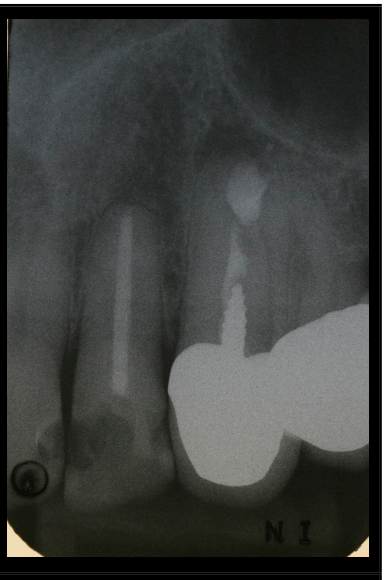

Fig. 3 After periapical sugery 2007

Clinical findings
11. November 2008

Extra-oral examination: within normal limits

Intra-oral examination:

	22	23	24
EPT	-	-	-
Cold	-	-	-
Percussion	-	+	-
Palpation	-	+	-
PPD	3mm	3mm	3mm

Table 1. Clinical findings

Soft tissue: within normal limits

Dental:

Tooth 22: composite restoration on the mesial, distal and palatal aspects of the crown
Tooth 23: porcelain fused to metal crown
Tooth 24: porcelain fused to metal crown

Radiographic findings
11. November 2008

Tooth 22: Normal lamina dura. No apical radiolucency. PAI 2.

Tooth 23: Discontinuous lamina dura. Apical radiolucency. Endodontically treated. The quality of the retrograde filling appears poor. Radiopaque material on the mesial, occlusal, and distal aspects of the crown tooth. PAI 5.

Tooth 24: Normal lamina dura. No apical radiolucency. PAI 1.

Fig.4 Periapical radiograph

Diagnosis

Tooth 23:
Pulpal: Endodontically treated tooth (K04.19)
Periapical: Chronic apical periodontitis (K04.5)
Pathologic resorption(K03.39)
Marginal: Within normal limits

Problem list

Prior apical surgery
Remaining tooth structure

Treatment plan

Apicoectomy with retrograde filling tooth 23

Treatment
10. February 2009

Pre-operative procedure. Septocaine® 3 x 1.8 ml. Marginal incision from the mesial aspect of tooth 22 to the distal aspect of tooth 25. Vertical releasing incision on the mesial aspect of tooth 22, approximately 3cm. Elevation of full mucoperiostal flap. A pathological fenestration of the buccal cortical bone was observed. The prior retrograde filling was loose, and removed with a curette. Curettage of granulation tissue. Part of the root end seemed to resorbed. Osteotomy. Root-end resection. The internal part of the root end was prepared with diamond coated ultrasonic tip. Stryphnon gauze and ferric sulfate were used for hemorrhage control. White MTA (ProRoot® MTA) was applied as retrograde filling material. The operation site was inspected and carefully

rinsed with sterile saline. Suturing with five 4-0 Supramide® sutures. Post-operative instructions. Patient given six tablets of 400 mg Ibuprofen to take one tablet every fourth hour the first day after surgery.

