UNIVERSITY OF OSLO

FACULTY OF DENTISTRY

Department of Endodontics

Postgraduate Program in

Endodontics

Case Book

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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)

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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

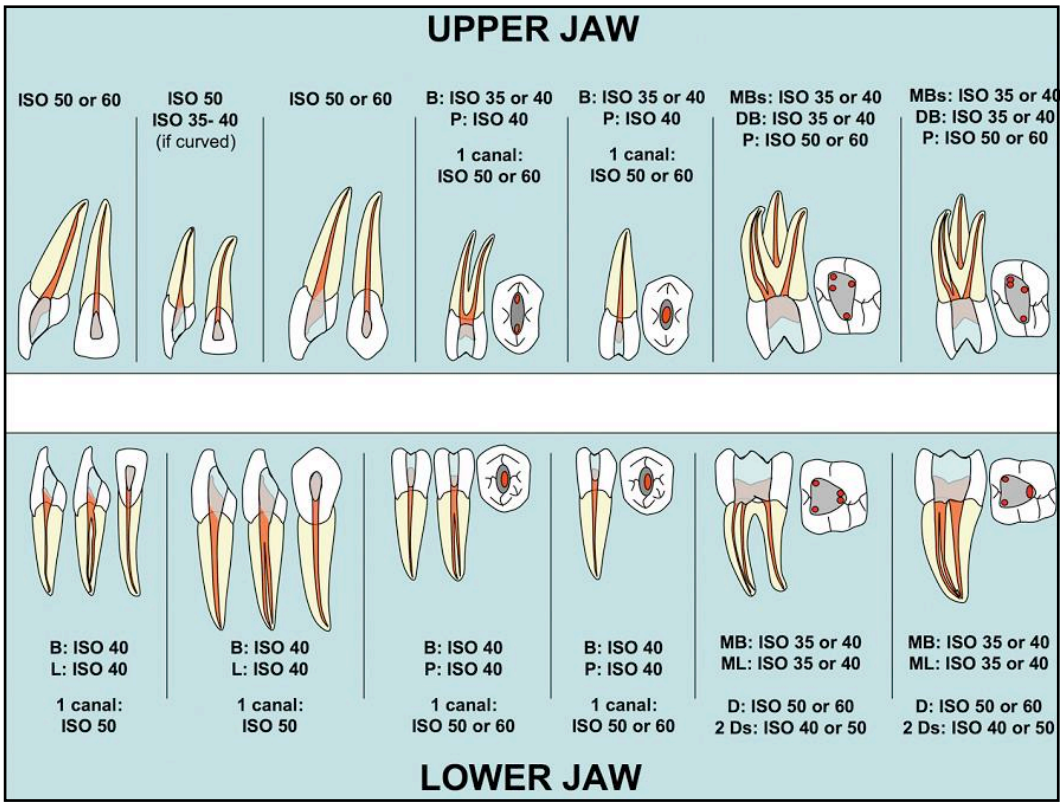


Figure 1: Normative apical sizes for safe and effective disinfection in permanent teeth. The clinician must use his or her clinical judgment in choosing apical sizes for each individual tooth.

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.

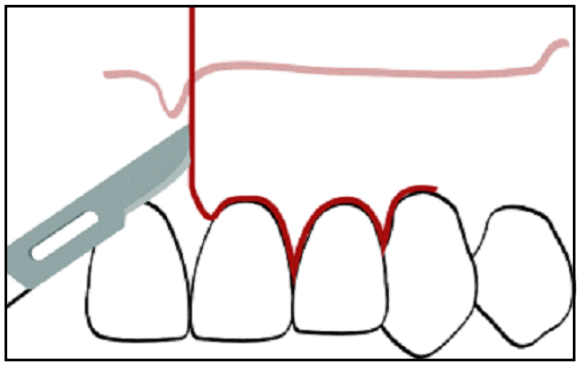


Figure 4: Triangular flap with intrasulcular incision (Velvart et al. 2002)

- 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.

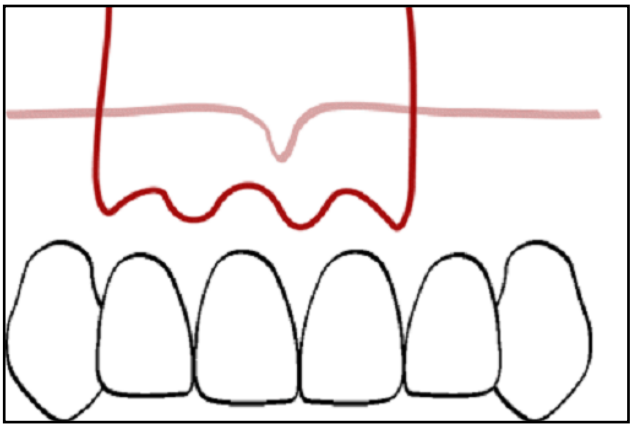


Figure 5: Submarginal flap (Velvart et al. 2002)

- 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)

Pulpectomy of a mandibular molar

Introduction

Fiftytwo year old caucasian male

Figure 1 - Frontal view

Chief complaint

Pain from his lower left side when chewing.

Medical history

Non-contributory

Dental history

The patient was originally referred to the specialist clinic for endodontic treatment of tooth 45. This tooth had been extracted, but the patient felt pain from the third quadrant when chewing. It was decided to treat the patient at the specialist clinic.

Clinical findings

Figure 2 - Occlusal view

Extra-oral examination:

Non-contributory

Intra-oral examination:

Non-contributory

Tooth	38	37	36
Cold	+	+	+
Percussion	-	+	-
Palpation	-	-	-
Mobility	I	I	I
PPD	Normal	Normal	Normal

Table 1 - Clinical findings

Soft tissue:

Non-contributory

Dental:

Tooth 38: O amalgam filling.

Tooth 37: MO composite filling.

Tooth 35: PFM crown.

Radiographic findings:

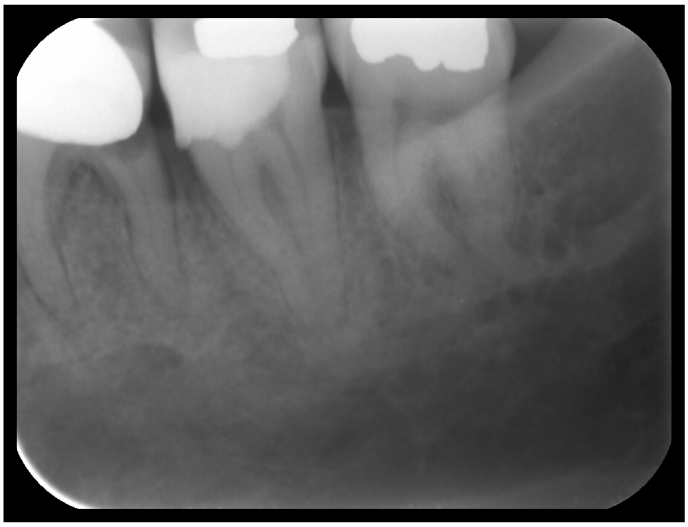


Figure 3 - Periapical radiograph

November 11th 2009

Tooth 38: Normal lamina dura. PAI 1.

Tooth 37: Normal lamina dura. PAI 1.

Tooth 36: Normal lamina dura. PAI 1. Caries on the distal root.

Diagnosis

Tooth 37:

Pulpal: Acute, irreversible pulpitis (K04.1).

Apical: Within normal limits.

Marginal: Within normal limits.

Treatment plan

Tooth 37:

Pulpectomy.

Treatment

October 29th 2009

Clinical examination. 1.8 ml Septocaine®. Preparation of the entrance cavity. Rubber dam. Localized three canals. Prepared the canals using Gates-Glidden burs and BioRace® files. The lengths of the canals were determined using by apex locator (Root ZX®) and periapical radiographs. 1% NaOCl and 17% EDTA were used for chemical root disinfection. The canals were dried with paper

points and filled with gutta-percha and AH+ sealer. An IRM restoration was placed on top.

MB canal: R35 / 21mm

ML canal: R35 / 20,5mm

D canal: R60 / 21mm

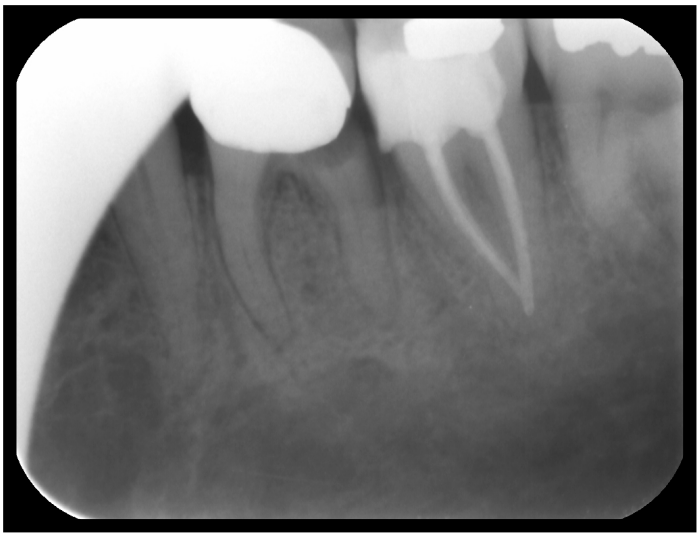


Figure 4 - Final radiograph

Result

Evaluation

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

Prognosis

Endodontic: good.

Tooth: good, given that the tooth gets a crown.

Follow-up examination

April 20th 2010

The tooth is now an abutment in a PFM bridge. The patient is asymptomatic. No periapical pathology can be seen.

Figure 5 - Follow-up radiograph.

Discussion

When a pulp has the diagnosis irreversible pulpitis, the pulp is still vital but so inflamed that it will not be able to heal again. It is therefore necessary to remove it and replace it with a root-filling. If nothing is done with the inflamed pulp, it will become necrotic. Bacteria will then have an easy access to the apex and the periapical tissues[1].This treatment ensures that inflamed tissue is removed to an apical level where the wound surface can be kept to a minimum. At this level, the residual pulp tissue is well vascularized, and the conditions for healing are optimal. One important condition for having a high success rate is that the entire treatment is carried out under aseptic conditions[6]. The optimal wound level in teeth with vital pulp appears to be 1-2 mm from the radiographic apex[2]. Studies have shown that a distance from radiographically apex to root-filling exceeding 3 mm reduces the success rate compared to filling the root 0-3 mm short of the radiographic apex[3,7].

Endodontic treatment of the vital pulp has a very good prognosis because the pulp tissue and the surrounding dentine walls are not infected. It is essential to maintain optimal aseptic conditions so that no bacteria are introduced into the canals. Aseptic procedures involve the use of rubber dam, disinfection of the surgical field, mechanical and chemical preparation with, and the use of sterile instruments[2]. The prognosis of initial root canal treatment in teeth without apical periodontitis varies in different studies. The long-term results are ranging from 93-97%[3,4,5]. In a study by Friedman et al.[8], they found a significantly higher healing rate in teeth without a periapical radiolucency. Using odds ratio, they found that teeth with a radiolucency had almost four times higher risk of not to heal than in teeth without.

References

1. Sigurdsson A. Clinical manifestation and diagnosis. In: Ørstavik D, Pitt Ford TR (eds). Essential Endodontology: Prevention and Treatment of Apical Periodontitis, 2nd Ed Blackwell Munksgaard, Oxford 2008, pp 235-258.

2. Spångberg L. Endodontic Treatment of Teeth Without Apical Periodontitis. In: Ørstavik D, Pitt Ford TR (eds). Essential Endodontology: Prevention and Treatment of Apical Periodontitis, 2nd Ed Blackwell Munksgaard, Oxford 2008, pp 316-342.

3. Kerekes K and Tronstad L. Long-term results of endodontic treatment preformed with a standardized technique.J Endod. 1979 Mar;5(3):83-90.

4. Sjøgren U, Hagglund RP, Sundquist G and Wing K. Factors affecting the long-term results of endodontic treatment. J Endod. 1990 Oct;16(10): 498-504.

5. Marquis V, Dao T, Farzaneh M, Abitbol S and Friedman S. Treatment outcome in endodontics: The Toronto study. Phase III: Initial treatment. J Endod. 2006 Apr;32(4):299-306.

6. Hørsted-Bindeslev P, Løvschall H. Treatment outcome of vital pulp treatment. Endod Topics. 2002;2(1):24-34.

7. Grahnen H, Hansson L. The prognosis of pulp and root canal therapy. A clinical and radiographic follow-up examination. Odont Revy. 1961;12:146-165.

8. Friedman S, Abitbol S, Lawrence HP. Treatment outcome in endodontics: the Toronto Study—phase I: initial treatment. J Endod. 2003 Dec;29(12): 787-93.

Removal of a fractured instrument

Introduction

Thirtysix year old Norwegian male

Figure 1 - Frontal view

Chief complaint

Non-contributory

Medical history

Non-contributory

Dental history

The referring dentist had started endodontic treatment on the tooth, which resulted in a fracture of a R10 file in MB2.

Clinical findings

Intra-oral examination:

Tooth	17	16	15
Cold	+	-	+
Percussion	-	-	-
Palpation	-	-	-
Mobility	I	I	I
PPD	Normal	Normal	Normal

Table 1 - Clinical Findings

Soft tissue: within normal limits.

Dental:

Tooth 17: MO composite filling.

Tooth 14: O IRM temporary filling.

Tooth 15: OD composite filling.

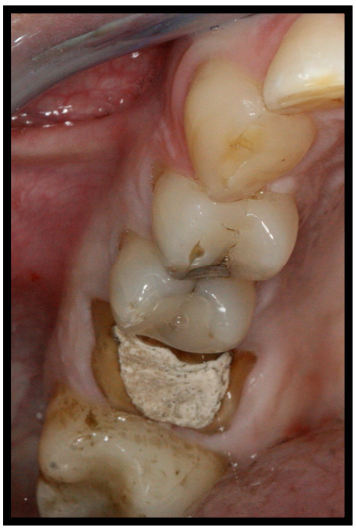


Figure 2 - Intraoral view

Radiographic findings:

Figure 3 - Periapical radiograph

September 15th 2008

Tooth: 17: Normal lamina dura. PAI 1. Composite filling. Normal marginal bone level.

Tooth 16: Normal lamina dura. PAI 1. Fractured file in the mesial root. Normal marginal bone level.

Tooth 15: Normal lamina dura. PAI 1. Composite filling.

Diagnosis

Tooth 17:

Pulpal: Previously endodontically treated tooth (K04.19)

Apical: Within normal limits

Marginal: Within normal limits.

Problem list

Not being able to remove the instrument.

Weakening of the mesial root in trying to remove the fractured instrument..

Treatment plan

Tooth 17:

Non-surgical endodontic treatment.

Treatment

April 15th 2008

First consultation. Clinical examination. Tooth diagnosed with necrotic pulp.

May 14th 2008

1.8 ml Septocaine®. Rubber dam. Removal of the IRM filling. Using a dental microscope and a modified Gates-glidden bur, a ledge was created just above the fractured instrument. Using ultrasonics instruments, tooth substance around the fractured instrument was removed. The IRS system was used to remove the fractured instrument. Because of lack of time, the canal was not instrumented in this session.

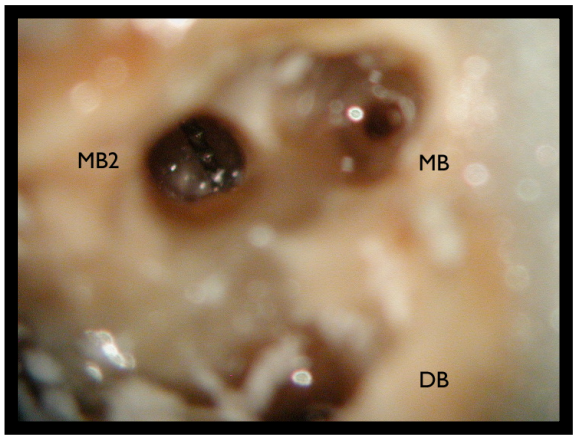


Figure 4 - Intracoronal view

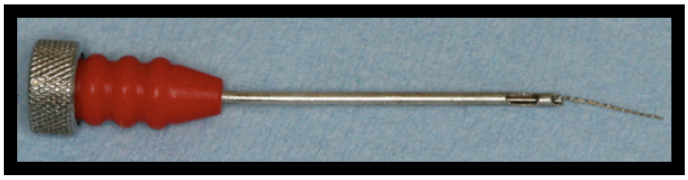


Figure 5 - The IRS system with the separated file

1% NaOCl and 17% EDTA were used for chemical root disinfection. The 3 other root canals (P, DB, MB1) were dried with paper points and filled with $Ca(OH)_2$ using a lentulo needle. An IRM restoration was placed on top.

September 16th 2008

1.8ml Septocaine®. Rubber dam. Removal of the IRM filling. Instrumented the canals. 1% NaOCl and 17% EDTA were used for chemical root disinfection. The root canals were dried with paper points and filled with $Ca(OH)_2$ using a lentulo needle. An IRM restoration was placed on top.

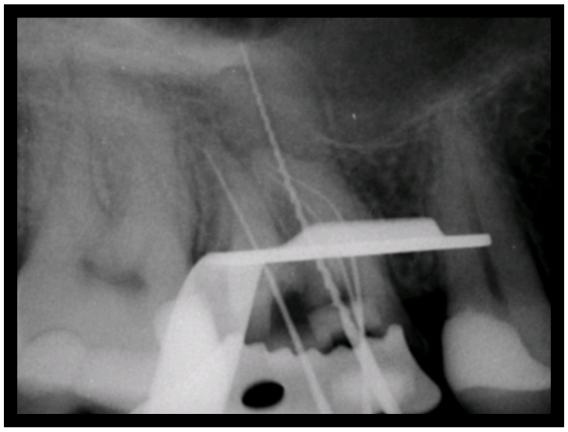


Figure 6 - Working length radiograph

October 16th 2008

1.8ml Septocaine®. Rubber dam. Removal of the IRM filling. The Ca (OH)2 was removed using hand files and NaOCl and EDTA. The canals were dried using paper points, and filled using gutta-percha and AH+ sealer. Gutta-percha was removed in the palatal canal to make room for a post. The empty areas was filled with $Ca(OH)_2$. After removal of the root filling material surplus, the access cavity was sealed with an IRM restoration.

Result

Evaluation

No complications during the treatment. The root filling appeared dense and good. A sealer puff can be seen from the palatal root.

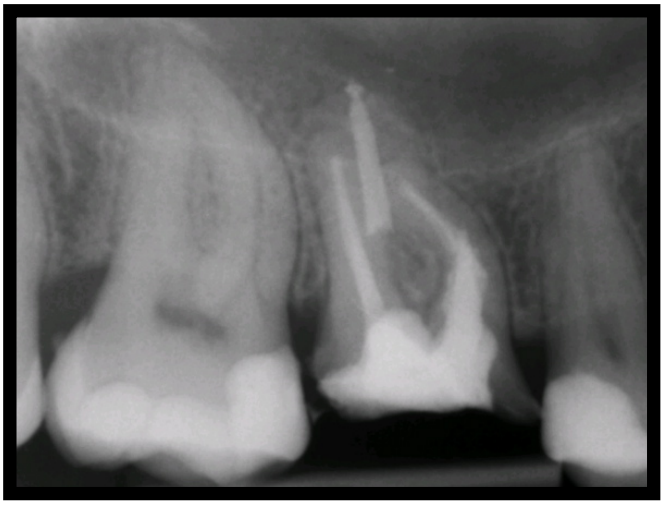


Figure 7 - Final radiograph

Prognosis

Endodontic: good.

Tooth: good, given that the tooth gets a post + crown.

Discussion

When an instrument separates during treatment, one should always try to remove the fractured instrument. Only then can the canal be properly cleaned and shaped, thereby removing any remaining bacteria, which may compromise the the outcome of root canal treatment[1]. Eventually the treated case may end in failure. The prevalence of separated steel files is between 0,5 to 6% [10]. NiTi files allows the canal to be instrumented better, but they tend to fracture more than steel files, up to 2 to 7 times more[11].

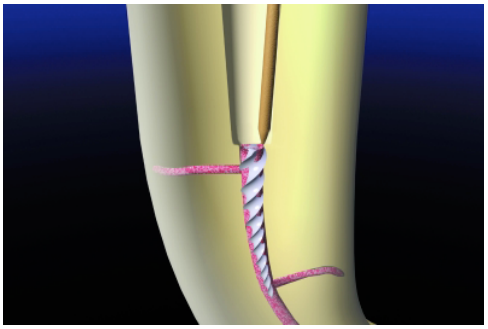
Different factors may contribute to the separation of endodontic files, especially the root canal anatomy and the frequency of use of the endodontic files[2]. Debelian and Ørstavik[12] mention cyclic fatigue and torsional fracture as two of the most important physical reasons to file fractures (figure 1). One of the most important factors to avoid file fractures, is to make sure that the files has a straight line access to the canal. If this is not achieved, the file will be subjected to more stress, and can eventualle frature.

Spili et al had a healing rate of 91,8% of teeth with a fractured instrument. If the tooth had a periapical lesion, this healing rate would drop to 86,7%. The matched control group (just periapical lesion, no instrument fracture) was 92,9%, showing how important it is to properly clean the canal[3].

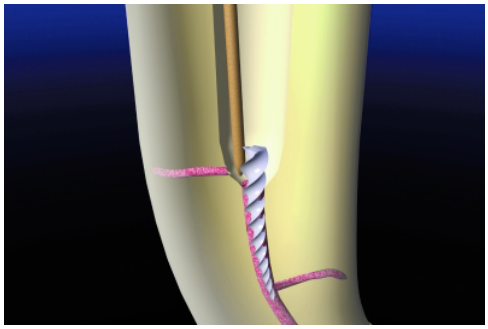
Souter et al. found that a decrease in success rate was evident with increasing treatment time[5]. In this study, they were able to remove 87% of the fractured instruments. A number of different methods have been developed to help in the removal of these separated files[5,6,7,8,9]. A factor one should take in to consideration when trying to remove fractured instruments, is the effect the removal of tooth substance will have on the root strength. Ledge formation, over-enlargement and transportation of the root canal are other factors one should try to avoid when removing the separated instrument. Souter et al found that file removal had a significant effect on root strength, 30-40% less compared with the control group[4]. Therefore, if a file should fracture in a canal with a vital pulp, or if the canals already have been disinfected (after $Ca(OH)_2$-treatment), it can be an option to leave the separated instrument rather than to remove it and risk a possible root fracture in the future.

Ruddle[13] lists some factors that influence the removal of the broken instrument. Instruments that lie in a straight portion of the tooth can typically be removed. NiTi-files are usually more difficult to remove than stainless steel files, as they may break during the removal process.

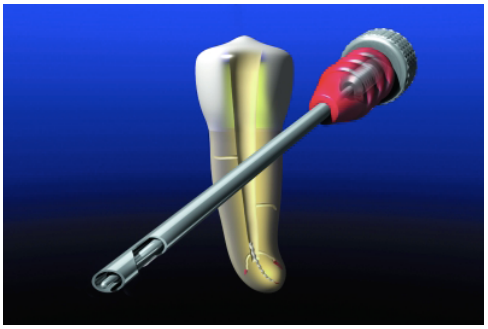
A guide on how the fractured instrument in the above mentioned study was removed, can be seen in figure 8.



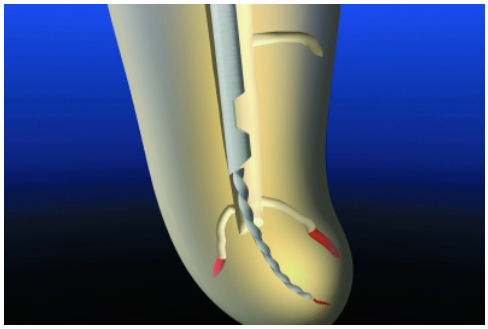
A platform has been made above the fractured file using modified Gates-Glidden burs.



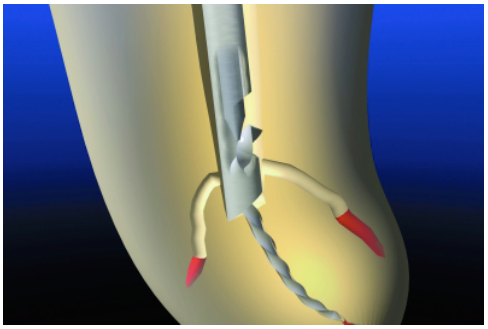
Using an ultrasonic instrument to work around the fractured file.