Fig. 5 Pathological fenestration of the cortical bone

Fig. 6 After root end preparation

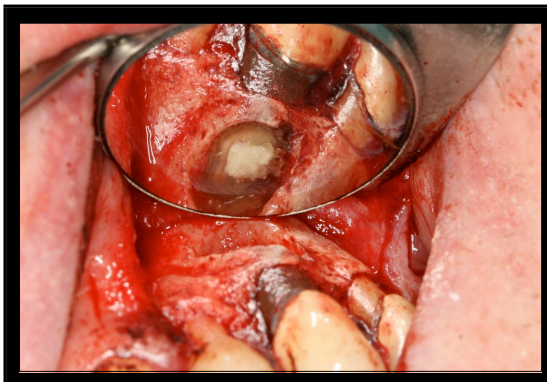

Fig. 7 Retrograde filling MTA

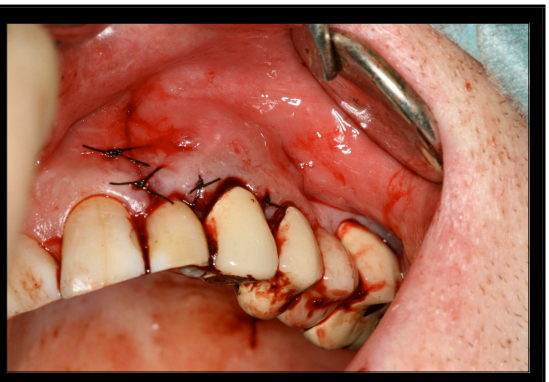

Fig. 8 Flap sutured

Fig. 9 Posttreatment radiograph

17. February 2009

Suture removal. Good soft tissue wound healing. Patient had experienced no discomfort after the surgery

Fig. 10 Before removal of sutures

Fig. 11 After removal of sutures

Result

Fig. 12 Before treatment

Fig. 13 After treatment

Evaluation

No complications during treatment. The retrograde filling appeared dense and good.

Prognosis

Endodontic: Good

Tooth: Uncertain. Because of the small amount of remaining tooth substance.

Follow-up examination
3. November 2009 and 23. February 2010

Extra-oral examination: within normal limits

The radiographs showed evidence of apical healing. The patient was asymptomatic.

Fig. 14 Nine months after surgery

Fig. 15 Thirteen months after surgery

Discussion

Surgical endodontics is now a reliable therapeutic procedure for the treatment of teeth with periapical lesions, particularly when orthograde retreatment is problematical (1,2).
There is little information available regarding the outcome of surgical operations performed on teeth that had previously undergone periapical surgery. Persson (1973) looked at 129 cases reoperated after «unsuccesusful» apicectomy. The late results of the reoperation proved «successful» in about 35%, which is a much lower figure than that found after primary amputation of the root(3).
In a systematic review, Peterson & Gutmann(4) (2001) reported that healing associated with surgical retreatment was approximately 36%. This compares unfavorably with surgery on teeth previously treated by orthograde techniques alone, where the outcome would reflect healing in over 60% of cases.

In «The Toronto Study. Phases I and II: Apical surgery» they investigated many pre-operative factors. One of them was previous apical surgery. Eight out of the 100 teeth treated had had previous apical surgery. Five of these healed (63%). That is far better than reported in earlier studies(5). When surgery was repeated, the technique differed from that of the first-time surgical procedure. Root-end preparations were made with ultrasonic tips and current root-end filling materials were used. The modified case selection and techniques may have contributed to the higher healing rate observed after repeat surgery in the present study than in the previous one(5).

Gagliani et al did a five year longitudinal comparison of periapical resurgery versus periapical surgery. A total of 164 patients with 231 roots were included in the study. Of the 231 roots examined after 5 years, 78% had completely healed, 10% had incompletely healed and 11% were associated with post-treatment disease. Divided into the two groups, it was complete healing in 86% of the roots in the first time periapical group compare to 59% healing in the resurgery group. A possible explanation for the lower treatment outcome in the resurgery group can be that a large number of the roots was previously treated in a specialist centre specifically dedicated to endodontic surgery(6).

Tsesis et al did a retrospective study on traditional versus modern technique. They found that differences in the healing outcome were highly significant (p 0.0001). Complete healing was found in 41 teeth (91.1%) treated with the modern technique compared to only 19 teeth (44.2%) treated with the traditional technique. Uncertain healing was found in five teeth (11.6%) treated with the traditional technique compared to only two teeth (4.4%) treated with the modern technique. Failure was found in 19 teeth (44.2%) treated with the traditional technique compared to only two teeth (4.4%) treated with the modern technique

In this case the surgical protocol differed from the first time surgery, and can possibly explain the healing.