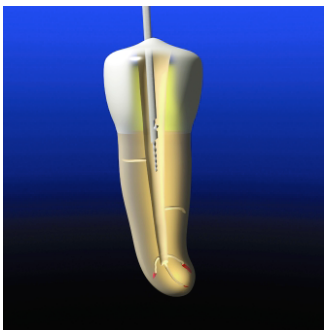
The IRS system, a microtube and screw wedge for mechanically removing broken instruments.



The head of the fractured files is inserted into the microtube.



The wedge is turned counter-clockwise to fasten the file inside the tube.



Removal of the fractured file.

Figure 8 - Removal of a fractured instrument using the IRS system:

The British Dental Journal had an article where the authors listed factors to be considered to minimise the incidence of endodontic file separation (2). These were::

1. Appropriate training before using files of new design.
2. Understanding of root canal anatomy and establishing of glide path before cleaning and shaping.
3. Examination of new files as some defects can occur while being manufactured.
4. Examination of files during treatment regularly even with a single use
5. Use of magnification for file examination as some defects can not be seen by naked eye.
6. Adherence to the manufacturer's instructions.

References

1. Sjögren U, Hagglund B, Sundqvist G, Wing K. Factors affecting the long-term results of endodontic treatment.J Endod. 1990 Oct;16(10):498-504.
2. Madarati AA, Watts DC, Qualtrough AJ. Factors contributing to the separation of endodontic files. Br Dent J. 2008 Mar 8;204(5):241-5.
3. Spili P, Parashos P, Messer HH. The impact of instrument fracture on the outcome of endodontic treatment. J Endod. 2005 Dec;31(12):845-50.
4. Souter NJ, Messer HH. Complications Associated with Fractured File Removal Using an Ultrasonic Technique. J Endod. 2005 Jun;31(6):450-2.

5. Suter B, Lussi A, Sequeira P. Probability of removing fractured instruments from root canals. Int Endod J. 2005 Feb;38(2):112-23.

6. Carr GB. Microscopes in endodontics. J Calif Dent Assoc. 1992 Nov;20(11): 55-61.

7. Eleazer PD, O'Connor RP. Innovative uses for hypodermic needles in endodontics. J Endod. 1999 Mar;25(3):190-1.

8. Machtou P, Reit. Non-surgical retreatment. In: Bergenholtz G, Hørsted-Bindslev P, Reit C, eds. Textbook of Endodontology, 1st edn. Oxford 2003: Blackwell Munksgaard, pp. 300–10.

9. Ruddle CJ (2003) Removal of broken instruments. Endodontic Practice. 2003; 6 (13–9).

10. Hülsman M, Schinkel I. Influence of several factors on the success or failure removal of fractured instruments from the root canal. Endod Dent Traumatol. 1999, 15(6): 252-8.

11. Iqbal MK, Kohli MR, Kim JS. A retrospective clinical study of the incidence of root canal instrument separation in endodontics graduate program: A PennEndo database study. J Endod. 2006 Nov;32(11):1048-52.

12. Debelian G, Ørstavik D. In: Holmstrup P, red. Aktuel nordisk odontologi 2008. København: Munksgaard Danmark, 2008: pp. 125-145.

13. Ruddle CJ. Broken instrument removal. The endodontic challenge, Dent Today. 2002 Jul;21(7):70-2.

Figures:

Figure 8: Ruddle CJ. Broken instrument removal. The endodontic challenge, Dent Today. 2002 Jul;21(7):70-2.

Perforation repair on a maxillary incisor

Introduction

Twelve year old girl of Somali origin.

Figure 1 - frontal view

Chief complaint

Non-contributory

Medical history

Non-contributory

Dental history

2003: Trauma against the tooth.

2007: Trauma against the tooth. Endodontic treatment started at the public dental service. This resulted in a buccal root perforation. The patient was referred to the departement of oral surgery and oral medicine for an apicoectomy. The oral surgeon referred the patient to the endodontics departement for root canal therapy

Clinical findings

Extra-oral examination:

Non-contributory.

Intra-oral examination:

Non-contributory.

Tooth	11	21	22
Cold	-	-	+
Percussion	-	-	-
Palpation	-	-	-
Mobility	I	I	I
PPD	Normal	Normal	Normal

Table 1 - Clinical findings

Soft tissue: within normal limits.

Dental:

Tooth 11: Composite filling palatinally.
Tooth 21: IRM restoration palatinally.

Radiographic findings:

Figure 2 - Radiograph from the referring dentist, showing the perforation.

September 29th 2007

Tooth: 11:

Normal lamina dura. PAI 1. Root canal filled. Composite filling. Normal marginal bone level.

Tooth 21:

Widened lamina dura. PAI 2. Radiolucent area in the middle 1/3 of the tooth. Filling material in the most coronal part of the canal.

Figure 2 - periapical radiograph

Diagnosis

Tooth 21:

Pulpal: Necrotic (K04.1)

Apical: Within normal limits.

Marginal: Within normal limits.

Problem list

Localizing the canal.

Perforation repair.

Treatment plan

Tooth 11

Short term: observe.

Long term: implant treatment.

The patient has scheduled for an orthodontic consultation in December.

Tooth 21

Preparation of the root canal, tooth 21.

Perforation repair.

Orthograde endodontic treatment of non-vital pulp, tooth 21.

Treatment

September 27th 2007

Clinical examination. Tooth diagnosed with necrotic pulp. 1.8 ml Septocaine®. Rubber dam. Removal of the IRM filling. The access cavity was extended more palatinally, and using a dental microscope and LN-burs the canal was localized. Length of the canal was determined using by apex locator (Root ZX®) and a periapical radiograph. Root canal preparation was done mechanically using NiTi hand files to size:

One canal: R60/20 mm/incisal edge.

1% NaOCl and 17% EDTA were used for chemical root disinfection. The canal was dried with paper points and filled with $Ca(OH)_2$ using a lentulo needle. $Ca(OH)_2$ was also placed in the perforation, and an IRM restoration was placed on top.

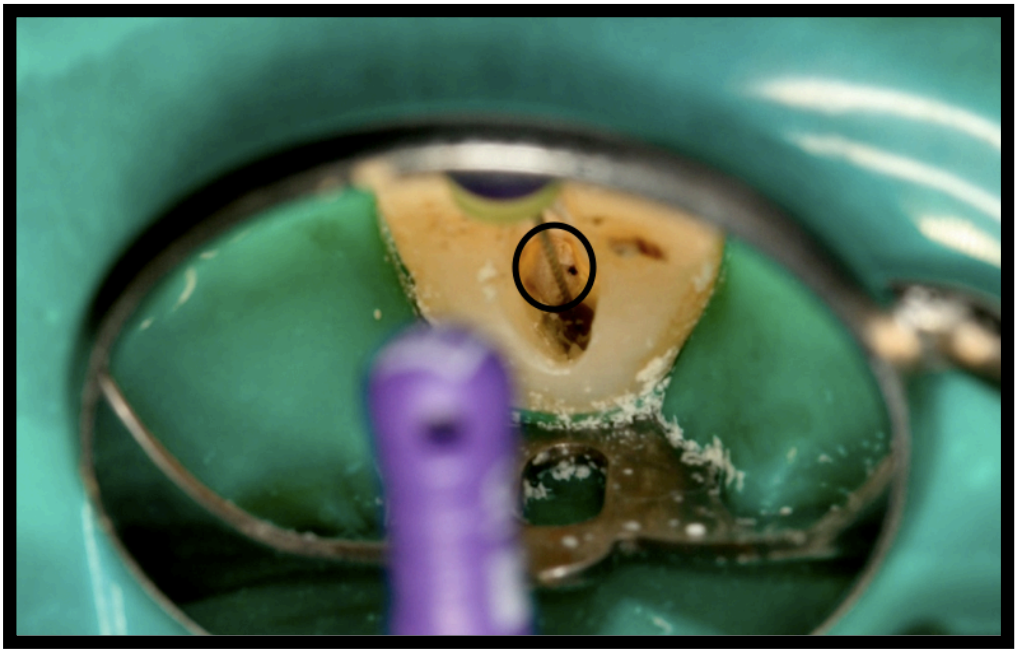


Figure 3 - Localization of the canal. The perforation can be seen buccal to it.

October 25th 2007

1.8ml Septocaine®. Rubber dam. Removal of the IRM filling. The $Ca(OH)_2$ was removed using a hand file size 60 and using NaOCl and EDTA. The canal and perforation were dried using paper points. The canal was then filled using gutta-percha and AH+ sealer. After removal of the root filling material surplus, the perforation was filled using mineral trioxide aggregate, MTA. A moist cotton pellet was placed on top, the access cavity was sealed with an IRM restoration, and the patient was scheduled for a permanent restoration.

Figure 4 - Intracoronal photo, canal filled.

November 1st 2007

1.8ml Septocaine®. Rubber dam. Removal of the IRM restoration. The MTA filling was checked to see that it had set. A new IRM restoration was placed on top of the MTA and gutta-percha, and a composite filling was placed on top.

Result

Evaluation

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

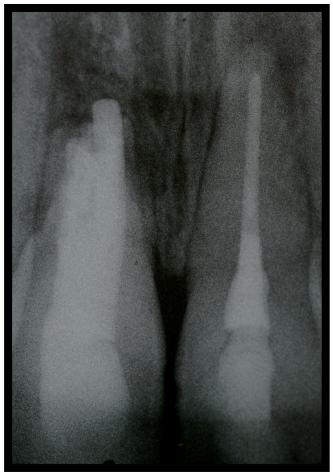


Figure 4 - Final radiograph

Prognosis

Endodontic: good.

Tooth: good.

Follow-up examination:

October 28th 2008

Radiograph showed normal lamina dura and no apical radiolucency on tooth 21. The patient was asymptomatic and without clinical findings. Tooth 11 was in infra-occlusion, and a percussion test revealed a metallic sound, characteristic of ankylosed teeth.

The patient´s mother was informed of the possibility of this, and was recommended to see an orthodontist in order to have a plan made for further treatment of the tooth.

Figure 5 - Periapical radiograph taken at the follow-up examination.

Figure 6 - photo taken at the follow-up examination

Discussion

The major goal in endodontic therapy is elimination of the bacteria in the root canal. This is done through mechanical preparation of the canal and irrigation with antibacterial solutions. Still, after using this protocol, studies have shown that half of the canals harboured bacteria[1]. Mechanical instrumentation, even without disinfection, will reduce the volume of the microbial flora by more than 90%[1,2].

NaOCl is used together with the mechanical instrumentation. It has an antimicrobial effect and the ability to dissolve necrotic tissue[3,4]. It is used within endodontics in concentrations of 0,5% to 6%. Studies have shown that increased concentration does not increase the antimicrobial effect, but rather increases its toxic effects. It seems that the total volume of NaOCl is more important than the concentration for bacterial reduction[5,6,7].

EDTA is a chealting agent introduced in endodontics by Nygaard-Østby in 1957. It has the ability to soften the dentine to depths of 20-50um. It primary function is to remove the smear layer created by the mechanical instrumentation. EDTA has little or no antibacterial effect[8].

Calcium hydroxide is used as an intracanal medication. Its antibacterial effect is from the hydroxyl ions, which will produce a pH of over 11, which will prevent growth and survival of oral bacteria[9,10]. In addition to the high pH, calcium hydroxide will alter then biological properties of bacterial lipopolysaccarides and by inactivating enzymes in bacterial membranes[11]. A study by Sjögren showed that by using a seven-day dressing with calcium hydroxide effectively killed any bacteria which had survived the biomechanical instrumentation of the canal[12]. Another study have shown that a calcium hydroxide medication for 7 days will reduce the intracanal bacteria by 20%[3,12]. Using calcium hydroxide along with NaOCl and EDTA will result in negative bacteria cultures of 80-95%[3]. This will result in a treatment outcome that is similar to what is of expected from a vital tooth.

MTA was first described in the dental literature in 1993[13], and the material was approved for endodontic use by the FDA in 1998[14]. 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[15,16]. During this time, the pH will rise from 10,2 to 12,5[16,17]. 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.

References

1. Byström A and Sundquist G. Bacteriologic evaluation of the efficacy of mechanical root canal instrumentation in endodontic therapy. Scand J Dent Res. 1981 Aug;89(4):321-8.

2. Dalton BC, Ørstavik D, Phillips C, Pettiette M, Trope M. Bacterial reduction with nickel-titanium rotary instrumentation. J Endod. 1998 Nov;24(11): 763-7.

3. Shuping GB, Ørstavik D, Sigurdsson A, Trope M. Reduction of intracanal bacteria using nickel–titanium rotary instrumentation and various medications. J Endod. 2000 Dec;26(12):751-5.

4. Zehnder M. Root canal irrigants. J Endod. 2006 May;32(5):389-98.

5. McGurkin-Smith R, Trope M, Caplan D, Sigurdsson A. Reduction of intracanal bacteria using GT rotary instrumentation, 5.25% NaOCl, EDTA, and $Ca(OH)_2$. J Endod. 2005 May;31(5):359-63.

6. Byström A, Sundqvist G. The antibacterial action of sodium hypochlorite and EDTA in 60 cases of endodontic therapy. Int Endod J. 1985 Jan;18(1): 35-40.

7. Siqueira JF Jr, Rôças IN, Favieri A, Lima KC. Chemomechanical reduction of the bacterial population in the root canal after instrumentation and irrigation with 1%, 2.5%, and 5.25% sodium hypochlorite. J Endod. 2000 Jun;26(6):331-4.

8. Nygaard Østby B (1957) Chelation in root canal therapy. Odontologisk Tidskrift 1957;65: 3–11.

9. Byström A, Claesson R, Sundqvist G. The antibacterial effect of camphorated paramonochlorophenol, camphorated phenol and calcium hydroxide in the treatment of infected root canals. Endod Dent Traumatol. 1985 Oct;1(5): 170-5.

10. Cvek M, Nord CE, Hollender L. Antimicrobial effect of root canal debridement in teeth with immature root. A clinical and microbiologic study. Odontol Revy. 1976;27(1):1-10.

11. Safavi KE, Nichols FC. Alteration of biological properties of bacterial lipopolysaccharide by calcium hydroxide treatment. J Endod. 1994 Mar;20 (3):127-9.

12. Sjögren U, Figdor D, Spångberg L and Sundquist G. The antimicrobial effect of calsium hydroxide as a short-term intracanel dressing. Int Endod J. 1991 May;24(3):119-25.

13. S.J. Lee, M. Monsef and M. Torabinejad, Sealing ability of a mineral trioxide aggregate for repair of lateral root perforations. J Endod. 1993 Nov;19(11): 541-4.

14. D. Schmitt and G. Bogen, Multifaceted use of ProRoot MTA root canal repair material. Pediatr Dent. 2001 Jul-Aug;23(4):326-30.

15. T. Dammaschke, H.U.V. Gerth, H. Züchner and E. Schäfer. Chemical and physical surface and bulk material characterization of white ProRoot MTA and two Portland cements. Dent Mater. 2005 Aug;21(8):731-8.

16. M. Torabinejad, C.U. Hong, F. McDonald and T.R. Pitt Ford. Physical and chemical properties of a new root-end filling material. J Endod. 1995 Jul;21 (7):349-53.

17. J. Camilleri, F.E. Montesin, K. Brady, R. Sweeney, R.V. Curtis and T.R. Pitt Ford, The constitution of mineral trioxide aggregate. Dent Mater. 2005 Apr;21(4): 297-303.

Premolar with 3 separate roots

Introduction

Forty year old Middle-Eastern male

Figure 1 - Frontal view.

Chief complaint

Tenderness to palpation, swelling.

Medical history

Non-contributory.

Dental history

The referring dentist had started endodontic treatment on the tooth. In spite of several changes of $Ca(OH)_2$, the patient still had symptoms.

Clinical findings

Figure 2 - Occlusal view.

Extra-oral examination:

Non-contributory.

Intra-oral examination:

Tooth	13	14	15
Cold	+	-	-
Percussion	-	+	-
Palpation	-	+	-
Mobility	I	I	I
PPD	Normal	Normal	Normal

Table 1 - Clinical findings.

Soft tissue:

Swollen gingiva, tooth 14.

Dental:

Tooth 13: PFM crown.

Tooth 14: MO composite filling
DO IRM temporary filling.

Tooth 15: PFM crown.

Radiographic findings:

Figure 3 - Periapical radiograph.

September 29th 2007

Tooth: 14: Widened lamina dura. PAI 3. Composite filling and IRM temporary filling. Normal marginal bone level.

Tooth 15: Normal lamina dura. PAI 1. Root filled tooth. PFM crown.

Tooth 16: Normal lamina dura. PAI 1. Amalgam filling.

Diagnosis

Tooth 14:

Pulpal: Necrotic (K04.1)

Apical: Chronic apical periodontitis (K04.5).

Marginal: Within normal limits.

Problem list

Persisting infection.

Localizing all of the canals.

Treatment plan

Tooth 15:

Non-surgical endodontic treatment.

Treatment

November 13th 2007

Clinical examination. Tooth diagnosed with necrotic pulp. 1.8 ml Septocaine®. Rubber dam. Removal of the IRM filling. Using a dental microscope and LN-burs an additional buccal canal was localized. The lengths of the canals were determined using by apex locator (Root ZX®) and periapical radiographs. Root canal preparation was done mechanically using NiTi hand files to to following sizes:

MB canal: R35/20 mm/B-cusp

DB canal: R40/20 mm/B-cusp

P canal: R45/20 mm/ P-cusp

1% NaOCl and 17% EDTA were used for chemical root disinfection. The canals were dried with paper points and filled with $Ca(OH)_2$ using a lentulo needle. An IRM restoration was placed on top.

December 6th 2007

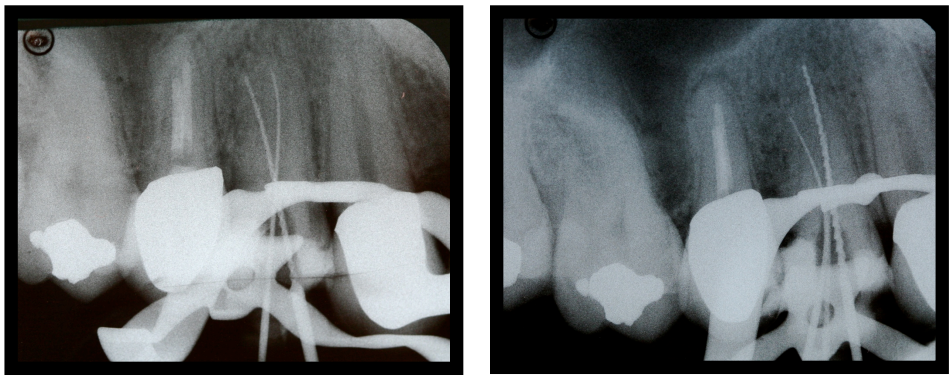


Figure 4 - Working length radiographs.

The patient was asymptomatic. 1.8ml Septocaine®. Rubber dam. Removal of the IRM filling. The $Ca(OH)_2$ was removed using hand files and NaOCl and EDTA. The canals were dried using paper points, and filled using gutta-percha and AH+ sealer. After removal of the root filling material surplus, the access cavity was sealed with an IRM restoration.

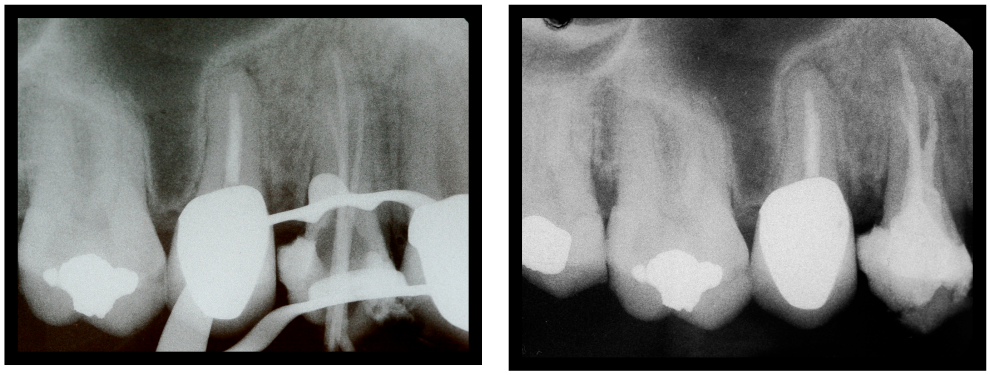


Figure 5 - Mastepoint and final radiographs.

Result

Evaluation

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

Prognosis

Endodontic: good.

Tooth: good.

Discussion

When performing endodontic therapy, the inability to detect, locate, negotiate and instrument all root canals may lead to endodontic failure. Selzer and Bender[7] wrote that «unless debridement is performed, there can be no cure» Textbooks always describe the "typical" anatomy of the tooth. But, as it has been shown in this case, and other case reports, variations from the "typical" anatomy do occur. Visualization of three-canalled maxillary premolars on preoperative radiographs can often be difficult[5].

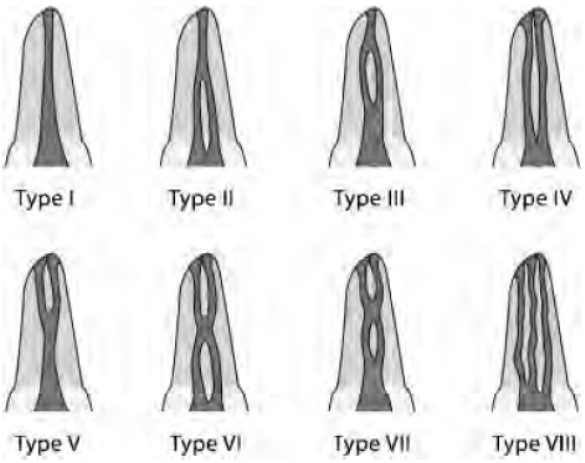


Figure 6 - Canal configurations (after Vertucci).

Vertucci[1] made a classification of the different canal configurations (figure 6). According to his study, 5% of the maxillary first premolar teeth have canal configuration VIII, which has three separate canals at the apex. When one reviews the literature, it becomes apparent that there is a divergence of opinion concerning the root canal and canal morphology of the first maxillary premolar[2]. Hess[3] found three roots in 1,2% of the teeth he studied. Carns and Skidmore[4] studied the configurations and deviations of root canals of maxillary first premolars, finding three roots in 6%, whereas Kartal et al.[6] only found maxillary premolars with a type VIII or XI root canal anatomy in 1,66%.

A summary of different studies on canal and root morphology can bee seen in tables 2 and 3:

Table 2 - In vitro studies on root morphology of the first maxillary premolar

Author (year)	Number of teeth	One root (%)	Two roots (%)	Three roots (%)
Carns and Skidmore (1973)	100	22.0	72.0	6.0
Vertucci and Gegayff (1979)	400	26.0	70.0	4.0
Loh (1996)	957	49.4	50.6	0
Kartal et al. (1998)	300	37.3	61.3	1.3
Lipski et al. (2003)	142	15.5	75.4	9.2

Table 3 - In vitro studies on canal morphology of the first maxillary premolar

Author (year)	Number of teeth	One canal (%)	Two canals (%)	Three canals (%)
Pineda and Kuttler (1972)	259	26.2	73.3	0.5
Green (1973)	50	8	92	0.5
Carns and Skidmore (1973)	100	9	85	6
Vertucci and Gegauff (1979)	400	8	97	5
Kartal et al. (1998)	300	8.7	89.6	1.7
Lipski et al. (2003)	142	2.1	88.6	9.2

This case, and the studies mentioned here, emphasise the importance of a good knowledge of root canal morphology and the need for a careful radiographic examination of these teeth prior to endodontic therapy.

References

1. Vertucci F. Root canal morphology and its relationship to endodontic procedures. Endodontic Topics 2005; 10: 3-29.

2. Lipski M, Woźniak K, Łagocka R, Tomasik M. Root and canal morphology of the first human maxillary premolar. Durham Anthropology Journal 2005; 12: 2-3.

3. Hess W. Anatomy of the root canals of the teeth of the permanent dentition. Part I. New York William Wood; 1925. p. 3-49.

4. Carns EJ, Skidmore AE. Configurations and deviations of root canals of maxillary first premolars. Oral Surg Oral Med Oral Pathol. 1973;36:880-6.

5. Sieraski SM, Taylor GN, Kohn RA. Identification and endodontic management of three-canalled maxillary premolars. J Endod. 1989 Jan;15 (1):29-32.

6. Kartal N, Ozçelik B, Cimilli H. Root canal morphology of maxillary premolars. J Endod. 1998 Jun;24(6):417-9.

7. Seltzer S, Bender IB. Cognitive dissonance in endodontics. Oral Surg Oral Med Oral Pathol. 1965 Oct;20(4):505-16.

Figures:

Figure 6: Vertucci F. Root canal morphology and its relationship to endodontic procedures. Endodontic Topics 2005; 10: 3-29.