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7. Tsesis I, Rosen E, Schwartz-Arad D, Fuss Z, Retrospective Evaluation of Surgical Endodontic Treatment: Traditional versus Modern Technique. J Endod 2006;32:412– 416

Case 20

Apicoectomy of a mandibular molar

Introduction

58 year old white northern European female

Fig.1 Frontal view

Chief complaint

27. November 2008

The patient has been complaining about tenderness in all four quadrants. The patient was referred to Department of Endodontics for examination and treatment .

Medical history

Non contributory

Dental history

Tooth 46: Endodontically treated some years ago.

Clinical findings

27. November 2008

Extra-oral examination: within normal limits

Intra-oral examination:

	47	46	45
EPT	35	-	24
Cold	+	-	+
Percussion	-	-	-
Palpation	-	-	-
PPD	2mm	2mm	2mm

Table 1. Clinical findings

Soft tissue: Sinus tract at the buccal in the attached gingiva.

Dental:

Tooth 45: Amalgam filling at the occlusal aspect of the crown.
Tooth 46: Porcelain fused to metal crown
Tooth 47: Amalgam filling at the occlusal and mesial aspect of the crown

Radiographic findings
27. November 2008

Tooth 45: Normal lamina dura. No apical radiolucency. PAI 1. Radiopaque material at the occlusal of the crown.

Tooth 46: Discontinued lamina dura at the M root. Apical radiolucency at the M root. PAI 4. Metal crown with post in both mesial an distal canal. Endodontically treated.

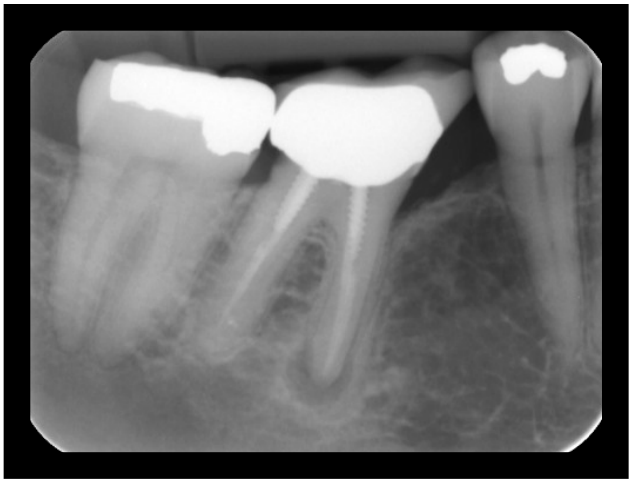

Fig. 2 Periapical radiograph

Tooth 47: Normal lamina dura. No apical radiolucency. PAI 1. Radiopaque material at the occlusal aspect of the crown

Diagnosis

Tooth 46:

Pulpal: Endodontically treated tooth(K04.19)
Periapical: Chronic apical periodontitis (K04.5)
Marginal: Within normal limits

Treatment plan

Orthograde endodontic retreatment of tooth 46. Removal of posts instrument in the mesial and distal canal.

Problem list

Difficult to remove the posts.

Treatment

17. December 2008

Clinical examination.Tooth 46 diagnosed with chronic apical periodontitis. Removed the crown. Located three posts. Rubber dam. Three posts were easily removed. Ca(OH)2 and temporary sealed with IRM.

Fig. 3 Periapical radiograph

6. January 2009

Rubber dam. Instrumentation was done mechanically with K-and NiTi hand files. Root canal length was determined by radiographic image and apex locator (Root ZX®) .
Four canals:
MB: R45/16mm
ML: R45/15mm
DB: R45/16mm
DL: R45/16mm
1% NaOCL, 17% EDTA and 2%CHX were used for chemical root canal disinfection, in conjunction with irri-safe ultra sound. The canal was dried with paper points, filled with Ca(OH)2 and temporary sealed with IRM.

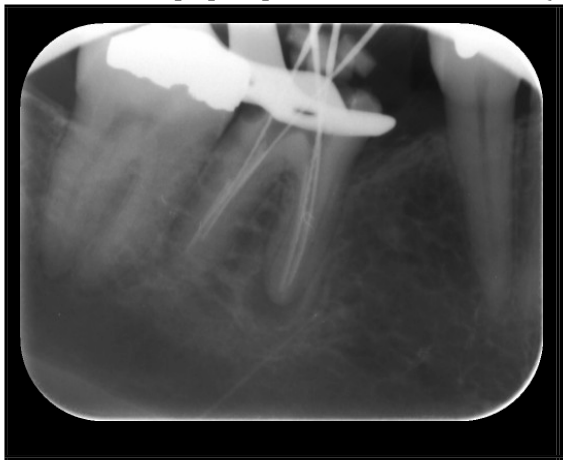

Fig. 4 Working length radiograph

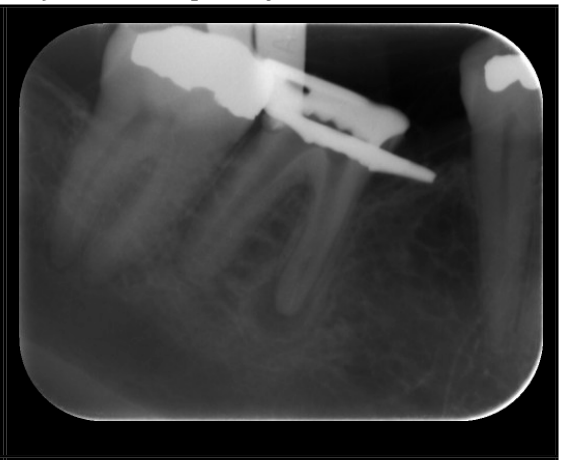

Fig. 5 Removed old root canal filling

14. January 2009

The patient returned with no symptoms. 1% NaOCL and 17% EDTA were used for chemical root canal disinfection. The canals was dried with paper points and filled with Ah-plus and gutta-percha. IRM was applied as a temporary filling.

Fig. 6 Master point radiograph

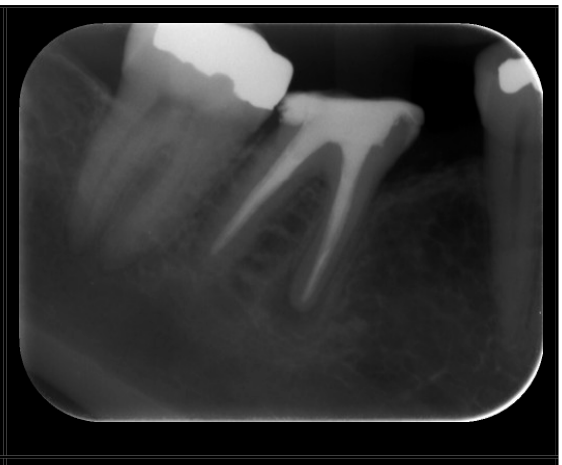

Fig. 7 Final radiograph

Result

Fig. 8 Before treatment

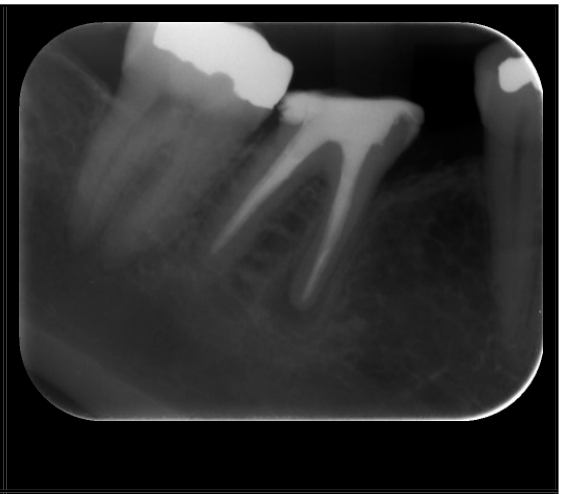

Fig. 9 After treatment

Evaluation

No complications during treatment. The root filling appeared dense and good.