Tables:

Table 2 and 3: Lipski M, Woźniak K, Łagocka R, Tomasik M. Root and canal morphology of the first human maxillary premolar. Durham Anthropology Journal 2005; 12: 2-3.

Dens invanginatus in a mandibular incisor

Introduction

Seventeen year old Norwegian female

Figure 1 - Frontal view.

Chief complaint

Non-contributory

Medical history

Non-contributory

Dental history

The referring dentist had done emergency dental treatment on the tooth, meaning a cotton pellet with eugenol + an IRM temporary filling on top.

Clinical findings

Figure 2 - Incisal view.

Intra-oral examination:

Tooth	33	32	31	41	42	43
Cold	+	+	+	+	+	+
Percussion	-	-	-	-	-	-
Palpation	-	+	-	-	-	-
Mobility	I	I	I	I	I	I
PPD	Normal	Normal	Normal	Normal	Normal	Normal

Table 1 - Clinical findings.

Soft tissue:

Within normal limits.

Dental:

Tooth 32: IRM temporary filling.

Radiographic findings:

June 12th 2008

Tooth 32: Radiolucent area apically, PAI 3. IRM temporary filling. Normal marginal bone level. Inside the root, one can notice an unusual radiographic appearance of something with the same density as enamel.

Figure 3 - Periapical radiograph.

Diagnosis

Tooth 32:

Pulpal: Chronic pulpitis (K04.0)

Apical: Chronic apical periodontitis (K04.5)

Marginal: Within normal limits.

Problem list

Instrumenting the dens in dente, filling of the malformation.

Atypical pulp anatomy

Treatment plan

Tooth 32:

Non-surgical endodontic treatment.

Treatment

Figure 4 - Intracoronal view.

June 12th 2008

First consultation. Clinical examination. 1.8 ml Septocaine® Removal of the IRM, prepared the access cavity. Rubber dam. Using an operating microscope and ultrasonic files, the dens in dente was localized mesially for the pulp. 1% NaOCl and 17% EDTA were used for chemical root disinfection. Steel files were used in instrumenting the dens in dente. The canals were filled with $Ca(OH)_2$, and an IRM filling was placed on top.

August 28th 2008

1.8 ml Septocaine®. Rubber dam. Removal of the IRM filling. The $Ca(OH)_2$ was rinsed out using 1% NaOCl and 17% EDTA. The canals were dryed using sterile paper points, and filled using gutta-percha and a lentulo needle with AH+ sealer. After removal of the root filling material surplus, the access cavity was sealed with an IRM restoration.1% NaOCl and 17% EDTA were used for chemical root disinfection. The 3 other root canals (P, DB, MB1) were dried with paper points and filled with $Ca(OH)_2$ using a lentulo needle. An IRM restoration was placed, before a permanent composite filling was placed on top.

M: R40 / 22,5mm / inc
D: R55 / 23,5mm / inc

Figure 5 - Final radiograph.

Result

Evaluation

No complications during the treatment. The root filling in the main canal appeared dense and good. The root filling appeared dense in the apical half of the root canal, whereas it appeared incompletely filled in the upper half of the canal.

Prognosis

Endodontic: good.

Tooth: good.

Follow-up examination

Figure 6 - Follow-up radiograph.

February 2nd 2010

The patient was asymptomatic. The periapical lesion had healed.

Discussion

Dens invaginatus is a malformation of teeth probably resulting from an infolding of the dental papilla during tooth development. Other names for this malformation are dens in dente, invaginated odontome, dilated gestant odontome, dilated composite odontome, tooth inclusion, dentoid in dente[1]. It was first described by the dentist Socrates in 1856 [2].

There are several theories to why this malformation develops, but it is still not known why this happens to some teeth. Most authors consider dens invaginatus as a deep folding of the foramen coecum during tooth development, which in some cases may result in a second apical foramen[2].

The most commonly used classification of dens invaginatus is the one created by Oehler in 1957 (fig 1). He described the malformation occurring in three forms3.

Type 1:

an enamel-lined minor form occurring within the confines of the crown not extending beyond the amelocemental junction.

Type 2:

an enamel-lined form which invades the root but remains confined as a blind sac. It may or may not communicate with the dental pulp.

Type 3:

> a form which penetrates through the root perforating at the apical area showing a 'second foramen' in the apical or in the periodontal area. There is no immediate communication with the pulp. The invagination may be completely lined by enamel, but frequently cementum will be found lining the invagination

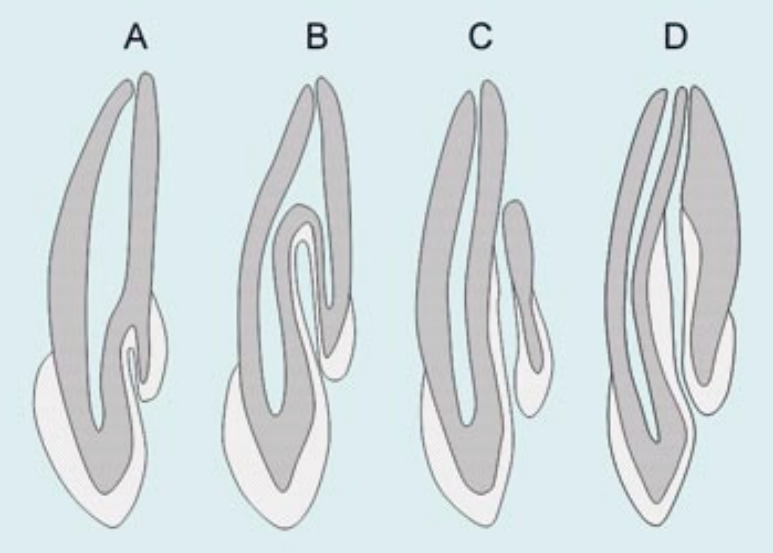


Figure 6 - Classification of dens invaginatus.

The teeth most affected are maxillary lateral incisors and bilateral occurrence is not uncommon and occurs in 43% of all cases[3].

The reported prevalence of adult teeth affected with dens invaginatus is between 0.3% and 10% with the problem observed in 0.25% to 26.1% of individuals examined (table 2). The wide variation in reported prevalence may be explained by the different cohorts studied, identification criteria used and diagnostic difficulties.

The permanent maxillary lateral incisor appears to be the most frequently affected tooth[1]. According to an article by Carvalho-Sousa[4], a review of the English literature only identified three cases involving four mandibular incisors[5,6,7].

Clinically, dens invaginatus can be diagnosed radiographically, often by chance. The crown morphology may be unusual, often wider than a «normal» clinical crown is. A deep pit may be found at the foramen coecum. If one tooth is diagnosed with dens in dente, one should look at the contralateral tooth, as 43% of the contralateral teeth are affected. When the malformation occurs in maxillary lateral incisors, bilateral appearance is not uncommon.

Looking back at this case, the obturation would probably have been better using a thermoplastic technique instead of lateral condensation. The type of invagination is probably a type III (after Oehler). In figure 1, this would be a type C or D.

References	Sample	Frequency
Mühlreiter (1873)	500 Lateral maxillary incisors	2.8%
Atkinson (1943)	500 Lateral incisors	10% of teeth
Boyne (1952)	1000 Maxillary incisors	0.3% of teeth
Stephens (1953)	150 Full mouth surveys	8%
Shafer (1953)	2542 Full-mouth surveys	1.3% of patients (as cited by Hovland & Block 1977)
Hallet (1953)	586 Full-mouth surveys	6.6% of lateral incisors & 0.5% of maxillary central incisors.
Amos (1955)	1000 Full-mouth surveys 203 Full-mouth surveys	5.1% of patients 6.9% of students of dentistry
Grahnen *et al.* (1959)	3020 Right maxillary incisors	2.7% of patients
Ulmansky & Hermel (1964)	500 Full-mouth surveys	2% of patients
Poyton & Morgan (1966)	5000 Full-mouth surveys	0.25% of patients
Miyoshi *et al.* (1971)	Extracted maxillary lateral incisors	38.5% of teeth (as cited by Gotoh *et al.* 1979)
Fujiki *et al.* (1974)	2126 Lateral maxillary incisors	4.2% of teeth (as cited by Gotoh *et al.* 1979)
Thomas (1974)	1886 Full-mouth surveys	7.74% of patients
Gotoh *et al.* (1979)	766 Maxillary lateral incisors	9.66% of teeth
Ruprecht *et al.* (1986)	1581 Full-mouth surveys	1.7%of patients
Ruprecht *et al.* (1987)	300 Full-mouth surveys	10% of patients
Thongudomporn and Freer (1998)	111 Full-mouth surveys	26.1% patients
Backman & Wahlin (2001)	739 Full-mouth surveys	6.8% of patients
Hamasha & Al-Omari (2004)	1660	2.95% of patients and 0.65% of teeth
Ezoddini *et al.* (2007)	480 Dental panoramic tomograms	0.8%

Table 2 - Prevalence studies on dens invaginatus.

References

1. Hülsmann M. Dens invaginatus: aetiology, classification, prevalence, diagnosis and treatment considerations. Int Endod J. 1997 Mar;30(2): 79-90.

2. Schulze C. Developmental abnormalities of the teeth and the jaws. In: Gorlin O, Goldman H, editors. Thoma's Oral Pathology, St Louis, USA: Mosby; 1970. pp. 96–183.

3. Oehlers FA. Dens invaginatus. I. Variations of the invagination process and associated anterior crown forms. Oral Surg Oral Med Oral Pathol. 1957 Nov; 10(11):1204-18.

4. Carvalho-Sousa B, Almeida-Gomes F, Gominho LF, Albuquerque DS. Endodontic treatment of a periradicular lesion on an invaginated type III mandibular lateral incisor. Indian J Dent Res. 2009 Apr-Jun;20(2):243-5.
5. Conklin WW. Bilateral dens invaginatus in the mandibular incisor region. Oral Surg Oral Med Oral Pathol. 1978 Jun;45(6):905-8.

6. Khabbaz MG, Konstantaki MN, Sykaras SN. Dens invaginatus in a mandibular lateral incisor. Int Endod J. 1995 Nov;28(6):303-5.

7. Mupparapu M, Singer SR. A rare presentation of dens invaginatus in a mandibular lateral incisor occurring concurrently with bilateral maxillary dens invaginatus: case report and review of literature. Aust Dent J. 2004 Jun;49(2):90-3.

8. H. Grahnen, B. Lindahl and K. Omnell, Dens invaginatus: I—a clinical, roentgenological and genetical study of permanent upper lateral incisors, Odontologisk Revy 1959; 10: 115–137.

Figures:

Figure 6: Karlsen GS, Hansen JG, Fristad I. Dens invaginatus – a review. Nor Tannlegeforen Tid 2006; 116(4): 218-22

Tables:

Table 2: Alani A, Bishop K. Dens invaginatus. Part 1: classification, prevalence and aetiology. Int Endod J. 2008 Dec;41(12):1123-36.

Perforation repair of a mandibular molar

Introduction

Seventeen year old Norwegian female

Figure 1 - Frontal view

Chief complaint

Non-contributory

Medical history

Non-contributory

Dental history

The patient was referred to the specialist clinic for treatment of the first left mandibular molar.

Clinical findings

Figure 2 - Intraoral view

Extra-oral examination:

Non-contributory.

Intra-oral examination:

Non-contributory.

Tooth	27	26	25
Cold	+	-	-
Percussion	-	-	-
Palpation	-	-	-
Mobility	I	I	I
PPD	Normal	Normal	Normal

Table 1 - Clinical findings.

Soft tissue: within normal limits.

Dental:

Tooth 37: MO composite filling.

Tooth 36: O IRM filling.

Tooth 35: OD composite filling.

Radiographic findings:

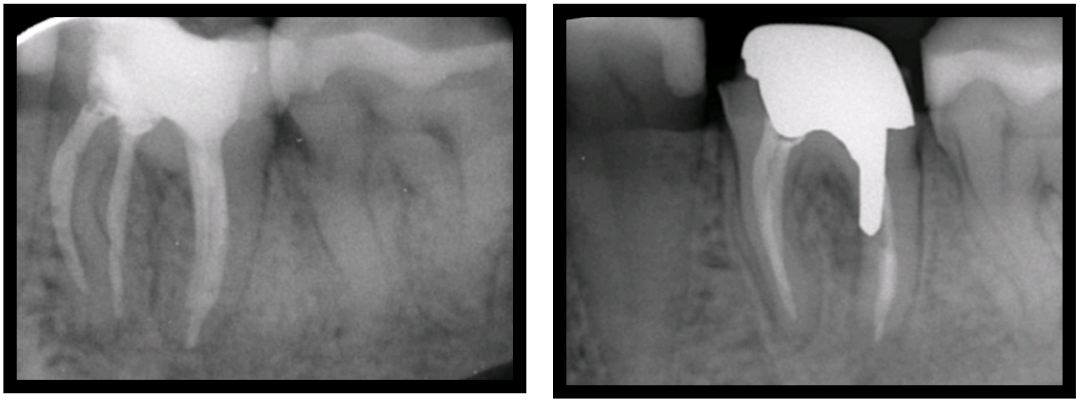


Figure 3 - Final radiograph after endodontic treatment and fitting of the cast post

April 10th 2008

Tooth 37: The patient had undergone endodontic treatment at the student clinic, and the tooth was prepared for a post and crown. During the try-in of the post, it was discovered that the distal root had been perforated.

Diagnosis

Tooth 32:

Pulpal: Root-filled tooth (K04.19)

Apical: Within normal limits

Marginal: Within normal limits.

Problem list

The perforation had weakened the root, and there is hightened risk of root fracture in the future.

Treatment plan

Tooth 37:

Repair the perforation with MTA.

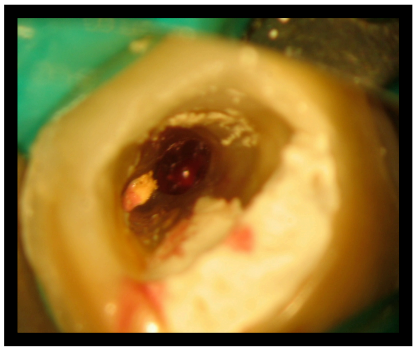
Treatment

June 19th 2008

First consultation. Clinical examination. 1.8 ml Septocaine® Removal of the IRM. Insception of the perforation using an operating microscope. Irrigation of the perforation with 1% NaOCl, 17% EDTA for chemical root disinfection. The perforation was dried and filled with Ca(OH)2. An IRM filling as placed on top.

August 27th 2008

1.8 ml Septocaine®. Rubber dam. Removal of the IRM filling. The Ca(OH)2 was rinsed out using 1% NaOCl and 17% EDTA. The canals were dryed using sterile paper points, and filled with MTA using the MAP-system® . A moist cotton pellet was placed on top of the MTA-filling, and a IRM filling was placed on top. A new appointment was scheduled for a permanent filling. An IRM restoration was placed.



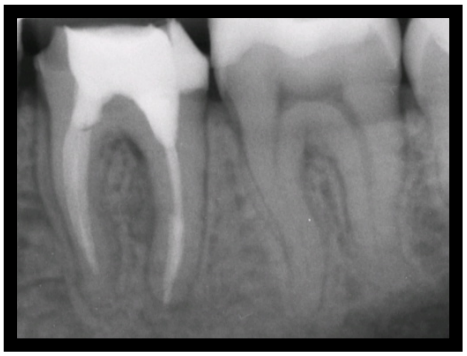


Figure 4 - Intraoral view and radigraph taken after the first visit.

September 3rd 2008

1.8 ml Septocaine®. Rubber dam. Removal of the IRM filling and the cotton pellet. The MTA was controlled to be sure that it had set. An IRM filling was placed on top of the MTA before a composite filling was placed on top.

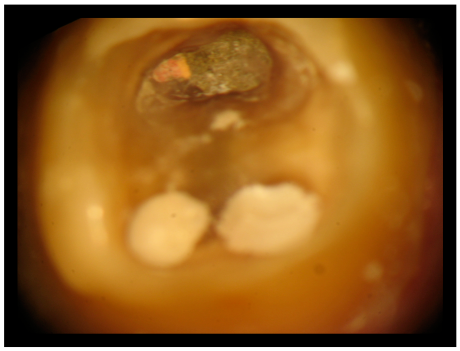


Figure 5 - Placement of MTA

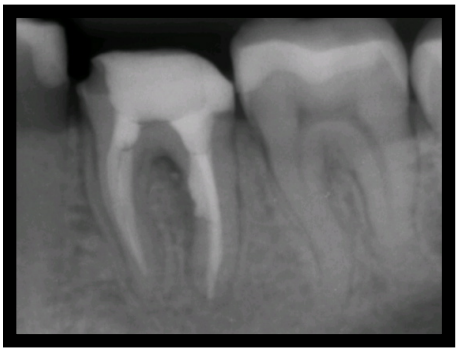


Figure 6 - Final radiograph

Result

Evaluation

No complications during the treatment. The MTA appears dense and good. There was no overfilling of the MTA material. The IRM were placed 2-3mm in the root.

Prognosis

Endodontic: good.

Tooth: good, given that the tooth gets a crown.

Follow-up examination:

October 28th 2009

Figure 7 - Follow-up radiograph.

The tooth had, as recommended, gotten a PFM crown. No new post has been made. The radiograph shows healing next to the MTA filling. The patient was asymptomatic.

Discussion

The role of posts in teeth are to increase the retention of the crown to the tooth. They are either prefabricated or custom-cast. The prefabricated ones can be either active, where the post is treaded into the dentin, or passive, where the post gets its retention through the cement. A cast core will be stronger than one made out of resin[1].

Trope et al found that a post space preparation would significantly weaken the resistance of teeth to fracture, and a post did not significantly strengthen endodontically treated teeth[5].

According to the Washington study, root perforations resulted in endodontic failure in approximately 10% of all failed cases[3]. The long-term prognosis of a perforated tooth is dependent upon the location of the perforation, how long the perforation is exposed to oral contamination, and the ability to seal the perforation[3]. Kvinnsland et al.[2] observed that more than half of the perforations in their cases of root perforation occurred during post-preparation procedures. Midroot perforations, such as those resulting from postspace preparations, should be immediately sealed internally, if possible, or calcium hydroxide should be placed as an intracanal dressing and sealed at a subsequent appointment[6]. In a case series by Pace et al. , they found that by using MTA to repair furcal perforations, healing was seen in 9 out of 10 teeth[10].

If the perforation has a communication with the oral cavity, there is a risk that the MTA will become washed out with time.

Because of its biocompatibility, MTA has become more and more popular as a reparation material in root perforations. The advantage to MTA over other materials is the possibility of cementum growth over the material[4]. The use of biocompatible materials to repair perforations might be advocated to reduce the incidence of inflammatory reactions in the surrounding tissues[11,12]. In a study using MTA, no inflammatory cell infiltrate could be seen when this material was used in dog´s teeth[13]. In a series of literature-review articles, Torabinejad looks at MTA[7,8,9]. Some of the drawback of MTA is discoloration potential, presence of toxic elements in the material composition, difficult handling characteristics, long setting time, high material cost, an absence of a known solvent for this material, and the difficulty of its removal after curing. In spite of these drawbacks of the material, the authors´ conclusion is to leave the material as it is for for. Adding or removing various elements to alleviate these shortcomings can affect MTA's ideal characteristics, and one should investigate any new compositions of MTA both in vitro and in vivo before applying the «new» material in humans[9].

References

1. In: Karlsson S, Nilner K, Dahl BL (eds). A textbook of fixed prosthodontics: The Scandinavian Approach, 1st ed. Gothia, Stockholm, 2000. Chapter 5.3: Posts and cores,

2. Kvinnsland I, Oswald RJ, Halse A, Grønningsaeter AG. A clinical and roentgenological study of 55 cases of root perforation. Int Endod J. 1989 Mar;22(2):75-84.

3. Ingle JI, Beveridge E, Glick D, Welchman J. The Washington study. In: Ingle JI, Bakland, LK (eds) Endodontics, 5th ed, Willams and Wilkins, Baltimore. 2002. pp.747-757.

4. Torabinejad M, Pitt Ford TR, McKendry DJ, Abedi HR, Miller DA, Kariyawasam SP. Histologic assessment of Mineral Trioxide Aggregate as root end filling material in monkeys. J Endod. 1997 Apr;23(4):225-8.

5. Trope M, Maltz DO, Tronstad L. Resistance to fracture of restored endodontically treated teeth. Endod Dent Traumatol. 1985 Jun;1(3):108-11.

6. Chapter 12: «Endodontic surgery». In: Ingle JI, Bakland, LK (eds) Endodontics, 5th ed, Willams and Wilkins, Baltimore. 2002. pp.747-757

7. Parirokh M, Torabinejad M. Mineral trioxide aggregate: a comprehensive literature review—part I: chemical, physical and antibacterial properties, J Endod. 2010 Jan;36(1):16-27.

8. Torabinejad M, Parirokh M. Mineral trioxide aggregate: a comprehensive literature review—part II: leakage and biocompatibility investigations. J Endod. 2010 Feb;36(2):190-202.

9. Parirokh M, Torabinejad M. Mineral trioxide aggregate: a comprehensive literature review—part III: Clinical Applications, Drawbacks, and Mechanism of Action. J Endod. 2010 Mar;36(3):400-13.

10. Pace R, Giuliani V, Pagavino G. Mineral trioxide aggregate as repair material for furcal perforation: case series. J Endod. 2008 Sep;34(9):1130-3

11. Seltzer S, Sinai I, Augusr D. Periodontal effects of root perforations before and during endodontic procedures. J Dent Res. 1970 Mar-Apr;49(2):332-9.

12. Balla R, LoMonaco CJ, Skribner J, Lin LM. Histological study of furcation perforations treated with tricalcium phosphate, hydroxylapatite, amalgam, and Life. J Endod. 1991 May;17(5):234-8.

13. Pitt Ford TR, Torabinejad M, McKendry DJ, Hong DU, Kariyawasam SP. Use of mineral trioxide aggregate for repair of furcal perforations. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1995 Jun;79(6):756-63.

Mandibular canine with two separate foramina

Introduction

Sixty year old Norwegian male.

Figure 1 - Frontal view.

Chief complaint

Non-contributory

Medical history

Non-contributory

Dental history

The patient was referred to the specialist clinic for treatment of the lower right canine.

The referring dentist had started endodontic treatment on the tooth, which had resulted in a fracture of a R10 file in one of the canals.

Clinical findings

Figure 2 - Intraoral view.

Soft tissue: within normal limits.

Dental:

Tooth 44: Abutment in the PFM bridge.

Tooth 43: Abutment in the PFM bridge.

Radiographic findings:

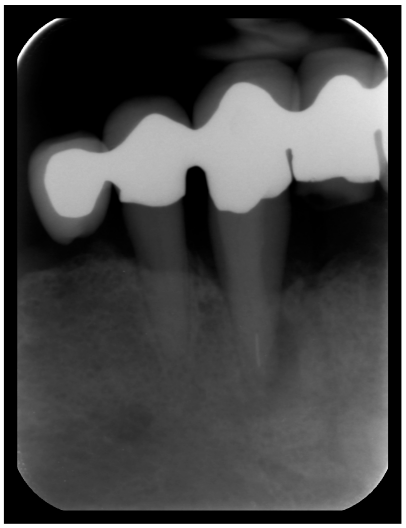


Figure 3 - Periapical radiograph.

February 26th 2008

Tooth: 44: Normal lamina dura. PAI 1. Abutment in the PFM bridge. Reduced alveolar bone height.

Tooth 43: Widened lamina dura. PAI 3. Abutment in the PFM bridge. Fractured instrument in one of the canals. Reduced alveolar bone height.

Diagnosis

Tooth 43:

Pulpal: Necrotic pulp (K04.1).

Apical: Chronic apical periodontitis (K04.3).

Marginal: Chronic marginal periodontitis (K05.3)

Problem list

Persisting infection. The fractured instrument could pose a problem, as the entire length of the root would not be instrumented (if removal was not possible).

Treatment plan

Tooth 43:

Non-surgical treatment of the roots.

If possible, removal of the fractured instrument.

Treatment

February 26th 2008

1.8 ml Septocaine®. Rubber dam. Removal of the IRM filling. By expanding the access cavity in a more lingual direction, the entrance to the lingual was located. The canals were then prepared. It was decided not to try to remove the fractured file in the lingual canal, as the risk of damaging the root was to big. Irrigation of the perforation with 1% NaOCl, 17% EDTA for chemical root disinfection. The canals were filled with $Ca(OH)_2$. An IRM filling as placed on top.

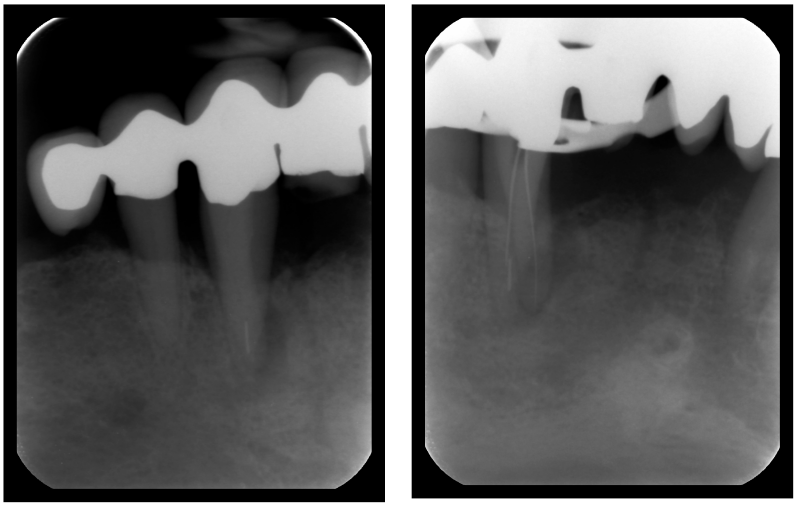


Figure 4 - Working length radiograph.

March 19th 2008

1.8 ml Septocaine®. Rubber dam. Removal of the IRM filling. The Ca(OH)2 was rinsed out using 1% NaOCl and 17% EDTA. The canals were dryed using sterile paper points, and filled with gutta-percha and AH+ sealer. A IRM filling was placed on top.

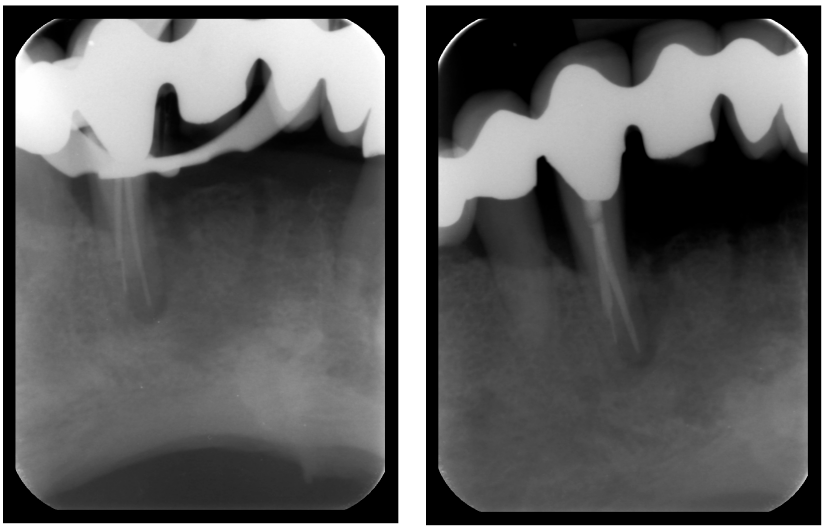


Figure 5 - Masterpoint and final radiograph.

Result

Evaluation

No complications during the treatment. The root filling appears dense and good, although it is short in the buccal root because of the separated file. The IRM was placed as 2-3mm plugs in the root.

Prognosis

Endodontic: uncertain.

Tooth: good.

Follow-up examination:

Figure 6 - Follow-up radiograph

February 25th 2010

The patient is asymptomatic. A periapical lesion can still be seen.

Discussion

Knowledge of root canal anatomy is mandatory for the success of endodontic treatment. A lack of knowledge of the external and internal tooth anatomy may lead to failure of root canal therapy[2]. To help in this, careful examination of the tooth and x-rays may provide hints to why a tooth does not respond to endodontic treatment. The initial radiograph is extremely important because it allows for the identification or suspicion of root and root canal anatomical variations[5]. If possible, one should always attempt to remove separated instruments. If the root canal cannot be cleaned and shaped successfully, remnants of pulp tissue and bacteria may remain and compromise the outcome of root canal treatment1.

In most cases,the mandibular canines present only one root[2,3,4,5]. The occurrence of two roots and even more two root canals is rare, ranging from 1% [3] to 5% [4]. Vertucci reported the presence of two canals in 18% of the mandibular canines[6]. Even though the most common anatomy of mandibular canines comprises a single root and a single root canal, clinicians should consider the possible variations and always search for the second root canal in teeth with either one or two roots[5]. In a study by Pécora et al.[9] , they looked at 830 mandibular canines. 1.2% of these had two canals and two foramina.

In Friedman´s article, he looks at different studies, and introduces the term «functional»[7]. These teeth are clinically normal, but have an unchanged radiolucency apically. Thus the rate of asymptomatic, functional teeth after initial endodontic therapy of apical periodontitis probably approaches or even exceeds 95%. But «functional» teeth are not

the same as «surviving» teeth, as some of the «functional» teeth may have been extracted. Endodontically treated teeth with apical periodontitis have a survival rate of 80%. Combined with the very high rate of functional teeth, there is a strong indication of the potential of teeth with apical periodontitis to remain in a functional, asymptomatic state after endodontic therapy. If one looks at the «success» rate for single-tooth implant-supported replacements[8], such a high percentage is almost the same as for these.

In this case, the patient has a deep pocket which stops just short of the apex on the lingual root (at the follow-up control). If this pocket should develop any more in the apical direction, there is a possibility that the lesion will not heal. This tooth is one of the abutments for the bridge and it has a short root. Apicoectomy on this tooth is not an option, and it can be discussed if the best solution for the patient is to leave the tooth / root as it is, even though the lesion might not heal. In this case, the patient is not interested or motivated to go through an implant procedure.

References

1. Sjögren U, Hagglund B, Sundqvist G, Wing K. Factors affecting the long-term results of endodontic treatment. J Endod. 1990 Oct;16(10):498-504.

2. Sharma R, Pécora JD, Lumley PJ, Walmsley AD. The external and internal anatomy of human mandibular canine teeth with two roots. Endod Dent Traumatol. 1998 Apr;14(2):88-92.

3. Laurichesse JM, Maestroni J, Breillat J. Endodontie Clinique. 1st ed. Paris, France: CdP;1986:64-66.

4. Ouellet R. Mandibular permanent cuspids with two roots. J Can Dent Assoc 1995;61:159-61.

5. Victorino FR, Bernardes RA, Baldi JV, Moraes IG, Bernardinelli N, Garcia RB, Bramante CM. Bilateral mandibular canines with two roots and two separate canals: case report. Braz Dent J. 2009;20(1):84-6.

6. Vertucci FJ. Root canal anatomy of the mandibular anterior teeth. J Am Dent Assoc. 1974;89:369-371.

7. Friedman S. Prognosis of initial endodontic therapy. Endodontic Topics 2002; 2(1): 59-88.

8. Creugers NH, Kreulen CM, Snoek PA, de Kanter RJ. A systematic review of single-tooth restorations supported by implants. J Dent. 2000 May;28(4): 209-17.

9. Pécora JD, Sousa Neto MD, Saquy PC. Internal anatomy, direction and number of roots and size of human mandibular canines. Braz Dent J. 1993;4 (1):53-7.

Fractured cusp

Introduction

Thirtyfour year old Norwegian male

Figure 1 - Frontal view

Chief complaint

Pain when chewing food.

Medical history

Non-contributory

Dental history

The patient was referred to the specialist clinic for treatment of the upper right maxillary molar.

Clinical findings

Extra-oral examination:

Non-contributory.

Figure 2 - Intraoral view

Inta-oral examination:

Tooth	17	16	15
Cold	+	+	+
Percussion	-	-	-
Palpation	-	-	-
Mobility	I	I	I
PPD	Normal	Normal	Normal

Table 1 - Clinical Findings

Soft tissue: within normal limits.

Dental:

Tooth 15: OD composite filling.

Tooth 16: MODP composite filling.

Tooth 17: MO amalgam filling.

Using a FracFinder® instrument on the different cusps of tooth 16, the patient felt a sharp pain when the DB was tested. The patient felt the pain when he opened his mouth, and not when biting down on the FracFinder®. The discomfort did not last long.

Radiographic findings:

Figure 3 - Periapical radiograph

November 27th 2007

Normal periapical status of all teeth, amalgam and composite fillings as described above can be seen.

Diagnosis

Tooth 16:

Pulpal: Symptomatic reversible pulpitis (K04.00).

Periapical: Healthy apical periodontium (K04.b)

Periodontal: Within normal limits.

Treatment plan

Tooth 16:

Reduction of the DB cusp, and replace it with an IRM filling.

Problem list

No relief in symptoms, despite cuspal reduction, ie irreversible pulpitis.

Treatment

November 27th 2007

First consultation. Clinical examination. 1.8 ml Septocaine®. Removal of the composite filling. Using a dental operating microscope, a fracture line along the DB cusp was revealed. The DB cusp was redused, and an IRM filling was placed.

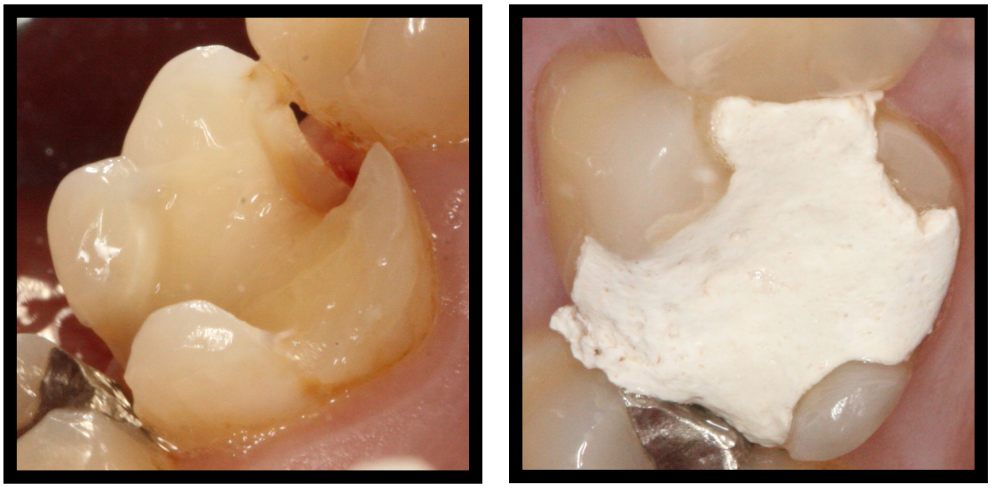


Figure 4 - Removal of the composite filling, replacement with IRM

December 4th 2007

Consultation. The patient was symptom-free, and could chew on the tooth. 1.8 ml Septocaine®. Removal of the IRM filling. The IRM was replaced with a composite filling. The patient was informed that a crown or onlay would be needed in the future.

Result

Evaluation

No complications during the treatment.

Prognosis

Endodontic: good.

Tooth: good.

Discussion

In 1964, Cameron[1] used the term 'cracked tooth syndrome' in his report to describe the uncommon clinical situations characterized by discomfort to chewing pressure and abnormal sensitivity to thermal changes in otherwise normal teeth. Fractured teeth is a common finding in patients with complaints of pain when chewing. One important diagnostic tool is using an instrument that allows the dentist to put a load on each cusp separately. In a study by Roh et al.[2], they found that out of 154 teeth diagnosed with cracks, 96,1% of them responded to a bite test. Another finding is this study was that larger restorations lead to more superficial cracks, because the occlusal stress concentrates in the tooth-restoration interface. Cracks in teeth with no restorations would occur more centrally and closer to the dental pulp, which might produce more severe symptoms.

Simon[3] categorised a tooth fracture into five major classes; craze line, cuspal fracture, cracked tooth, split tooth and vertical root fracture. The craze line is a fracture line confined to the coronal enamel without signs and symptoms. Split tooth means a complete tooth fracture, which was already movable equally, and it usually involves the infrabony structures. A vertical root fracture is defined as a longitudinal fracture confined to the root. It usually begins on the internal wall of root canal and extends outward to the root surface. A crack is defined as an incomplete fracture of a vital tooth involving the dentin and possibly the dental pulp, while a cusp fracture is a tooth fracture caused by the lack of cusp support as a result of a weakened marginal ridge.

The main characteristics of a cusp fracture are that it generally involved one cusp and usually terminated parallel to the gingival margin or slightly subgingivally (figure 5).

Figure 5 - Fractured cusp

Krell et al.[4] identified cracks in 796 of 8175 teeth evaluated. Out of these, 127 patients were diagnosed with reversible pulpitis. The teeth were diagnosed with RP if (1) there was no history of spontaneous pain; (2) the response to cold went away in less than 3–5 seconds; (3) there was no radiographic pathosis. In this study, 21% of these cases diagnosed with RP and a crack eventually required root canal treatment. The teeth in need of root canal treatment were diagnosed within 6 months after being given the diagnosis reversible pulpitis.

In this case, either an onlay or a crown would be the recommended treatment. In AAE´s newsletter[3] fall / winter 1997 (and later, summer 2008), they wrote about the prevention of cracks:

«Prompt restoration with full cuspal coverage can help prevent fractured cusp, cracked tooth, and split tooth in endodontically treated molars and premolars.»

A figure in an article by Lynch et al.[5] suggests how to treat teeth with cracks:

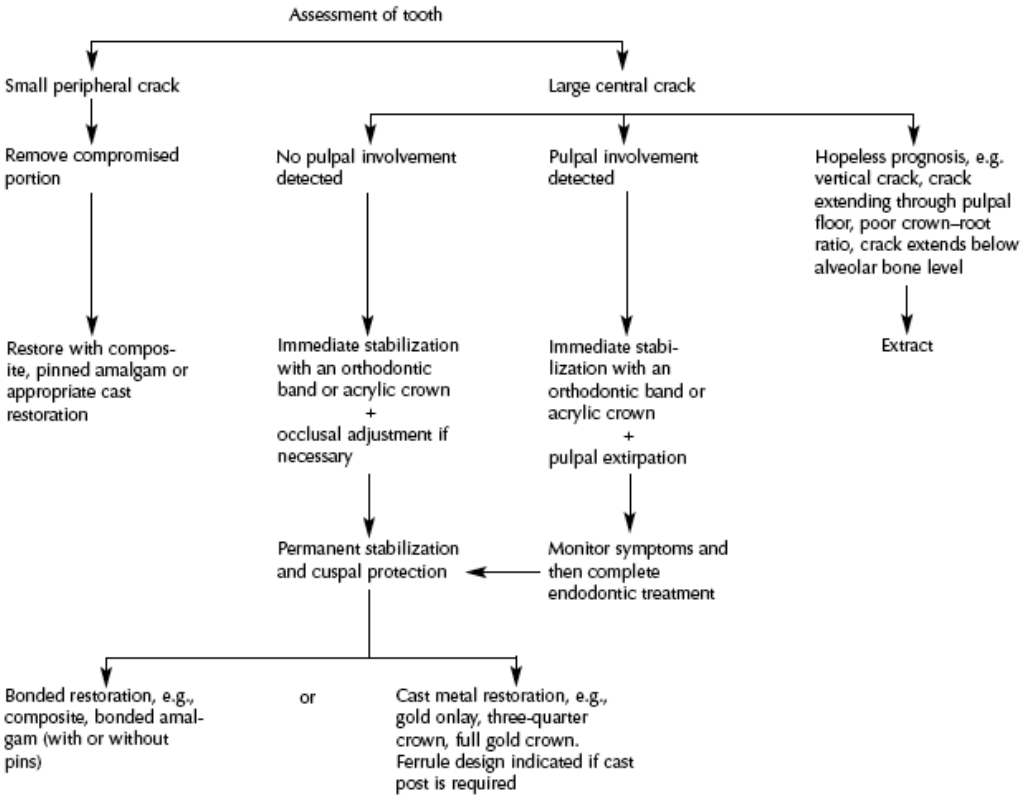


Figure 6 - treatment of cracked teeth

Kahler[6] has a treatment flow chart (adapted from Abbott) where he looks at the different treatment options, based on the AAE´s diagnostic classification of the tooth.

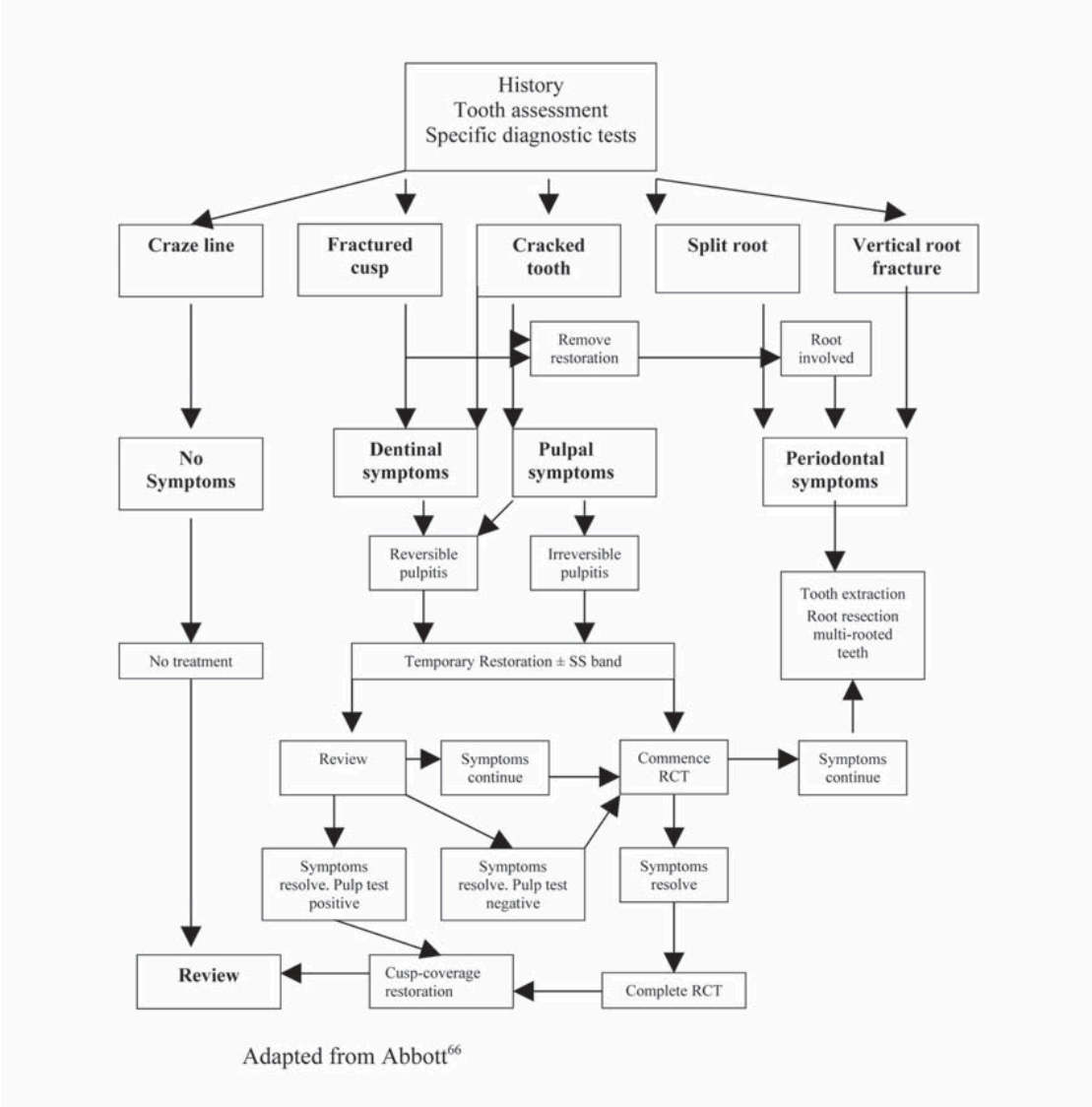


Figure 7 - Treatment flow chart

References

1. Cameron CE. Cracked-tooth syndrome. J Am Dent Assoc 1964;68:406–11.

2. Roh BD, Lee YE. Analysis of 154 cases of teeth with cracks. Dent Traumatol. 2006 Jun;22(3):118-23.

3. Simon DE. Cracking the cracked tooth code. AAE newsletter fall/winter 1997.

4. Krell K, Rivera EM. A Six Year Evaluation of Cracked Teeth Diagnosed with Reversible Pulpitis: Treatment and Prognosis. J Endod. 2007 Dec;33(12): 1405-7.

5. Lynch CD, McConnell RJ. The cracked tooth syndrome. J Can Dent Assoc. 2002 Sep;68(8):470-5.

6. Kahler W. The cracked tooth conundrum: terminology, classification, diagnosis, and management. Am J Dent. 2008 Oct;21(5):275-82.

Figures

Figure 5 Lynch CD, McConnell RJ. The cracked tooth syndrome. J Can Dent Assoc. 2002 Sep;68(8):470-5.

Figure 6 AAE Colleagues for Excellence. Summer 2008. Cracking the Cracked Tooth Code: Detection and Treatment of Various Longitudinal Tooth Fractures.

Figure 7 Kahler W. The cracked tooth conundrum: terminology, classification, diagnosis, and management. Am J Dent. 2008 Oct;21(5):275-82.

Internal resportion in a maxillary molar

Introduction

Twentyeight year old Norwegian male

Figure 1 - Frontal view.

Chief complaint

Non-contributory.

Medical history

Non-contributory.

Dental history

The patient was referred from his dentist to an endodontist. This endodontist referred the patient to the specialist clinic at the University of Oslo. He had diagnosed the tooth with two cervical lesions, one on each of the maxillary first molars.

Clinical findings

Figure 2 - Occlusal view.

Extra-oral examination:

Non-contributory.

Intra-oral examination:

Tooth	17	16	15
Cold	+	+	+
Percussion	-	-	-
Palpation	-	-	-
Mobility	I	I	I
PPD	Normal	Normal	Normal

Table 1 - Clinical findings.

Soft tissue: within normal limits.

Dental:
NA

Figure 3 - Intraoral view

Radiographic findings:

September 15th 2008

Tooth: 17: Normal lamina dura. PAI 1. Normal marginal bone level.

Tooth 16: Normal lamina dura. PAI 1. Normal marginal bone level. A radiolucent area could be seen in the crown of the tooth.

Tooth 15: Normal lamina dura. PAI 1. Normal marginal bone level.

The patient was referred to the department of oral radiology, University of Oslo, for an OPG and a CT-scan to exactly localise the lesions. The CT-scan revealed that neither of the lesions did perforate the tooth, and should therefore be regarded as internal lesions.