Prognosis

Endodontic: Good
Tooth: Good

Follow-up examination
2. December 2009(Eleven month after endodontic treatment)

The patient was asymptomatic and experienced no sensitivity to percussion or palpation tests

The radiograph showed no evidence of healing of the apical periodontitis.

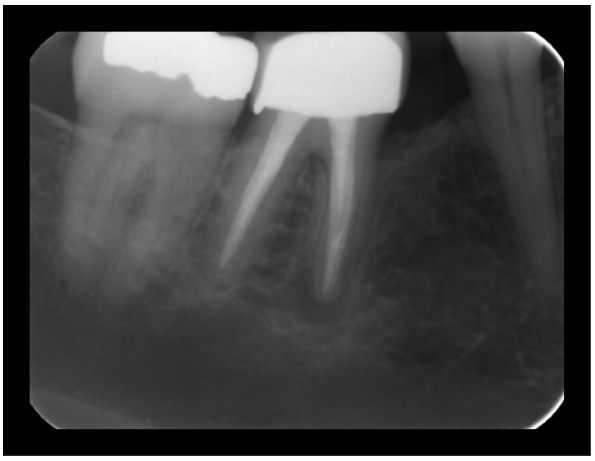

Fig. 10 Follow up radiograph

Fig. 11 Orthophantogram

New treatment plan

Apicoectomy with retrograde filling of the mesial root.

Treatment
27. January 2010

Pre-operative procedure. Septocaine® 3 x 1.8 ml. Marginal incision from the mesial aspect of tooth 43 to the distal aspect of tooth 47. Vertical releasing incision on the mesial aspect of tooth 43 approximately 3cm. Elevation of full mucoperiostal flap. No pathologic fenestration of the buccal cortical bone was observed. Osteotomy. Curettage of granulation tissue. Root-end resection. Root-end preparation with diamond coated ultrasonic tip. Stryphnon gauze and ferric sulfate were used for hemorrhage control. White MTA (ProRoot® MTA) was applied as

retrograde filling material. The operation site was inspected and carefully rinsed with sterile saline. Suturing with eight 4-0 Supramide® sutures. Post-operative instructions. Patient was given six tablets of 400 mg Ibuprofen to take one tablet every fourth hour the first day after surgery.