Figure 4 - Periapical radiograph

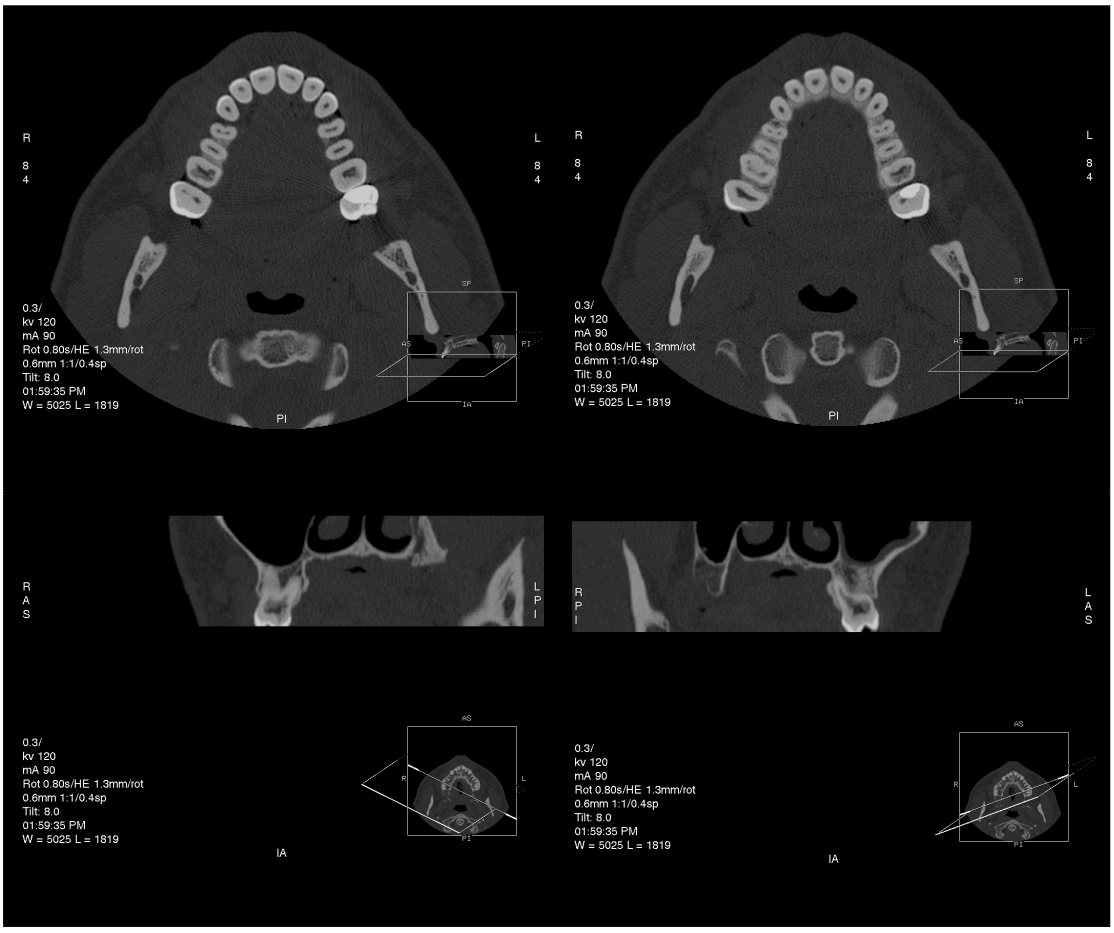


Figure 5 - CT scans - curtosy of Department of Maxillofacial Radiology, Institute of Clinical Dentistry, University of Oslo, Oslo, Norway

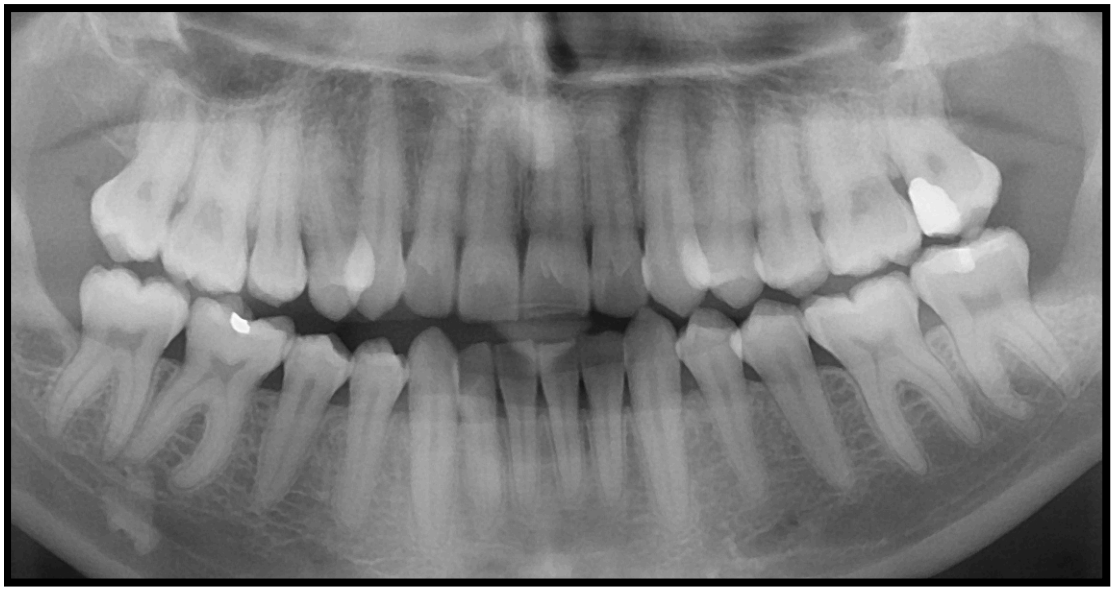


Figure 6 - OPG radiograph

Diagnosis

Tooth 16:

Pulpal: Internal resorption (K03.31).

Apical: Within normal limits.

Marginal: Within normal limits.

Problem list

Continued development of the resorption.

Treatment plan

Tooth 16:

Removal of the resorption using LN-burs and ultrasonic instruments. Afterwards, a non-surgical endodontic treatment was planned.

Treatment

October 6th 2009

First consultation. Clinical examination. Intraoral photos, x-rays, referred the tooth for CT. Tooth diagnosed with vital pulp.

November 26th 2009

1.8 ml Septocaine®. Rubber dam. Access cavity preparation. The palatal part of the cavum had irregular dentin with sugar-like appearance. After removal of this dentin and the sourrounding pulp-tissue, 3 root canals were localized. The canals were prepared using BioRace® files. 1% NaOCl and 17% EDTA were used for chemical root disinfection. The canals were dried with paper points and filled with $Ca(OH)_2$ using a lentulo needle. An IRM restoration was placed on top.

December 12th 2009

1.8ml Septocaine®. Rubber dam. Removal of the IRM filling. Removed the $Ca(OH)_2$, 1% NaOCl and 17% EDTA were used for chemical root disinfection. Irrisafe was used to activate the irrigants. The root canals were dried with paper points and filled with gutta-percha with AH+ Sealer. An IRM restoration was placed on top.

January 13th 2010

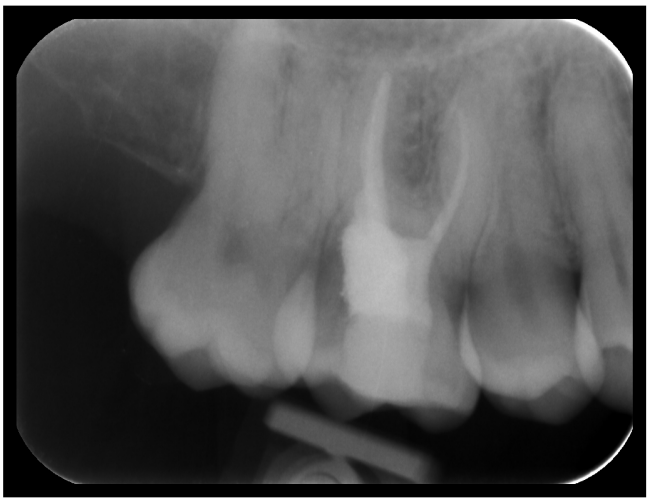


Figure 7 - Postoperative radiograph

Removal of the upper part of the IRM filling. A composite filling, 3M Z250, was placed. A new appointment was scheduled with another specialist candidate for treatment of tooth 26.

Result

Evaluation

No complications during the treatment. The root filling appeared dense and good. There were no perforations to the outside of the tooth.

Prognosis

Endodontic: good.

Tooth: good.

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[5]. No clear factor has been linked to internal resorption, but several have been suggested in the litterature, e.g. pulpitis, trauma, pulpotomy, invagination, cracked tooth, tooth transplantation and orthodontic treatment[5].

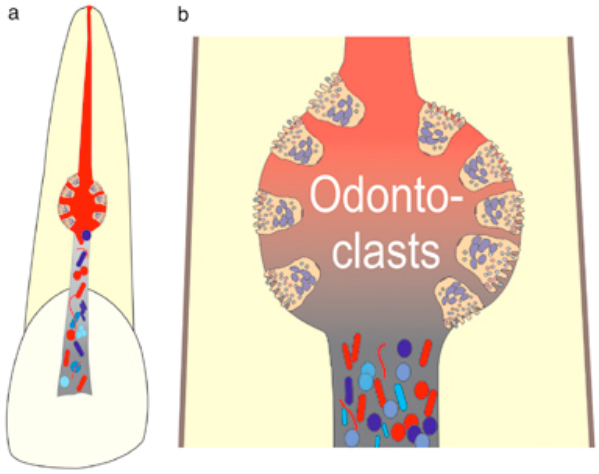


Figure 8:
A schematic drawing showing the pathogenesis of internal inflammatory root resorption. The canal coronal to the resorption is necrotic and invaded by microbes. The resorption cavity contains highly vascularized resorption tissue with multinuclear odontoclast cells. (b) A close-up image of the resorption.

The prevalence of internal resorption varies, depending on the type of treatment the tooth has recieved. Cabrini et al.[6] 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, whereas Ahlberg[7] found internal resorption in 55% of the teeth that had undergone autotransplantation. Haapasalo and

Endal[6] believe that the prevalence of internal resorptions is between 0,01-1%.

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[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 maximise the effect of the disinfection procedures[8]. As long as the resorption has not perforated the tooth, the tooth has a good prognosis[9].

References

1. Tronstad L. Root resorption—etiology, terminology and clinical manifestations. Endod Dent Traumatol. 1988 Dec;4(6):241-52.

2. Wedenberg C, Lindskoj S. Experimental internal resorption in monkey teeth. Endod Dent Traumatol. 1985 Dec;1(6):221-7.

3. In: JJ Pindborg, Editor, Pathology of the dental hard tissues., Munksgaard, Copenhagen (1970).

4. Heithersay GS. Clinical endodontic and surgical management of tooth and associated bone resorption. Int Endod J. 1985 Apr;18(2):72-92.

5. Haapasalo M, Endal U. Internal inflammatory root resorption: the unknown resorption of the tooth. Endodontic Topics 2006; 14(1): 60-79

6. Cabrini R, Maisto O, Manfredi E. Internal resorption of dentine; histopathologic control of eight cases after pulp amputation and capping with calcium hydroxide. Oral Surg Oral Med Oral Pathol. 1957 Jan;10(1): 90-6.

7. Ahlberg K, Bystedt H, Eliasson S, Odenrick L. Long- term evaluation of autotransplanted maxillary canines with completed root formation. Acta Odontol Scand. 1983;41(1):23-31.

8. Spångberg LZ, Haapasalo M. Rationale and efficacy of root canal medicaments and filling materials with emphasis on treatment outcome. Endodontic Topics 2002; 2(1): 35–58.

9. Caliskan MK, Turkun M. Prognosis of permanent teeth with internal resorption: a clinical review. Endod Dent Traumatol. 1997 Apr;13(2):75-81.

Figures:

Figure 8: Haapasalo M, Endal U. Internal inflammatory root resorption: the unknown resorption of the tooth. Endodontic Topics 2006; 14(1): 60-79.

Retreatment, obturation with a thermoplastic-filled polymer

Introduction

Sixtyone year old caucasian female

Figure 1 - Frontal view

Chief complaint

Non-contributory

Medical history

Non-contributory

Dental history

The patient was originally referred to the specialist clinic for treatment of tooth 24, which had a persisiting infection. Radiographs of the area revealed that tooth 26 had an apical lesion, and only two canals were filled. After consulting the referring dentist and the patient, it was decided to retreat tooth 26.

Clinical findings

Figure 2 - Occlusal view

Extra-oral examination:

Non-contributory

Intra-oral examination:

Non-contributory

Tooth	24	25	26
Cold	-	+	-
Percussion	-	-	-
Palpation	-	-	-
Mobility	I	I	I
PPD	Normal	Normal	Normal

Table 1 - Clinical findings

Soft tissue:

Non-contributory

Dental:

Tooth 25: PFM crown

Tooth 26: Gold-cast onlay.

Tooth 27: PFM crown.

Radiographic findings:

Figure 3 - periapical radiograph

January 6th 2010

Tooth 24: Widened lamina dura. PAI 5 . Retrograde MTA filling, guttapercha, IRM temporary filling, composite filling.

Tooth 25: Normal lamina dura. PAI 1. PFM crown.

Tooth 26: Widened lamina dura. PAI 3. Gold-cast onlay. Root filled tooth.

Diagnosis

Tooth 26:

Pulpal: Previously root-filled tooth (K04.1)

Apical: Chronic apical periodontitis (K04.5).

Marginal: Within normal limits.

Problem list

Persisting infection.

Localizing any remaining canals.

Treatment plan

Tooth 26:

Non-surgical endodontic retreatment.

Treatment

January 6th 2010

Clinical examination. 1.8 ml Septocaine®. Rubber dam. Removal of the permanent filling. Removal of gutta-percha remains on the caum of the tooth. One extra canal was localized. Removal of the old root-filling material and instrumentation of the newly found canal was done mechanically using Gates-Glidden burs and BioRace files. The lengths of the canals were determined using by apex locator (Root ZX®) and periapical radiographs.

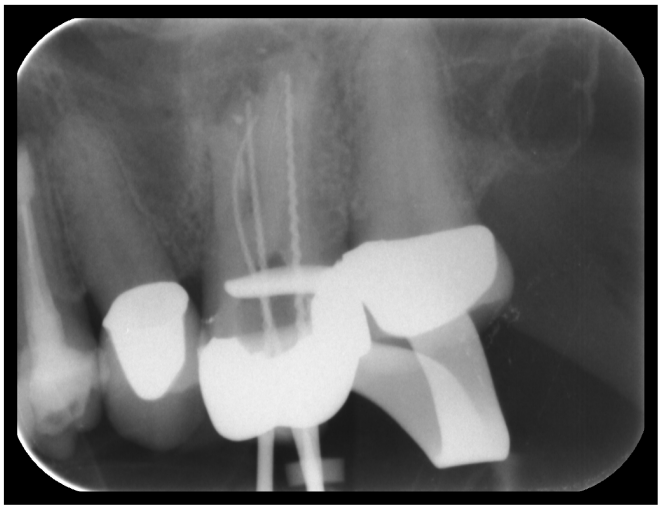


Figure 4 - working length radiograph

MB canal R35 / 21 mm

DB canal: R50 / 20 mm

P canal: R60 / 20 mm

An apical perforation was discovered upon removal of the old gutta-percha in the DB canal.

1% NaOCl and 17% EDTA were used for chemical root disinfection. The canals were dried with paper points and filled with $Ca(OH)_2$ using a lentulo needle. An IRM restoration was placed on top.

January 20th 2010

The patient was asymptomatic. 1.8ml Septocaine®. Rubber dam. Removal of the IRM filling. The $Ca(OH)_2$ was removed using hand files, NaOCl and EDTA. The canals were dried using paper points. A MTA filling was placed in the DB canal. After the MTA had set, the canals were filled with Resilon and Epiphany sealer. After removal of the root filling material surplus, the access cavity was sealed with an IRM restoration.

Figure 5 - Postoperative radiograph

Result

Evaluation

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

Prognosis

Endodontic: good.

Tooth: good.

Discussion

The purpose of a root filling is to entomb any remaining bacteria in the canal, to stop influx of periapical tissue-derived fluid from nourishing the remaining microbiota and prevent re-infection of the root canal system[9].

Resilon is a thermoplastic-filled polymer used with a dual curable dental resin composite sealer, Epihany, as a root canal filling material. It was introduced in 2004. The theory behind this material to create a bond between the root canal filling material and the dentinal wall, a so-called «monoblock»[1] (figure 6). The material has the same handling properties as those of gutta-percha, and can be dissolved with the same solvents like chlorofom[1].

Some in vitro tests[1,2] have shown the Resilon system superior to gutta percha/sealer in leakage testing, whereas others[3,4] have shown no significant difference. In a dog model, Shipper and colleagues[5] found less apical periodontitis associated with teeth filled with the Resilon system than those filled with gutta percha/sealer. In a study by Teixeira et al.[6], they found an increased resistance to fracture in teeth filled with Resilon compared with gutta-percha. Cotton et al.[8] , did a retrospective study where they looked at 117 teeth obturated with either gutta-percha and Kerr pulp canal sealer or Resilon and Epiphany sealer, that were recalled 2-25 months postoperatively. Both groups had statistically indistinguishable differences in the clinical outcome.

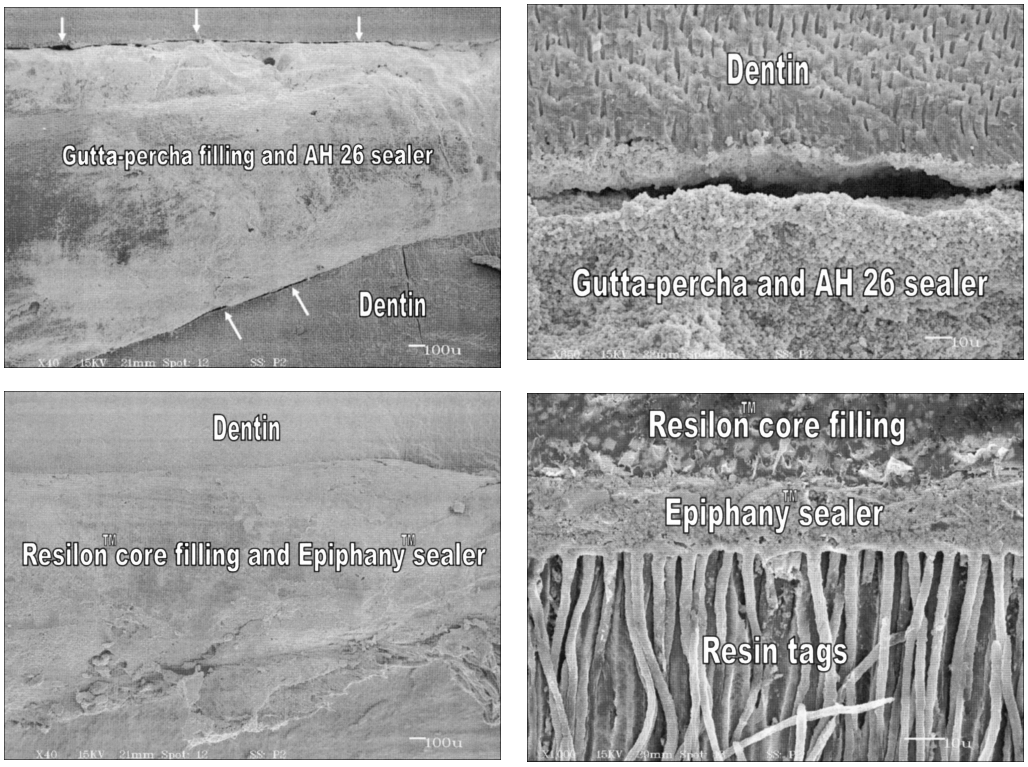


Figure 6 - SEM micrographs showing the gaps between GP / AH26 sealer and the dentin, and the resin tags from the Epiphany sealer entering the dentine tubuli.

References

1. Shipper G, Ørstavik D, Teixeira FB, Trope M. An evaluation of microbial leakage in roots filled with a thermoplastic synthetic polymer-based root canal filling material (Resilon). J Endod. 2004 May;30(5):342-7.

2. Tunga U, Bodrumlu E. Assessment of the sealing ability of a new root canal obturation material, J Endod. 2006 Sep;32(9):876-8.

3. Biggs SG, Knowles KI, Ibarrola JL, Pashley DH. In vitro assessment of the sealing ability of resilon/epiphany using fluid filtration. J Endod. 2006 Aug;32(8):759-61.

4. Pitout E, Oberholzer TG, Blignaut E, Molepo J. Coronal leakage of teeth root-filled with gutta percha or resilon root canal filling material, J Endod. 2006 Sep;32(9):879-81.

5. Shipper G, Teixeira FB, Arnold RR, Trope M. Periapical inflammation after coronal microbial inoculation of dog roots filled with gutta-percha or resilon. J Endod. 2005 Feb;31(2):91-6.

6. Teixeira FB, Teixeira EC, Thompson JY, Trope M. Fracture resistance of roots endodontically treated with a new resin filling material. J Am Dent Assoc. 2004 May;135(5):646-52.

7. Mjör IA, Smith MR, Ferrari M, Mannocci F. The structure of dentine in the apical region of human teeth. Int Endod J. 2001 Jul;34(5):346-53.

8. Cotton TP, Schindler WG, Schwartz SA, Watson WR, Hargreaves KM. A Retrospective Study Comparing Clinical Outcomes after Obturation with Resilon/Epiphany or Gutta-Percha/Kerr Sealer. J Endod. 2008 Jul;34(7): 789-97.

9. Sundqvist G, Figdor D, Persson S, Sjögren U. Microbiologic analysis of teeth with failed endodontic treatment and the outcome of conservative re-treatment. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1998 Jan;85(1):86-93.

Figures:

Figure 6: Shipper G, Ørstavik D, Teixeira FB, Trope M. An evaluation of microbial leakage in roots filled with a thermoplastic synthetic polymer-based root canal filling material (Resilon). J Endod. 2004 May;30(5):342-7.

Necrotic maxillary canine

Introduction

Twenty year old female of Persian decent.

Figure 1 - Frontal view.

Chief complaint

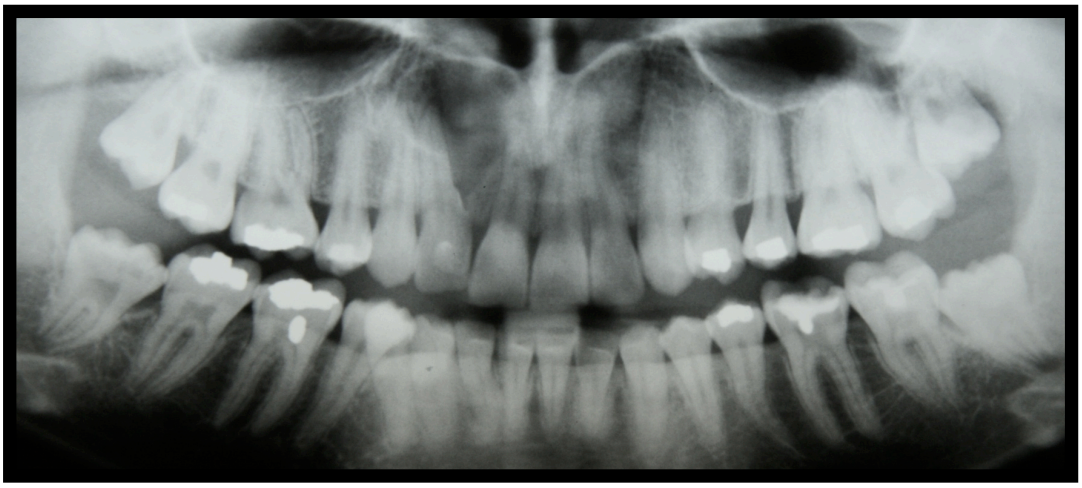
None.

Medical history

None.

Dental history

The patient had undergone endodontic treatment at the specialist clinic in 2007. Tooth 12 was diagnosed with a dens in dente, and this was treated, with a continued vital pulp. The patient was referred for a consultation regarding this tooth as, according to the referring dentist, the radiolucency had not healed.



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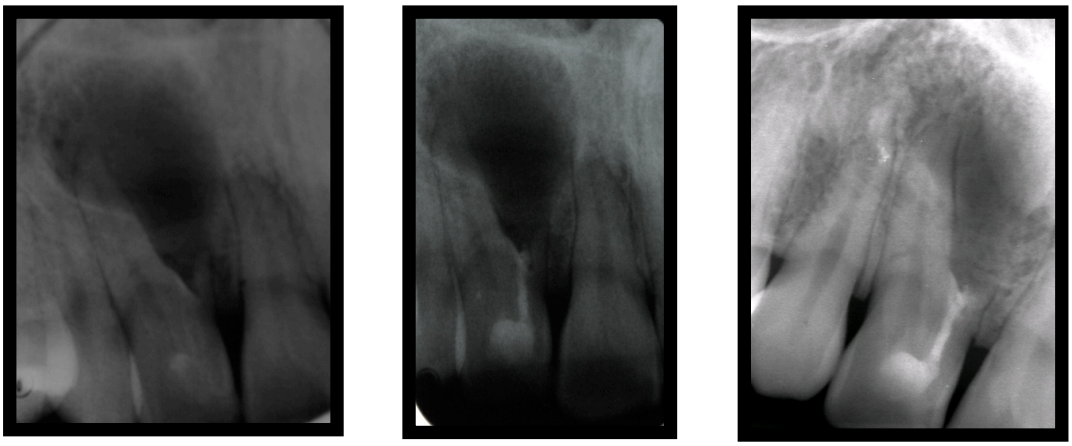


14.03.2007 18.04.2007 18.09.2008

Figure 2 - Prior endodontic treatment.

Clinical findings

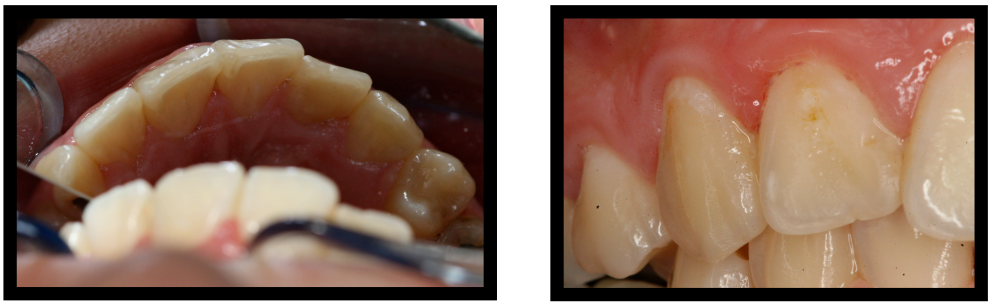


Figure 3 - Intraoral photos

Extra-oral examination:

Non-contributory

Intra-oral examination:

Both maxillary laterals are wider then a «normal» lateral, indicating that the anatomy may differ from the norm. A vertical fracture-line was observed buccally on tooth 13. The same tooth did not respond to a thermal test.

Tooth	13	12	11	21	22	23
Cold	-	+	+	+	+	+
Percussion	-	-	-	-	-	-
Palpation	-	-	-	-	-	-
Mobility	I	I	I	I	I	I
PPD	Normal	Normal	Normal	Normal	Normal	Normal

Table 1 - Clinical findings.

Soft tissue:

Non-contributory.

Dental:

Tooth 12: P composite filling.

Figure 4 - Buccal fracture line visualized using a light probe.

Radiographic findings:

September 18th 2008

Tooth 13: Normal lamina dura. PAI 1.

Tooth 12: Root filled tooth. Widened lamina dura. PAI 4.

Figure 5 - Periapical radiograph.

Diagnosis

Tooth 13:

Pulpal: Necrotic pulp (K04.1)

Apical: Within normal limits.

Marginal: Within normal limits.

Tooth 12:

Pulpal: Healthy pulp (K04.a)

Apical: Chronic apical periodontitis (K04.5).

Marginal: Within normal limits.

Treatment plan

Nonsurgical endodontic treatment of tooth 13. It was decided to continue observation of tooth 12, as the radiological structure was probably scar tissue healing.

Treatment

September 18th 2008

Clinical examination. 1.8 ml Septocaine®. Preparation of the entrance cavity. Rubber dam. Prepared the canals using Gates-Glidden burs and handfiles. The length of the canal was determined using by apex locator (Root ZX®) and periapical radiographs. 1% NaOCl and 17% EDTA were used for chemical root disinfection. The canals were dried with paper points and filled with a $Ca(OH)_2$-paste. An IRM restoration was placed on top.

December 11th 2008

The patient was asymptomatic. 1.8ml Septocaine®. Rubber dam. Removal of the IRM filling. The $Ca(OH)_2$ was removed using hand files, NaOCl and EDTA. The canals were dried using paper points. The canal was filled with guttapercha and AH+ sealer. The access cavity was sealed with an IRM restoration.

Result

Evaluation

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

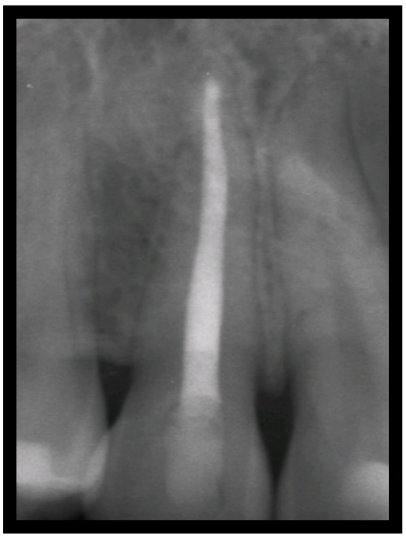


Figure 6 - Final radiograph.

Prognosis

Endodontic: good.

Tooth: good.

Discussion

The patient was originally referred for endodontic treatment on tooth 12, as the referring dentist still saw a radiolucency. This radiolucency was decided to be seen as a scar tissue, and can be seen when both cortical bone plates have been perforated by the inflammation, or by a surgical procedure[1]. The scar tissue can develop when precursors of soft connective tissue colonize both the root tip and periapical tissue[2]. Penick described a case report where he performed a periapical curretage on a maxillary lateral incisor, and found a dense, relatively avascular fibrous connective tissue with no signs of any inflammatory reaction[3].

According to an article by Hülsmann[5], maxillary lateral incisors are the teeth most affected. The most used classification is the one by Oehler. This tooth would be a type III, which is described as «a form which penetrates through the root perforating at the apical area showing a 'second foramen' in the apical or in the periodontal area. There is no immediate communication with the pulp. The invagination may be completely lined by enamel, but frequently cementum will be found lining the invagination».

With the exception of the vertical crack on the buccal surface of tooth 13 was sound. This crack has probably been used by the bacteria to gain access to the pulp, which resulted in pulpal necrosis. AAE have categorized cracks in teeth on the basis on where they start, and what part of the tooth is affected. Their definition of a cracked tooth is, by using transillumination, that the light will be blocked. If the tooth only has a craze line (which only affect the enamel), the entire tooth structure will light up[4].

References

1. Molven O, Halse A, Grung B. Incomplete healing (scar tissue) after periapical surgery – radiographic findings 8 to 12 years after treatment. J Endod. 1996 May;22(5):264-8.

2. Nair PNR, Sjögren U, Figdor D, Sundqvist G. Persistent periapical radiolucencies of root filled human teeth, failed endodontic treatments and periapical scars. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1999 May;87(5):617-27.

3. Penick EC (1961) Periapical repair by dense fibrous connective tissue following conservative endodontic therapy. Oral Surg Oral Med Oral Pathol 1961; 14: 239–42.

4. AAE Clinical Newsletter Summer 2008 - Cracking the Cracked Tooth Code: Detection and Treatment of Various Longitudinal Tooth Fractures.

5. Hülsmann M. Dens invaginatus: aetiology, classification, prevalence, diagnosis, and treatment considerations. Int Endod J. 1997 Mar;30(2): 79-90.

Filling of a maxillary molar using warm vertical compaction.

Introduction

Thirthysix year old female of Persian origin.

Figure 1 - Frontal view

Chief complaint

None.

Medical history

None.

Dental history

The patient was referred to the specialist clinic from the student clinic. The patient was going to receive several PFM crowns, and they wanted the tooth to be endodontically retreated.

Clinical findings

Figure 2 - Occlusal view

Extra-oral examination:

Non-contributory

Intra-oral examination:

Non-contributory.

Tooth	27	26	25
Cold	+	-	-
Percussion	-	-	-
Palpation	-	-	-
Mobility	I	I	I
PPD	Normal	Normal	Normal

Table 1 - Clinical findings

Soft tissue:

Non-contributory.

Dental:

Tooth 27: O composite filling.

Tooth 26: MO composite filling.

Tooth 25: O IRM temporary filling.

Radiographic findings:

Figure 3 - Periapical radiograph

November 27th 2008

Tooth 27: O Composite filling. Normal lamina dura. PAI 1.

Tooth 26: MO composite filling. Previously root-filled tooth. Separated file in the P canal. Normal lamina dura. PAI 1.

Tooth 26: O filling. Previously root-filled tooth.

Diagnosis

Tooth 26:
Pulpal: Previously root-filled tooth (K04.1)

Apical: Within normal limits.

Marginal: Within normal limits.

Treatment plan

Nonsurgical endodontic retreatment of tooth 26.

Problem list

To be able to see the separated file this high up in the canal could pose a problem.

Treatment

Novmber 27th 2008

Clinical examination. 1.8 ml Septocaine®. Preparation of the entrance cavity. Rubber dam. Localized the uninstrumented MB2. Prepared the canals using Gates-Glidden burs and hand files. Removal of the separated instrument was done using ultrasonic instruments. The lengths of the canal was determined using by apex locator (Root ZX®) and periapical radiographs. 1% NaOCl and 17% EDTA were used for chemical root disinfection. The canals were dried with paper points and filled with a $Ca(OH)_2$-paste. An IRM restoration was placed on top.

December 12th 2008

The patient was asymptomatic. 1.8ml Septocaine®. Rubber dam. Removal of the IRM filling. The Ca(OH)2 was removed using hand files, 1% NaOCl and 17% EDTA. 2%. The canals were dried using paper points and filled with guttapercha and AH+ sealer, using a warm vertical compaction technique. For delivery of the guttapercha, the Elements Obturation Unit was used. The access cavity was sealed with an IRM restoration.

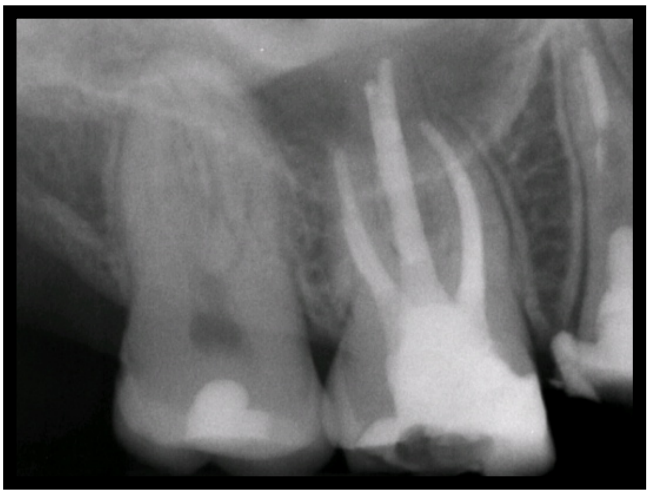


Figure 4 - Final radiograph

Result

Evaluation

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

Prognosis

Endodontic: good.

Tooth: good, given that the tooth gets a crown.

Discussion

The purpose of a root canal filling, is to fill the root canal space and eliminate all portals of entry between the canal and the periodontium[1]. The standard root filling is a combination of a sealer with a central core material. The most commonly taught and practiced filling technique worldwide, is the cold lateral condensation technique. The advantage to this technique compared to a warm vertical technique, is the controlled placement of the guttapercha in the root canal. Compared with cold lateral condensation, warm vertical condensation of GP can provide a high-density filling and better sealing at all portals of entry between the root canal and the periodontium. A disadvantage when using thermoplastic materials is the possibility of extrusion of the material apically. Studies have shown that extruded material will lower the chances of healing on teeth with apical periodontitis[4]. Friedman[5] has looked at several studies regarding the apical extent of treatment. His conclusion is that when there is no apical periodontitis, the apical extent of the should not be considered to influence the outcome of nonsurgical endodontic treatment. In teeth with apical periodontitis, the prognosis may be better if the root canal filling extends 0-2mm short of the root end[5]. Several other studies have compared lateral condensation with warm vertical compaction. Brothman[7] compared vertical with lateral condensation of gutta percha, but could not find any statistical difference in filling efficiency.
Wong et al.[8] compared compaction, lateral condensation and vertical condensation. Their conclusion was that the vertical condensation technique replicated the canal best, followed by the compaction technique.

In the study by Saunders they found that teeth obturated with Thermafil had significantly less leakage than those filled using other techniques[2]. Gilbert et al. found that vertical compaction leaked significantly less than lateral compaction during bacterial challenge. However, when dye was used there were no significant differences[3]. The problem with using a warm vertical technique, is the possibility of overextension of the root canal material. In the study by Peng, warm gutta-percha demonstrated a higher risk of overextending compared to cold lateral condensation, whereas the obturation quality was the same[1]. Another problem with thermoplastizied guttapercha is the shrinkage during cooling. In a study comparing lateral condensation to three chloroform+gutta-percha techniques, all groups but the lateral condensation shrunk[6].

References

1. Peng L, Ye L, Tan H, Zhou X. Outcome of Root Canal Obturation by Warm Gutta-Percha vs. Cold Lateral Condensation: A Meta.analysis. J Endod. 2007 Feb;33(2):106-9.

2. Saunders WP, Saunders EM. Influence of smear layer on the coronal leakage of Thermafil and laterally condensed gutta-percha root fillings with a glass ionomer sealer. J Endod. 1994 Apr;20(4):155-8.

3. Gilbert SD, Witherspoon DE, Berry CW. Coronal leakage following three obturation techniques. Int Endod J. 2001 Jun;34(4):293-9.

4. Sjögren U, Hagglund B, Sundqvist G, Wing K. Factors affecting the long-term results of endodontic treatment. J Endod. 1990 Oct;16(10):498-504.

5. Friedman S. Expected Outcomes in the Prevention and Treatment of Apical Periodontitis. In: Ørstavik D, Pitt Ford TR (eds). Essential Endodontology: Prevention and Treatment of Apical Periodontitis, 2nd Ed Blackwell Munksgaard, Oxford 2008, pp 408-454.

6. Wong M, Peters DD, Lorton L, Bernier WE. Comparison of gutta-percha filling techniques: three chloroform-gutta-percha filling techniques, part 2. J Endod. 1982 Jan;8(1):4-9.

7. Brothman P. A comparative study of the vertical and the lateral condensation of gutta-percha. J Endod. 1981 Jan;7(1):27-30.

8. Wong M, Peters DD, Lorton L. Comparison of gutta-percha filling techniques, compaction (mechanical), vertical (warm), and lateral condensation techniques, Part 1. J Endod. 1981 Dec;7(12):551-8.

Molarized mandibular premolar with apical periodontitis

Introduction

Fiftyfive year old caucasian male.

Figure 1 - Frontal view

Chief complaint

None.

Medical history

None.

Dental history

The patient was referred from the student clinic for endodontic retreatment of tooth 35 and tooth 36. These had both undergone endodontic treatment several years ago, the patient could not remember the exact date.

Clinical findings

Figure 2 - Occlusal view.

Extra-oral examination:

Non-contributory

Intra-oral examination:

Non-contributory

Tooth	33	34	35	36
Cold	+	+	-	-
Percussion	-	-	-	-
Palpation	-	-	-	-
Mobility	I	I	I	I
PPD	Normal	Normal	Normal	Normal

Table 1 - Clinical findings.

Soft tissue:

Non-contributory

Dental:

Tooth 35: OD amalgam filling.

Tooth 36: PFM crown.
O composite filling.

Radiographic findings:

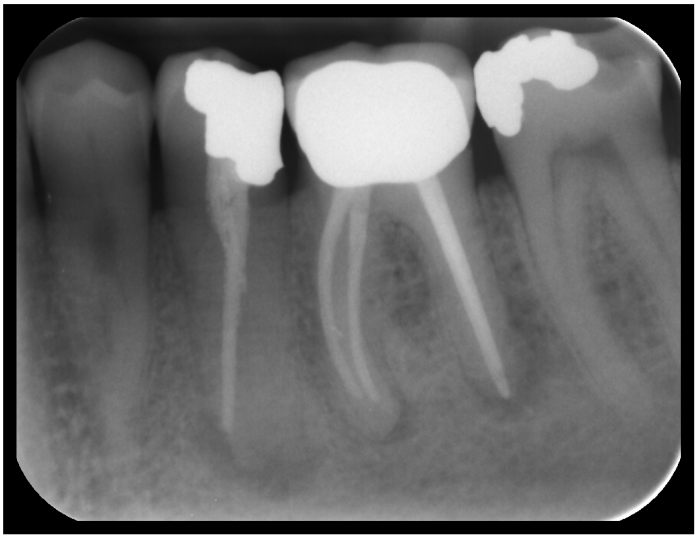


Figure 3 - Periapical radiograph.

February 4th 2010

Tooth 35: OD amalgam filling. Previously endodontically treated tooth.

Tooth 36: PFM crown. Previously endodontically treated tooth.

Tooth 37: MO amalgam filling.

Diagnosis

Tooth 35:

Pulpal: Previously root-filled tooth (K04.1)

Apical: Chronic apical periodontitis (K04.5).

Marginal: Within normal limits.

Treatment plan

Nonsurgical endodontic retreatment of tooth 35.

Treatment

February 4th 2010

Clinical examination. Preparation of the entrance cavity. Rubber dam. Removed the old root-canal filling using hand files and BioRace files. Localised the an extra distal canal, but was unable to prepare it as it was obliterated. The length of the canal was determined using by apex locator (Root ZX®) and periapical radiographs. 1% NaOCl and 17% EDTA were used for chemical root disinfection, in addition to chloroform which was used to remove the old root-canal filling. The canal was dried with paper points and filled with a $Ca(OH)_2$-paste. An IRM restoration was placed on top.

February 24th 2010

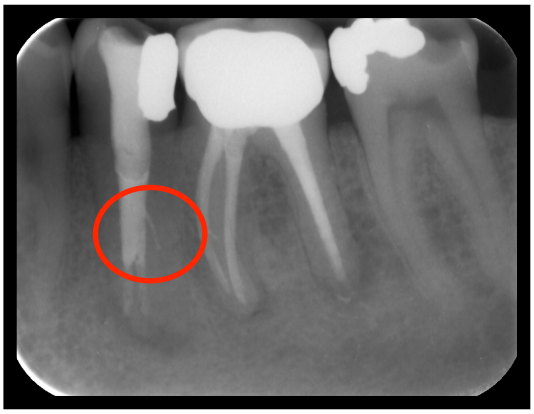
Rubber dam. Prepared the distal canal using ultrasonic instruments. The length of the canal was determined using by apex locator (Root ZX®) and periapical radiographs. 1% NaOCl and 17% EDTA were used for chemical root disinfection. The canals were dried with paper points and filled with a $Ca(OH)_2$-paste. An IRM restoration was placed on top.

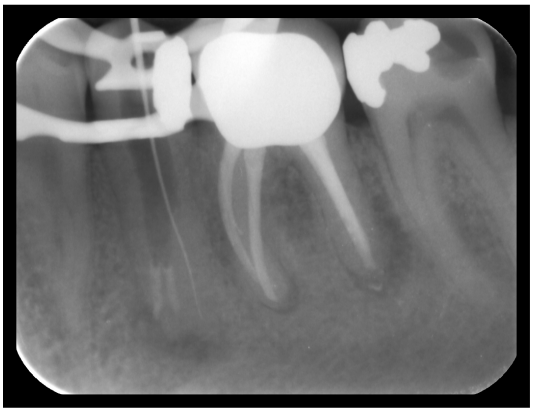
March 10th 2010

The patient was asymptomatic. Rubber dam. Removal of the IRM filling. The $Ca(OH)_2$ was removed using hand files, NaOCl and EDTA. 2%. The canals were dried using paper points. The mesial canal had been prepared beyond the apex, as had the distal canal. It was therefore decided to fill both canals with MTA. Both canals were filled with MTA-Angelus. A moist cotton pellet was placed on top for 15 minutes. After making sure the MTA had set, a temporary Cavit-G filling was placed on top, and a new appointment for a permanent filling was scheduled.

April 13th 2010

The patient was asymptomatic. Rubber dam. Removal of the temporary filling. A permanent root canal filling was placed using the Obtura system®. When the final radiograph was taken, an uninstrumented canal was discovered, as this had been filled partially with gutta-percha. The root-filling was removed, and the newly found canal was instrumented using hand files. Ca(OH)2 was placed in the canals, and an IRM filling was placed on top. A new appointment for for the root-filling was scheduled.

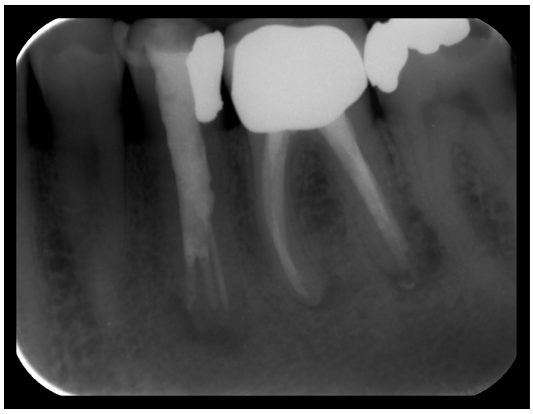




The extra canal filled with gutta percha, and the working length radiograph

April 20th 2010

The patient was asymptomatic. Rubber dam. Removal of the temporary filling. A permanent root canal filling was placed using a combination of the Obtura system® and lateral condensation in the canal without MTA apically. An IRM filling was placed on top.



04.02.2009 09.03.2010

Result

Evaluation

The extra canal was localised and instrumented. The MTA fillings got acceptable thicknesses.

Prognosis

Endodontic: good.

Tooth: good, given that it gets a PFM crown.

Discussion

When preparing a canal, it is important to stay in the canal, and not extend the preparation beyond the apex. According to the study by Sjögren[1], the best prognosis when retreating teeth with preoperative apical periodontitis is seen when the final level of root filling is 0-2mm from the root apex (figure 1). According to Friedman[13], a tooth with an apical radiolucency will have a prognosis which is 10-15% lower than in a tooth without. In studies on retreatment, this difference is 10-20%. If the quality of the previous root canal filling is inadequate, the outcome is significantly better than if it is adequate[14].

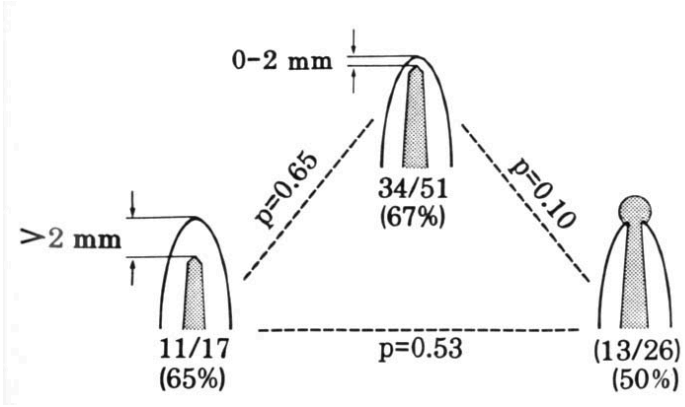


Figure 1 - Results of retreatment of previously filled roots with apical periodontitis with regard to the level of the final root filling in relation to the root apex.

When filling a root canal with gutta-percha, the operator has multiple choices of how to fill the canal. As Schilder writes in his article[3], «the final objective of endodontic procedures should be the total obturation of the root canal space». The problem is that this space varies from root to accessory canals. Schilder developed a technique using heated pluggers and small amounts of gutta percha that are used for a backfilling of the tapered canal.

The most common techniques are either a warm vertical condensation technique, delivering the heated and plasticised gutta-percha using a carrier or using a cold lateral condensation technique. Delivering the gutta-percha by heating it, will result in a shrinkage of about 2% when it solidifies[2].

Using a cold lateral condensation technique is used by most dentist world wide, as this enables the practitioner to maintain control of the placement of the gutta-percha. Using a masterpoint and lateral points, the canal space will be filled. A disadvantage with this technique is is that at no time is a homogeneous mass of gutta-percha developed[3]. The final filling is composed of a large number of gutta-percha cones tightly pressed together and joined by frictional grip and cementing substance.

Compared with cold lateral condensation, a warm, vertical condensation technique can provide a homogenous mass of gutta-percha which in theory will provide a better seal[4]. This technique is also better at filling lateral canals than cold lateral condensation[5]. The disadvantage is that the length of the root canal filling is difficult to control, as it depends on the rate of insertion of the material[6]. One way of avoiding overextension of the material is to have an apical plug, in this case MTA was used. In a study by Wong et al.[7], they used weight a measurement of how much filling material they were able to insert into an artificial canal. The vertical technique was judged significantly better than lateral or mechanical in its ability to replicate the test canal. Lateral condensation was consistently judged poor or barely acceptable by all investigators. According to a meta-analysis by Peng et al.[8], there were no difference in long-term outcome between cold lateral condensation and wam gutta-percha. The only difference was that the prevalence of overextension in the warm GP group was significantly higher than that in the CLC group.

The anatomy of the second mandibular premolar, as with all other teeth, varies. In most studies, two or more canals are rare[9]. Table 2 shows a summery of studies on the number of canals of the second mandibular premolar.

Reference	Number of teeth	1 Root	2 Roots	3 Roots
Sert and Bayirti (2004)	100	100 %	-	-
Zaatar et al. (1997)	64	95.6%	4.7%	-
Calişkan et al. (1995)	100	100 %	-	-
Geider et al. (1989)	328	97.6%	2.4%	-
Vertucci (1978)	400	100 %	-	-
Zillich and Dowson (1973)	906	96.6%	-	0.4%
Visser (1948)	2089	99.85%	0.05%	0.1%
Barrett (1925)	32	100 %	-	-
Total	**4019**	**99.6%**	**0.3%**	**0.1%**

Table 2 - Number of roots in the second mandibular premolar.

Several studies[9] have looked at the number of canals, and they found one canal in 91-92%. Two or more canals were reported between 8.2-9% of the teeth. Other studies[10,11,12] have reported higher incidences of multiple canals in the second mandibular premolar. These studies report by the number of patients instead of reporting by the number of teeth, leading to a higher incidence. Cleghorn et al.[9] argues for that, unless the anomaly is 100% bilateral, counting patients will give a higher occurrence. Their

conclusion is that the incidence of more than 1 root, more than 1 canal, and more than 1 foramen is less frequent in the mandibular second premolar than in the mandibular first premolar, but numerous case reports cite many variations, and anomalies might occur.

References

1. Sjögren U, Hagglund B, Sundqvist G, Wing K. Factors affecting the long-term results of endodontic treatment. J Endod. 1990 Oct;16(10):498-504.