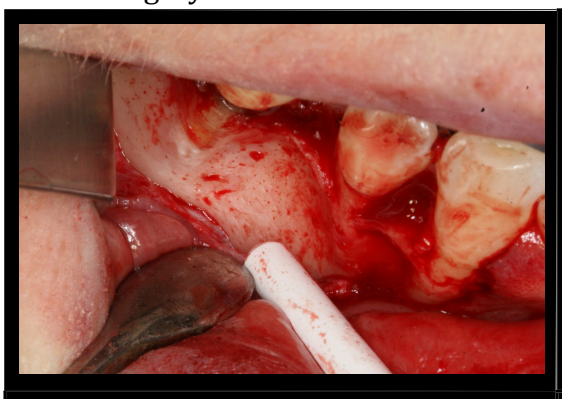

Fig. 12 Full mucoperiostal flap elevated

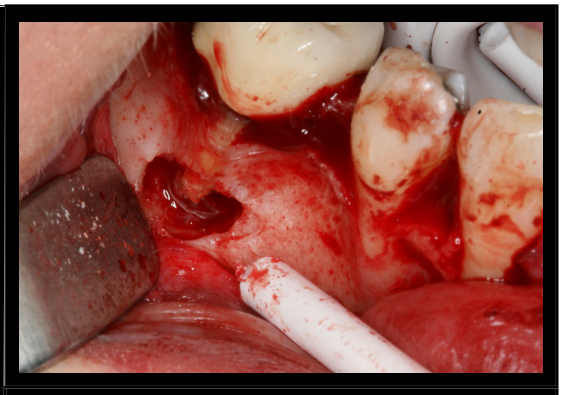

Fig. 13 Osteotomy

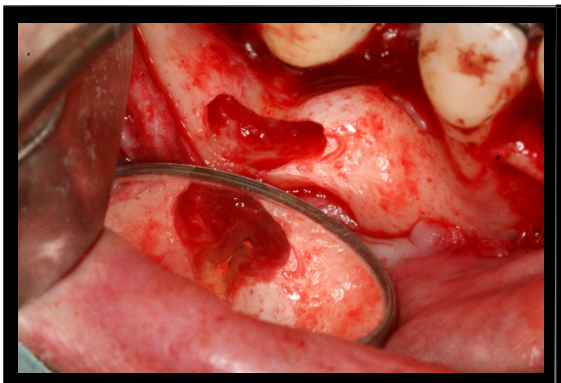

Fig. 14 Root-end resection

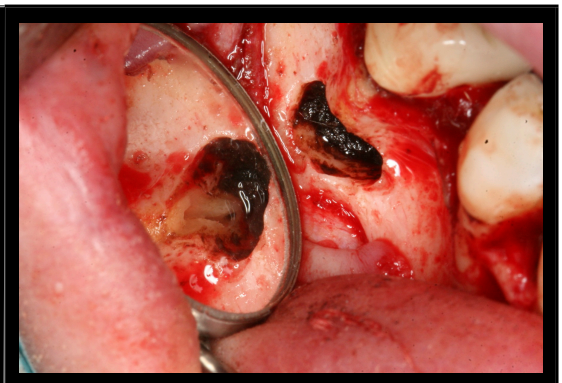

Fig. 15 Root-end preparation

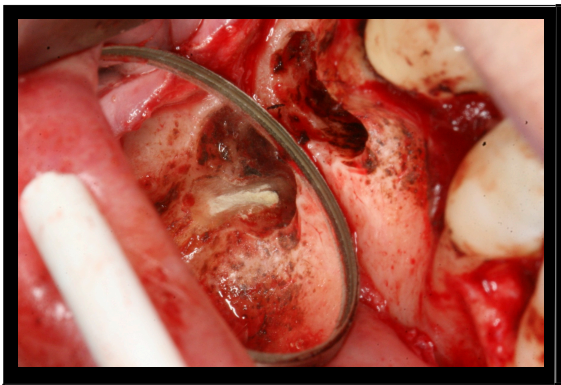

Fig. 16 Retrograde filling MTA

Fig. 17 Flap sutured

3. February 2010

Suture removal. Good soft tissue wound healing. Patient had experienced no discomfort after the surgery