2. McElroy DL (1955) Physical properties of root canal filling materials. Journal of the American Dental Association 50, 433–40.

3. Schilder H. Filling root canals in three dimensions. Dent Clin North Am 1967;11:723-44.

4. S.D. Gilbert, D.E. Witherspoon and C.W. Berry, Coronal leakage following three obturation techniques, Int Endod J 34 (2001), pp. 293–299.

5. K. Clinton and T. Van Himel, Comparison of a warm gutta-percha obturation technique and lateral condensation, J Endod 27 (2001), pp. 692–695.

6. M.E. Levitan, V.T. Himel and J.B. Luckey, The effect of insertion rates on fill length and adaptation of a thermoplasticized gutta-percha technique, J Endod 29 (2003), pp. 505–508.

7. Wong M, Peters DD, Lorton L. Comparison of gutta-percha filling techniques, compaction (mechanical), vertical (warm), and lateral condensation techniques, Part 1. J Endod. Dec 1981; 7(12):551-8.

8. Peng L, Ye L, Tan H, Zhou X. Outcome of Root Canal Obturation by Warm Gutta-Percha versus Cold Lateral Condensation: A Meta-analysis. J Endod. 2007 Feb;33(2):106-9.

9. Cleghorn BM, Christie WH, Dong CC. The root and root canal morphology of the human mandibular second premolar: a literature review. J Endod. 2007 Sep;33(9):1031-7.

10. Trope M, Elfenbein L, Tronstad L. Mandibular premolars with more than one root canal in different race groups. J Endod. 1986 Aug;12(8):343-5.

11. Sabala CL, Benenati FW, Neas BR. Bilateral root or root canal aberrations in a dental school patient population. J Endod. 1994 Jan;20(1):38-42.

12. Amos ER. Incidence of bifurcated root canals in mandibular bicuspids. J Am Dent Assoc. 1955 Jan;50(1):70-1.

13. Friedman S. Expected Outcomes in the Prevention and treatment of Apical Periodontitis. In: Ørstavik D, Pitt Ford TR (eds). Essential

Endodontology: Prevention and Treatment of Apical Periodontitis, 2nd Ed Blackwell Munksgaard, Oxford 2008, pp 408-454.

14. Farzaneh M, Abitbol S, Friedman S. Treatment outcome in endodontics: the Toronto study. Phases I and II: Orthograde retreatment. J Endod. 2004 Sep;30(9):627-33.

Tables

Table 2 Cleghorn BM, Christie WH, Dong CC. The root and root canal morphology of the human mandibular second premolar: a literature review. J Endod. 2007 Sep;33(9):1031-7.

Apicoectomy of maxillary molar

Introduction

Fortyseven year old Norwegian male

Figure 1 - Frontal view.

Chief complaint

Non-contributory

Medical history

The patient had undergone a heart attack March 7th 2008.

Dental history

The patient had nonsurgical endodontic treatment done at the specialist clinic in 2008.

Clinical findings

Extra-oral examinaiton:

Non-contributory.

Intra-oral examination:

Tooth	25	26	27
Cold	-	-	+
Percussion	-	-	-
Palpation	-	-	-
Mobility	I	I	I
PPD	Normal	Normal	Normal

Table 1 - Clinical findings.

Soft tissue: within normal limits.

Dental:

Tooth 25: Cast post.

Tooth 26: M amalgam filling.
D amalgam filling.
O IRM temporary filling.

Tooth 27: MO amalgam filling.

Figure 2 - Intraoral view.

Radiographic findings:

April 14th 2009

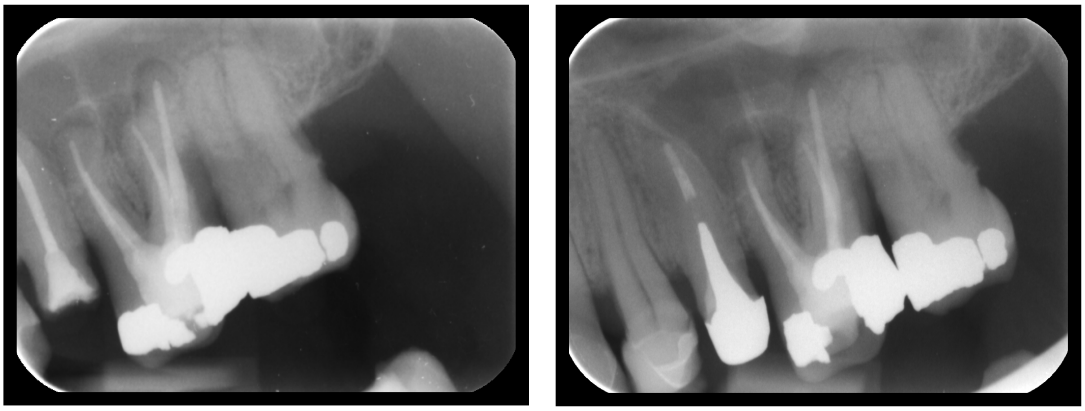


Figure 3: Final radiograph taken after endodontic treatment (right), and radiograph taken on the 1-year control (left).

Tooth: 27:

Normal lamina dura. PAI 1. Amalgam filling. Reduced height of the marginal bone level.

Tooth 26:

Widened lamina dura. PAI 4. IRM and amalgam fillings. Reduced height of the marginal bone level. Compared with the final radiograph taken after the endodontic treatment in 2008, the radiolucencies on the MB and DB roots had increased in size. The patient was informed of this, and consent to perform an apicoectomy was given.

Tooth 25:

Normal lamina dura. PAI 1. Cast post. Normal marginal bone level.

Diagnosis

Tooth 26:

Pulpal: Previously endodontically treated tooth (K04.19)

Apical: Chronic apical periodontitis (K04.5).

Marginal: Within normal limits.

Problem list

Vertical root fracture.

Moisture control.

Treatment plan

Tooth 26:

Apicoectomy of MB and DB root, placement of retrograde fillings.

Treatment

May 25th 2009

3 x 1.8ml Septocaine®. Marginal incision 15M-17D, with a vertical releasing incision 15M. Mobilised flap, located the lesion, there was already a small fenestration in the bone. Ostectomy, removal of the lesion. Apicoectomy of the MB and DB canal and retrograde preparation of the roots using ultrasonic instruments. Retrograde fillings of IRM were placed.

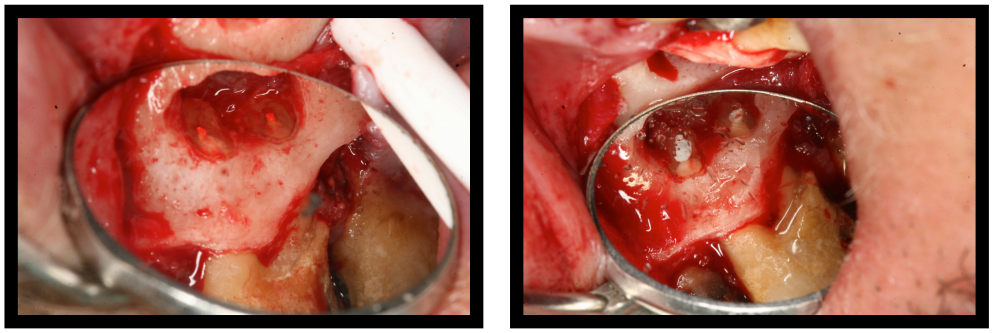


Figure 4 - Root resection and root-end filling

Figure 5 - Postoperative radiograph

June 10th 2009

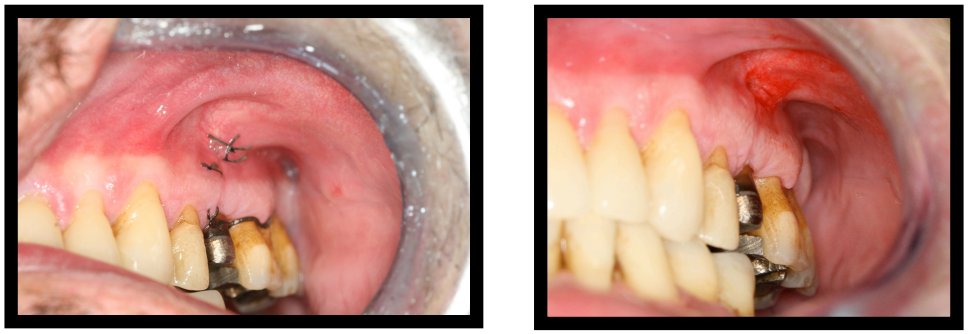


Figure 6 - Suture removal, one week after the surgery

Post-operative control and suture removal. The patient was asymptomatic.

Result

Evaluation

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

Prognosis

Endodontic: good.

Tooth: good, given that the tooth gets a crown.

Follow-up examination

April 22nd 2010

The patient is asymptomatic. A periapical lesion can still be seen on the MB root of tooth 26. Compared to the radiograph taken May 25th 2009, it it reduced in size.

Figure 7 - Follow-up radiograph.

Discussion

Endodontic surgery is preformed to salvage endodontically involved teeth that can not be satisfactory treated by conventional endodontic procedures.

Following the apicoectomy and visualization of the resected surface, two canals with a uniting isthmus are usually visible. It is therefore important to routinely prepare the isthmus to prevent coronal leakage, especially when the non-surgical root canal treatment fails to clean the canal system thoroughly[1]. Using surgical techniques, a resection of 3 mm is considered sufficient to eliminate apical pathology[4].

According to a study by Friedman[6], 37-91% of teeth that have undergone apical surgery can be expected to be healed. Up to 33% of the teeth can still be healing several years after the surgery. Importantly, 80-94% of teeth can remain in symptom-free function, even if they are not healed. Friedman recommends that apical surgery should be attempted when it is feasible, as the expected outcome of apical surgery is good, and the alternative would be extraction and possible replacement of the tooth.

After periradicular surgery, the ideal healing response is the re-establishment of an apical attachment apparatus and osseous repair. Histological studies have shown three types of tissue response[7]:

1. Healing with reformation of the periodontal ligament.

2. Healing with fibrous tissue (scar).

3. Moderate-to-severe inflammation without scar tissue.

The goal of a retrograde filling is to seal of an infected root canal causing periapical pathosis. Therefore, retrograde root canal fillings should be performed routinely during apical surgery regardless of the technical quality of the root canal obturation.

Different materials have been used as retrograde filling materials. The most important requirements for this kind of material is; easy manipulation and placement, dimensional stability, sealing ability, biocompatible and promote cementogenesis, insoluble, unaffected by moisture, bacteriostatic, radiopaque and not discolour[3].

Recent studies have shown that currently available root-end filling materials provide a good outcome[5]. Amalgam was widely used but research indicated that amalgam exhibits the greatest amount of leakage when compared with newer materials such as S-EBA and MTA[3]. Zinc oxide eugenol cements have been used extensively as retrograde materials. The two most widely accepted are IRM and Super EBA. These two materials are superior to amalgam. The success rates over a 10-year period were reported to be 95% for S-EBA, 91% for IRM, and 75% for amalgam. Both IRM and S-EBA exhibit similar and favourable properties and are clinically and histopathologically better than amalgam[9].

Chong and Pitt Ford[5] compared the success rate of IRM and MTA as root-end filling material in a randomized in vivo prospective study. When the numbers of teeth with complete and incomplete (scar) healing, and those with uncertain and unsatisfactory healing were combined, the success rate for MTA was higher (84% after 12 months, 92% after 24 months) compared with IRM (76% after 12 months, 87% after 24 months). Statistical analysis showed no significant difference in success between materials ($P > 0.05$) at 24 month. In an article by Chong and Pitt Ford, they emphasise that there is currently no «ideal» root-end filling material, but evidence points to ZOE cements, Diaket, MTA and Retroplast[8].

References

1. Degerness R, Bowles W. Anatomic Determination of the Mesiobuccal Root Resection Level in Maxillary Molars. J Endod. 2008 Oct;34(10):1182-6.

2. Stropko J, Doyon GE and Gutmann J. Root-end management: resection, cavity preparation, and material placement. Endodontic Topics 2005. 11(2); 131–151.

3. Wu MK, Kontakiotis EG, Wesselink PR. Long-term seal provided by some root-end filling materials.J Endod. 1998 Aug;24(8):557-60.

4. Kim S, Pecora G, Rubenstein RA. Osteotomy and apical root resection. In: Kim S, Pecora G, Rubenstein RA, eds. Color atlas of Microsurgery in Endodontics. Philadelphia: WB Saunders, 2001: 85–94.

5. Chong BS, Pitt Ford TR, Hudson MB. A prospective clinical study of Mineral Trioxide Aggregate and IRM when used as root-end filling materials in endodontic surgery. Int Endod J. 2009 May;42(5):414-20.

6. Shimon Friedman, The prognosis and expected outcome of apical surgery, Endodontic Topics 2005: 11(1); 219–262.

7. Andreasen JO Rud JO. Modes of healing histologically after endodontic surgery in 70 cases. Int J Oral Surg. 1972;1(3):148-60.

8. Chong BS, Pitt Ford TR. Root-end filling materials: rationale and tissue response. Endodontic Topics 2005; 11(1): 114–130.

9. Dorn SO, Gartner AH. Retrograde filling materials: a retrospective success-failure study of amalgam, EBA, and IRM. J Endod. 1990 Aug;16(8):391-3.

Persisting sinus tract - apicoectomy of mandibular premolar

Introduction

Sixtyone year old caucasian female

Figure 1 - Frontal view

Chief complaint

Tenderness to palpation, fistula.

Medical history

Non-contributory

Dental history

The referring dentist had started endodontic treatment on the tooth. After several changes of Ca(OH)2, the patient still had symptoms, along with a buccal fistula.

Clinical findings

Figure 2 - Occlusal view

Extra-oral examination:

Non-contributory

Intra-oral examination:

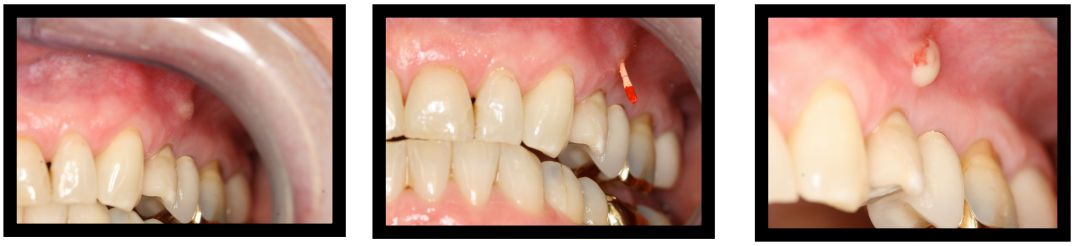


Figure 3 - Intraoral fistula

Tooth	23	24	25
Cold	+	-	+
Percussion	-	-	-
Palpation	-	+	-
Mobility	I	I	I
PPD	Normal	Normal	Normal

Table 1 - Clinical findings.

Soft tissue:

Fistula with pus excudate, tooth 24.

Dental:

Tooth 14: O IRM temporary filling.
OD composite filling.

Tooth 15: PFM crown.

Radiographic findings:

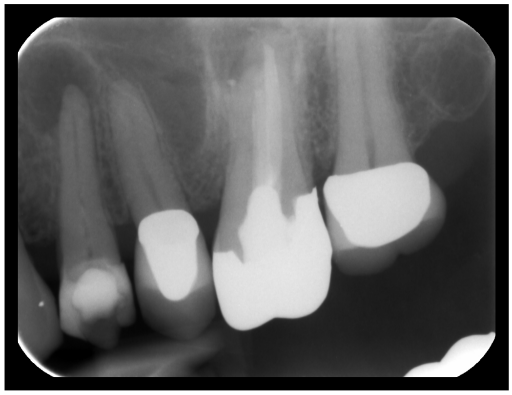


Figure 4 - Periapical radiograph

September 20th 2009

Tooth 24: Widened lamina dura. PAI 4. Composite filling and IRM temporary filling. Normal marginal bone level.

Tooth 25: Normal lamina dura. PAI 1. PFM crown.

Tooth 26: Widened lamina dura. PAI 3. Morrison crown. Root filled tooth.

Diagnosis

Tooth 24:

Pulpal: Necrotic (K04.1)

Apical: Chronic apical periodontitis (K04.5).

Marginal: Within normal limits.

Problem list

Persisting infection.

Treatment plan

Tooth 24:

Non-surgical endodontic treatment.

Treatment

September 20th 2009

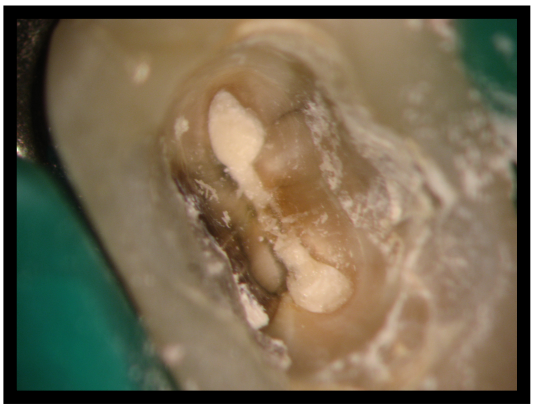
Clinical examination. Tooth diagnosed with necrotic pulp. 1.8 ml Septocaine®. Rubber dam. Removal of the IRM filling. Removal of the Ca(OH)2-paste placed by referring dentist. The lengths of the canals were determined using by apex locator (Root ZX®) and

periapical radiographs. Root canal preparation was done mechanically using NiTi hand files and BioRace® files to size:

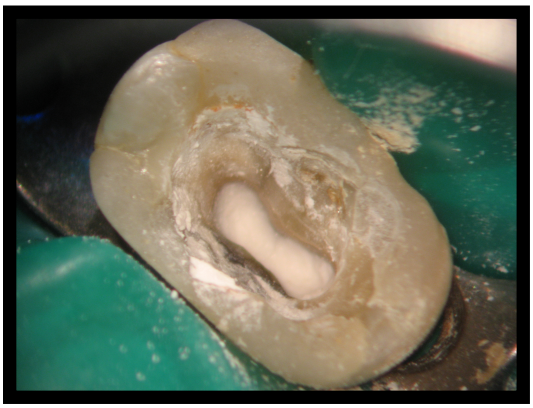
B canal: R40 /19,5 mm/ B-cusp

P canal: R40 / 17 mm/ P-cusp

1% NaOCl and 17% EDTA were used for chemical root disinfection. The canals were dried with paper points and filled with $Ca(OH)_2$ using a lentulo needle. An IRM restoration was placed on top.



Ca(OH)2 placed by referring dentist.



Ca(OH)2 placed by the candidate.

Figure 5 - Intracoronal view.

November 11th 2009

The patient was asymptomatic, but the fistula had not closed. It was decided, after informing the patient of the prognosis, to first fill the tooth, and then perform an apicoectomy on the tooth. 1.8ml Septocaine®. Rubber dam. Removal of the IRM filling. The $Ca(OH_2$ was removed using hand files and NaOCl and EDTA. The canals were dried using paper points, and filled using gutta-percha and AH+ sealer. After removal of the root filling material surplus, the access cavity was sealed with an IRM restoration.

December 9th 2009

1.8ml Septocaine®. Marginal incision 23M-27M, with a vertical releasing incision 23M, 7mm. Mobilised flap, located the lesion, there was already a fenestration in the bone. The lesion was cleaned, apicoectomy and retrograde preparation of the rot with ultrasonic instruments. A retrograde filling of white MTA was placed. The root was inspected under a dental operating microscope, but no fractures were found. 6 sutures were placed, and a new appointment a week later was scheduled.

December 16th 2009

Suture removal, the patient was asymptomatic. The fistula had closed. The operating area had healed well. The patient was informed of the apical lucency on tooth 26. After consulting with the patient and the referring dentist, approval was given to treat this tooth. A new appointment was scheduled.

Figure 6 - Final radiograph.

Result

Evaluation

The fistula did not close when using a non-surgical-approach, therefore a surgical approach was decided. After the surgery, the fistula closed. No complications during neither the non-surgical or the surgical treatment. The root filling and the retrograde filling appeared dense and good.

Prognosis

Endodontic: good.

Tooth: good.

Follow-up examination

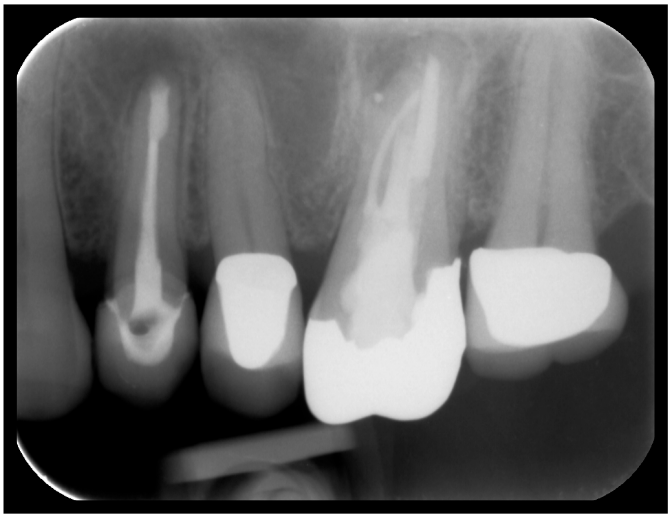


Figure 7 - Follow-up radiograph.

April 24th 2010

Healing can be seen on tooth 24, although not complete. The patient was asymptomatic, and was in the process of getting a crown on the tooth.

Discussion

Endodontic treatment of teeth in the presence of apical periodontitis has a success rate 10–25% lower than when it is not present preoperatively[1]. Chugal[2] studied 200 teeth with 441 root canals. She found that teeth with chronic apical periodontitis had the lowest success rate (63,8%) Roots with a diseased periapex had a 4.35 times greater risk of failure than roots with normal periapex, and larger lesions had a higher risk of failure than smaller lesions. In a classic study by Sjøgren et al.[11] the authors found a higher risk of failure in teeth with periapical lesions. A success rate of 86% of teeth with necrotic pulps and periapical lesions was found. One study[13] has reported a better outcome in teeth with lesions smaller than 5mm. If the lesion is larger than 10mm, more healing by scar tissue occurs[14,15]. Friedman[12] has looked at several studies and their proportion of healed teeth. His conclusion is that the chance of teeth with periapical periodontitis to heal completely after nonsurgical endodontic treatment is 73-86%. He further writes that if a tooth should need an apicoectomy, its prognosis would be better if the root canal has been retreated. The chance of complete healing after surgical endodontics is between 60-78% [12].

Studies have shown that bacteria that cause apical periodontitis can also be found in the periapical tissues[3,4,5,6]. Extraradicular infection is characterized by microbial infection of the inflamed periradicular tissues, and is almost invariably a sequel to the intraradicular infection[10]. In an article by Sunde et al.[7], they found that when proper endodontic treatment is ineffective, microorganisms are commonly recovered from

the periapical lesion and seemingly are able to maintain an infectious disease process extraradicularly. This view is not shared by everyone[8,9], arguing that the sampling procedure causes contamination. Siqueira[10] found that these infections can be depended on, or independent of intraradicular infection.

Apical actinomycosis is the most common form of extraradicular infection independent of the intraradicular infection, and is caused by the Actinomyces species or P.propionicum[10]. Apical actinomycosis is only successfully treated by periradicular surgery.

References

1. Trope M, Debelian G. Endodontic treatment of apical periodontitis. In: Ørstavik D, Pitt Ford TR (eds). Essential Endodontology: Prevention and Treatment of Apical Periodontitis, 2nd Ed Blackwell Munksgaard, Oxford 2008, pp 347-371.

2. Chugal NM, Clive JM, Spångberg LS. A prognostic model for assessment of the outcome of endodontic treatment: effect of biologic and diagnostic variables. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2001 Mar;91 (3):342-52.

3. Happonen RP, Söderling E, Viander M, Linko-Kettunen L, Pelliniemi LJ. Immunocytochemical demonstration of Actinomyces species and Arachnia propionica in periapical infections. J Oral Pathol. 1985 May;14(5):405-13.

4. Tronstad L, Barnett F, Riso K, Slots J. Extraradicular endodontic infections. Endod Dent Traumatol. 1987 Apr;3(2):86-90.

5. Siqueira JF Jr. Endodontic infections: concepts, paradigms, and perspectives. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2002 Sep;94(3):281-93.

6. Tronstad L, Sunde PT. The evolving new understanding of endodontic infections. Endod Topics 2003: 6(1); 57–77

7. Sunde PT, Olsen I, Lind PO, Tronstad L. Extraradicular infection: a methodological study. Endod Dent Traumatol. 2000. Apr;16(2):84-90.