Fig. 18 Before removal of sutures

Fig. 19 After removal of sutures

Result

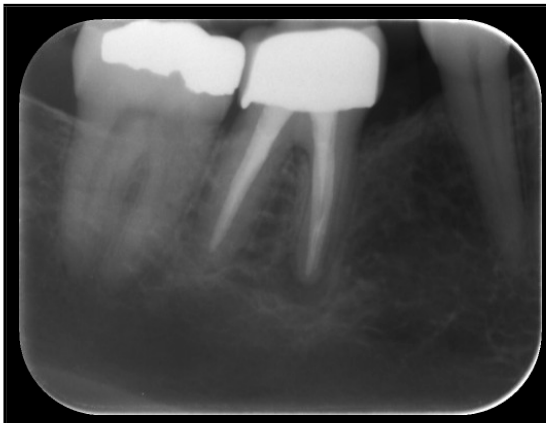

Fig. 20 Before treatment

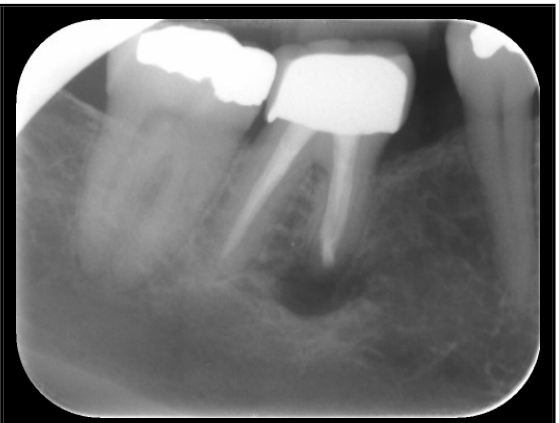

Fig. 21 After treatment

Evaluation

No complications during treatment. The retrograde filling appeared dense and good.

Prognosis

Endodontic: Good
Tooth: Good.

Follow-up examination

No follow-up examination because treatment was performed in February 2010.

Discussion

There are many factors affecting the outcome of endodontic treatment. Sjøgren et al (1990) evaluated 356 patients 8 to 10 years after treatment and found that the results of treatment were directly dependent on the preoperative status of the pulp and periapical tissues. A lower success rate (62%) was observed for roots with periapical lesions which were previously filled and

were retreated. The apical level of root filling had no significant influence on the outcome of treatment when previously root-filled teeth with periapical lesions were retreated(1)(figure below).

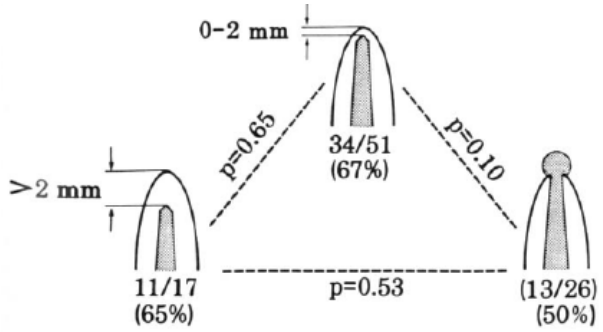

Fig 22. (1)

In the Toronto study (2004) they found that the healed rate (81%) differed significantly for preoperative apical periodontitis. When absent, 97% healed and when present 78% healed(2). In 2008 they pooled the results of the study with the results from 2004 and found that 82% healed(3).
Ng et al found in a review study on secondary root canal treatment that teeth without periapical lesion had 6,32 times higher odds of success than teeth with periapical lesion(4).
In conclusion the preoperative presence of apical periodontitis has a dominant negative influence on the outcome of nonsurgical endodontic treatment. But the apical extent of the treatment is ambigous, and the prognosis may be better if the root canal filling extends 0-2mm short of the root end(5).
In this case the extend of the rootcanal filling was approximately 1mm short of the root end. And since there were no evidence of healing after one year, surgical endodontic treatment was initiated.

Surgical intervention is an alternative when the nonsurgical approach is not feasible and a supplement when it has failed. Grung et al did during a 5-yr period periapical surgery on 545 roots. They found complete healing was observed for 78% and incomplete healing (scar tissue) for 9% of the teeth. The size of the latter group was strongly influenced by the number of cases with large preoperative lesions (6).
The Toronto study had nine variables listed, and only one association was statistically significant—the healed rate was higher among teeth with a small (5 mm) preoperative radiolucency than teeth with larger radiolucency. The 10% differential between surgery after initial treatment and after orthograde retreatment was not statistically significant(7).
According to all the pre-operative and intraoperative factors listed by Friedman (5) during surgical endodontics, some of these factors may have influence on the outcome. As preoperative factors, only lesion size and repeat surgery may have influence on the outcome, while intraoperative factors are more dependent on new operative procedures. A better outcome may be expected after a more radical resection of the root, and after a placement of a root-end filling(5).

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