8. Nair R, Sjögren U, Krey G, Kahnberg K-E, Sundqvist G. Intraradicular bacteria and fungi in root-filled, asymptomatic human teeth with therapy-resistant periapical lesions: a long term light and electron microscopic follow-up study. J Endod. 1990 Dec;16(12):580-8.

9. Nair PNR. Apical periodontitis: a dynamic encounter between root canal infection and host response. Periodontol 2000. 1997 Feb;13:121-48.

10. Siqueira JF Jr. Microbiology of Apical Periodontitis. In: Ørstavik D, Pitt Ford TR (eds). Essential Endodontology: Prevention and Treatment of Apical Periodontitis, 2nd Ed Blackwell Munksgaard, Oxford 2008, pp 135-183.

11. Sjögren U, Hägglund B, Sundqvist G, Wing K. Factors affecting the long-term results of endodontic treatment. J Endod. 1990 Oct;16(10):498-504.

12. Friedman S. Expected Outcomes in the Prevention and treatment of Apical Periodontitis. In: Ørstavik D, Pitt Ford TR (eds). Essential Endodontology: Prevention and Treatment of Apical Periodontitis, 2nd Ed Blackwell Munksgaard, Oxford 2008, pp 408-454.

13. Wang N, Knight K, Dao T, Friedman S. Treatment outcome in endodontics – The Toronto study. Phases I and II: apical surgery. J Endod. 2004 Nov;30 (11):751-61.

14. Grung B, Molven O, Halse A. Periapical surgery in a Norwegian county hospital: follow-up findings of 477 teeth. J Endod. 1990 Sep;16(9):411-7.

15. Molven O, Halse A, Grung B. Surgical management of endodontic failures: indications and treatment results. Int Dent J. 1991 Feb;41(1):33-42.

Vertical root fracture

Introduction

Forty year old caucasian female

Figure 1 - Frontal view

Chief complaint

Pain from her lower right side when chewing.

Medical history

Non-contributory

Dental history

The patient had undergone endodontic treatment 8 months ago at a private clinic. Six months later, the patient suddenly felt pain when chewing from her lower right side. The radiologic examination revealed nothing pathologic, but the clinical examination revealed a deep pocket along the mesial root. The patient was referred to the specialist clinic for an explorative surgery of the tooth, after being informed of the heightened risk of root fracture to the remaining root (should it be decided to remove the mesial root).

Clinical findings

Figure 2 - Occlusal view

Figure 3 - Pocket depth measuring.

Extra-oral examination:

Non-contributory

Intra-oral examination:

Tooth	47	46	45
Cold	+	-	+
Percussion	-	+	-
Palpation	-	+	-
Mobility	I	I	I
PPD	Normal	15 mm	Normal

Table 1 - Clinical findings.

Soft tissue:

Deep periodontal pocket buccal to tooth 46.

Dental:

Tooth 47: MO amalgam filling.

Tooth 46: PFM crown.

Tooth 45: No treatment done.

Radiographic findings:

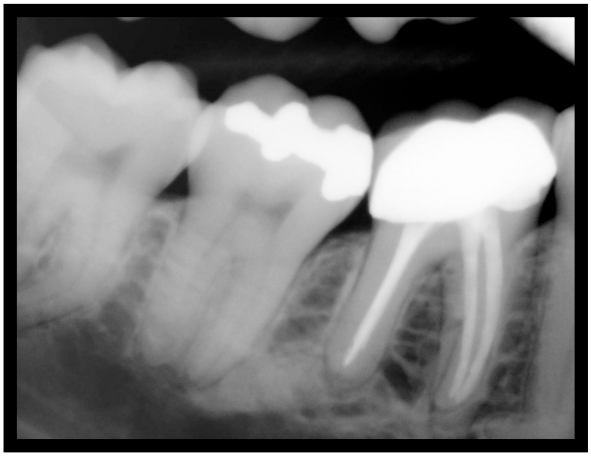


Figure 4 - Radiograph taken on December 16th 2010.

December 16th 2010

Tooth 47: Normal lamina dura. PAI 1. MO amalgam filling.

Tooth 46: Normal lamina dura. PAI 1. Root filled tooth. PFM crown.

Diagnosis

Tooth 46:

Pulpal: Previously root-filled tooth (K04.1).

Apical: Healthy apical periodontium.(K04.b).

Marginal: Possible vertical root fracture along the mesial root of tooth 46.

Treatment plan

Tooth 46:

Explorative surgery to inspect the mesial root.

Treatment

December 16th 2009

Clinical examination. Septocaine® 3 x 1.8 ml. Marginal incision from the distal aspect of tooth 47 to the mesial aspect tooth 45. Elevation of the mucoperiost to explore the area. No buccal bone along the entire length of the root. Staining the root with methylene-blue revealed no fractures on the surface of the root. After consulting the specialist, it was decided to remove the mesial root.

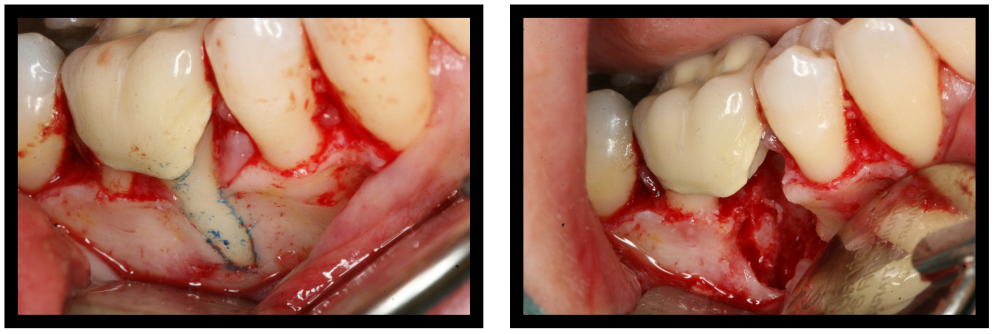


Figure 5 - Hemisection of the mesial root

Suturing was done using three 4-0 Supramid® sutures. Post-operative instructions.

December 22nd 2009

Post-operative control. The patient was asymptomatic. Removal of three sutures.

Result

Figure 6 - Postoperative radiograph.

Evaluation

No complications during the surgery. Evidence of good soft tissue healing. The patient became asymptomatic.

Prognosis

Endodontic: Good.

Tooth: Uncertain. There is a heightened risk of root fractures with only one root instead of two. The patient was informed of this risk before the surgery, but she wanted to try to keep the tooth for as long as possible.

Discussion

Endodontic treatment of teeth without apical periodontitis have an excellent prognosis, ranging from 93-97% [1,2,3].

In this case, the patent was asymptomatic for several months, before the sudden onset of pain. In molar teeth, a vertical root fracture is most commonly bucco-lingually in orientation in individual roots[5]. A vertical root fracture is located apically on the root and may extend coronally toward the cervical periodontal attachement. According to Moule et al.[6], teeth with vertical root fractures have a varied clinical presentation, with a long history of variable discomfort or soreness. A deep, narrow, isolated periodontal pocket is a common feature. This is different than in teeth with a periodontal disease, where the pocketing is fairly consistent in depth around a larger part of the tooth. In an article by Tamse[7], the most fractured teeth and roots are the maxillary and mandibular premolars and the mesial roots of mandibular molars.

According to an AAE compendium[4, figure 7], the vertical root fracture may mimic periodontal disease. Their recommendation is to minimise root dentin removal, avoid wedging posts, reduce condensation forces, and us carbon fibre posts. In this case, the tooth had been prepared with the BioRace rotary file system to a size #40 with a .04 taper. Some studies have shown that enlargement of the root canal can lead to a in increase in the risk of root fractures when obturating using a finger spreader for lateral condensation[8,9].

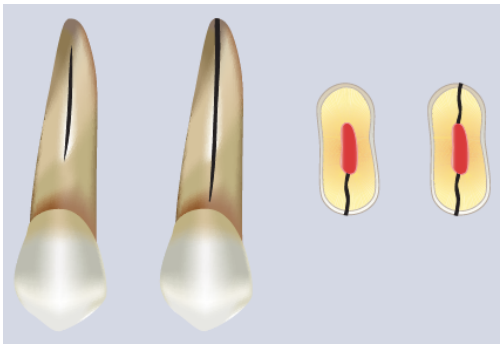


Figure 7:
Facial view of a vertical root fracture, a horizontal cross-section of a VRF affecting only the lingual root surface, and a horizontal cross section of a VRF affecting both the buccal and the lingual root surfaces; root canal-filling material is shown in the canal space.

The treatment of teeth with vertical root fractures is extraction or removal of the affected root. Multirooted teeth can often be successfully treated by resecting the fractured root, either by root amputation or hemisection[10,11].

An alternative to performing a root resection, is to extract the tooth and have either a bridge or implant inserted. In a retrospective, nonrandomized study, Zafiropoulos et al[12] compared root resected mandibular molars to implants. They found a higher rate of complications with teeth that were root resected, but almost 70% of these teeth remained complication free for an average of 5 years.

Fugazzotto[13] compared 701 root resected molars to 1472 molar implants. Some of these were followed for over 15 years. He found almost the same cumulative success rate for both groups. For root resected mandibular first molars, the success rate was 96.8%.

Bühler[14] evaluated root resected teeth after 10 years. Of 28 teeth, 9 of them failed. The different reasons for the failures can be seen in table 2.

Reasons for failure	Number of teeth failed	Failure percentage
Root fracture	1	3,6 %
Periodontal	2	7,1 %
Periodontal and endodontic	2	7,1 %
Endodontic	3	10,7 %
Loss of retention	1	3,6 %
Total	9	32,1 %

Table 2 - Results from Bühler.

References

1. Kerekes K and Tronstad L. Long-term results of endodontic treatment preformed with a standardized technique. J Endod. 1979 Mar;5(3):83-90.

2. Sjøgren U, Hagglund RP, Sundquist G and Wing K. Factors affecting the long-term results of endodontic treatment. J Endod. 1990 Oct;16(10): 498-504.

3. Marquis V, Dao T, Farzaneh M, Abitbol S and Friedman S. Treatment outcome in endodontics: The Toronto study. Phase III: Initial treatment. J Endod. 2006 Apr;32(4):299-306.

4. AAE Colleagues for Excellence. Summer 2008. Cracking the Cracked Tooth Code: Detection and Treatment of Various Longitudinal Tooth Fractures.

5. Holcomb JQ, Pitts DL, Nicholls JI. Further investigation of spreader loads required to cause vertical root fracture during lateral condensation. J Endod. 1987 Jun;13(6):277-84.

6. Moule AJ, Kahler B. Diagnosis and management of teeth with vertical root fractures. Aust Dent J. 1999 Jun;44(2):75-87.

7. Tamse A. Vertical root fractures in endodontically treated teeth: diagnostic signs and clinical management. Endodontic Topics 2006: 13 (1); 84–94.

8. Meister F Jr, Lommel TJ, Gerstein H. Diagnosis and possible causes of vertical root fractures. Oral Surg Oral Med Oral Pathol. 1980 Mar;49(3): 243-53.

9. Tamse A. Iatrogenic vertical root fractures in endodontically treated teeth. Endod Dent Traumatol. 1988 Oct;4(5):190-6.

10. Morfis AS. Vertical root fractures. Oral Surg Oral Med Oral Pathol. 1990 May;69(5):631-5.

11. Bergenholtz G, Hasselgren G. Endodontics and periodontics. In Lindhe J, Karring K, Lang NP. (eds) Clinical Periodontology and Implant Dentistry. 4th ed. 2003, Munksgaard, Copenhagen; pp. 318 - 351.

12. Zafiropoulos GG, Hoffmann O, Kasaj A, Willershausen B, Deli G, Tatakis DN. Mandibular molar root resection versus implant therapy: a retrospective nonrandomized study. J Oral Implantol. 2009;35(2):52-62.

13. Fugazzotto PA. A comparison of the success of root resected molars and molar position implants in function in a private practice: results of up to 15-plus years. J Periodontol. 2001 Aug;72(8):1113-23.

14. Bühler H. Evaluation of root-resected teeth. Results after 10 years. J Periodontol. 1988 Dec;59(12):805-10.

Tables:

Table 2: Bühler H. Evaluation of root-resected teeth. Results after 10 years. J Periodontol. 1988 Dec;59(12):805-10.

Figures:

Figure 7: AAE Colleagues for Excellence. Summer 2008. Cracking the Cracked Tooth Code: Detection and Treatment of Various Longitudinal Tooth Fractures.

Apicoectomies in the maxillary front

Introduction

Sixtysix year old caucasian female

Figure 1 - Frontal view

Chief complaint

Non-contributory.

Medical history

One tablet of Albyl-E (75mg) each day.

Dental history

The patient had undergone endodontic reatreatment of tooth 22 and 23 in October 2009 at the student clinic. She was then referred to the specalist clinic for apicoectomy of tooth 11 and 21.

Clinical findings

Figure 2 - Occlusal view.

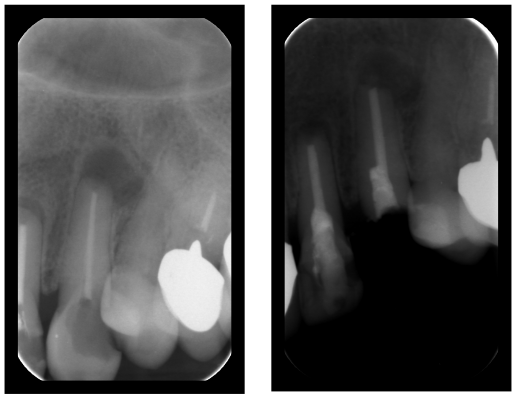


Figure 3 - Retreatment of teeth 22 and 23.

Extra-oral examination:

Non-contributory

Intra-oral examination:

Non-contributory

Tooth	12	11	21	22	23
Cold	-	-	-	-	-
Percussion	-	-	-	-	-
Palpation	-	-	-	-	-
Mobility	I	I	I	I	I
PPD	Normal	Normal	Normal	Normal	Normal

Table 1 - Clinical findings.

Soft tissue:

Non-contributory

Dental:

Tooth 12: PFM crown. P composite filling.
Tooth 11: PFM crown.
Tooth 21: PFM crown.
Tooth 22: P IRM filling.
Tooth 23: PFM crown.

Radiographic findings:

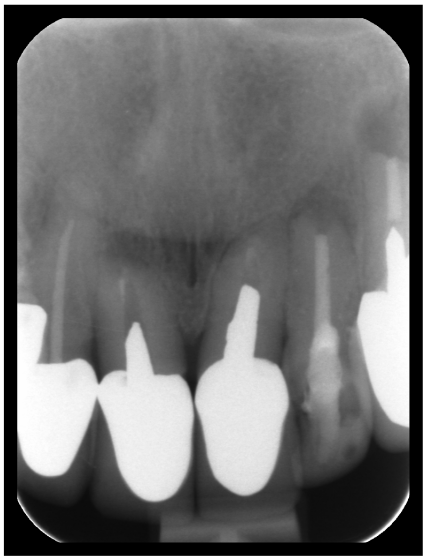


Figure 4 - Periapical radiograph.

February 3rd 2010

Tooth 13: Normal lamina dura. PAI 1.

Tooth 12: Root filled tooth. Normal lamina dura. PAI 1.

Tooth 11: Post in the canal. Widened lamina dura. PAI 3.

Tooth 21: Post in the canal. Widened lamina dura. PAI 3

Tooth 22: Root filled tooth. Widened lamina dura. PAI 4.

Tooth 23: Root filled tooth. Widened lamina dura. PAI 4.

Diagnosis

Tooth 11:

Pulpal: Previously root-filled tooth (K04.1)

Apical: Chronic apical periodontitis (K04.5).

Marginal: Within normal limits.

Tooth 21:

Pulpal: Previously root-filled tooth (K04.1)

Apical: Chronic apical periodontitis (K04.5).

Marginal: Within normal limits.

Tooth 22:

Pulpal: Previously root-filled tooth (K04.1)

Apical: Chronic apical periodontitis (K04.5).

Marginal: Within normal limits.

Tooth 23:

Pulpal: Previously root-filled tooth (K04.1)

Apical: Chronic apical periodontitis (K04.5).

Marginal: Within normal limits.

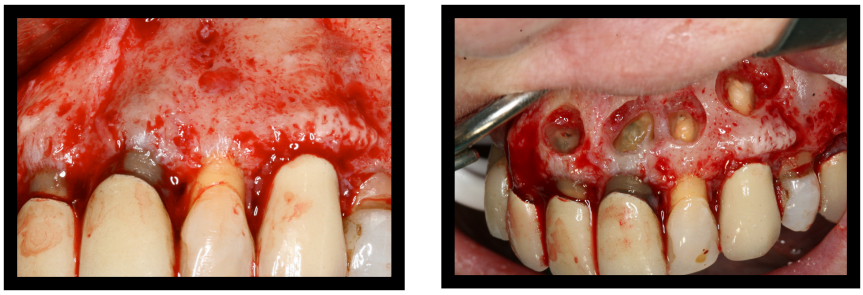
Treatment plan

When comparing the radiographs from October 2009, no healing could be observed apically on tooth 22 and 23. It was decided to perform apicoectomies on teeth 11 and 21. In addition, tooth 22 and 23 would be examined during the surgery, and apicoectomies on these teeth would be performed in addition if it was seen necessary. The patient was informed of this prior to the surgery.

Treatment

October 29th 2009

Clinical examination. 4 x 1.8 ml Septocaine®. Marginal incision 14D-25D with a vertical releasing incision on 14D. Elevation of the mucoperiostal flap. Pathological fenestrations of the buccal cortical bone could be seen on teeth 22 and 23, and it was decided to perform apicoectomies on these two teeth in addition to tooth 11 and 21. Osteotomy. Curettage of granulation tissue. Root-end resection. White MTA (ProRoot® MTA) was applied as retrograde filling material. The operation site was inspected and carefully rinsed with sterile saline. Suturing with nine 4-0 Supramid® sutures. Post-operative instructions.



Buccal fenestrations Ostectomies

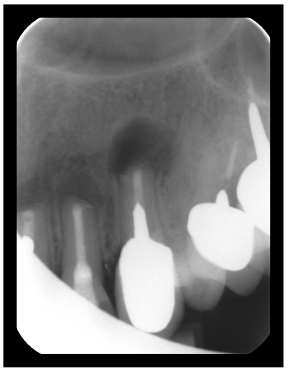
Figure 5 - Photos taken during surgery

Flap sutured

Figure 6 - Sutures

Before treatment.

After retrograde preparation.



After retrograde filling.

Figure 7 - Radiographs of the treatment.

February 10th 2010

Suture removal. The patient was asymptomatic.

Result

Evaluation

The retrograde root fillings appeared dense and good. No complications during the treatment. Gingival recession could be seen in the maxillary front, an unwanted result.

Before (top) and after (bottom) treatment

Figure 8 - Gingival retraction

Prognosis

Endodontic: good.

Tooth: good.

Follow-up examination

April 13th 2010

The patient was asymptomatic. Healing could be seen on the teeth involved. The patient was in the process of having new PFM crowns made on her central incisors.

Figure 9 - Follow-up radiograph taken April 13th 2010.

Discussion

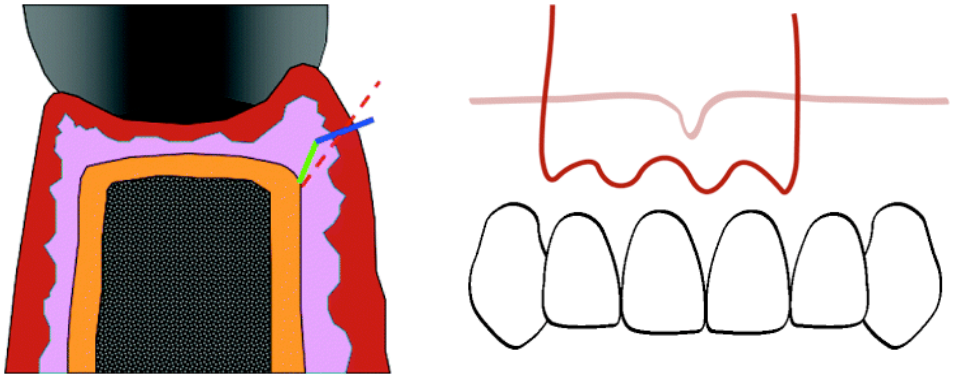
If nonsurgical endodontic treatment fails, and the infection persists, an operator has two options. Either retreatment or surgical treatment of the tooth. In this case, two of the teeth had already been retreated at the student clinic, without the desired result. No healing was observed within six months on either of the teeth. The other teeth both had posts, and a retreatment was not an option without removing the crowns and posts of the teeth.

Endodontic surgery is performed to resolve inflammatory processes that cannot be treated by conventional techniques[4]. When performing apical surgery on teeth, the operator will get an immediate access to the root apex. In the apical part of the root frequently contains infected canal ramifications, lateral canals and isthmuses[1,2,3]. The surgical intervention aims to remove the infected root-end and seal any remaining bacteria in the root canal system from the periradicual tissues. After the root-end has been removed, a retrograde filling must be placed to seal any remaining bacteria in the root canal system from the periradical tissues. The importance of having a root-end filling after a root-end resection was recently demonstrated in a RCT, where MTA was compared to burnishing of the GP[6]. The purpose of the root-end filling material is to fill the apical canal space and achieve a seal, preventing access to periapical tissues by microbial products from the root canal system, thus allowing tissue repair to occur. The root-end filling material should be biocompatible, easy to use, radio opaque, adhesive, antibacterial, insoluble, and unaffected by moisture[7].

At the Department of Endodontics, University of Oslo, the materials used as root-end filling materials are IRM or MTA. Both of these materials have the properties described above.

In addition to removing the bacteria when performing periapical surgery, one should also try to preserve the periodontal conditions as they were before the surgery. This can be achieved by using surgical techniques developed for the preservation for these structures. Velvart[8] developed the papilla-based incision in order to prevent loss of the interdental papilla height. When performing the papilla-based incision, the papilla remains untouched, thus eliminating any substantial loss of height. When comparing the sulcular full-thickness flap with the papilla base flap, Velvart found marked recession of the papilla in the sulcular full-thickness flap group[9].

Another technique to avoid gingival recession is the submarginal incision, introduced by Luebke[11]. Using this incision, a minimum of 2 mm of attached gingiva is necessary to maintain a stable position of the gingival margin[10]. If this it not achieved, deprivation of blood supply and necrosis can follow, leading to a major recession.



Papilla-based incision Submarginal flap

Figure 9 - Incisions

In this case, either the papilla-based incision or the submarginal incision would have been the best choice. Unfortunately, because of the lengths of the roots, the submarginal incision was not an option. The incision chosen was the «standard» marginal incision which unfortunately led to gingival recession.

References

1. Molven O, Halse H, Grung B. Surgical management of endodontic failures: indications and treatment results. Int Dent J. 1991 Feb;41(1):33-42.

2. Von Arx T. Frequency and type of canal isthmuses in first molars detected by endoscopic inspection during periradicular surgery. Int Endod J. 2005 Mar;38(3):160-8.

3. Weller RN, Niemczyk SP, Kim S. Incidence and position of the canal isthmus. Part 1. Mesiobuccal root of the maxillary first molar. J Endod. 1995 Jul;21 (7):380-3.

4. Lin LM, Pascon EA, Skribner J, Gängler P, Langeland K. Clinical, radiographic, and histologic study of endodontic treatment failures. Oral Surg Oral Med Oral Pathol. 1991 May;71(5):603-11.

5. Wada M, Takase T, Nakanuma K, Arisue K, Nagahama F, Yamazaki M. Clinical study of refractory apical periodontitis treated by apicoectomy Part 1. Root canal morphology of resected apex. Int Endod J. 1998 Jan;31(1):53-6.

6. Christiansen R, Kirkevang LL, Hørsted-Bindslev P, Wenzel A. Randomized clinical trial of root-end resection followed by root-end filling with mineral trioxide aggregate or smoothing of the orthograde gutta-percha root filling--1-year follow-up. Int Endod J. 2009 Feb;42(2):105-14.

7. Pitt Ford TR. Surgical treatment of apical periodontitis. In: Ørstavik D, Pitt Ford TR (eds). Essential Endodontology: Prevention and Treatment of Apical Periodontitis, 2nd Ed Blackwell Munksgaard, Oxford 2008, pp 381-401.

8. Velvart P. Papilla base incision: a new approach to recession-free healing of the interdental papilla after endodontic surgery. Int Endod J. 2002 May;35 (5):453-60.

9. Velvart P, Ebner-Zimmermann U, Ebner JP. Comparison of papilla healing following sulcular full-thickness flap and papilla base flap in endodontic surgery. Int Endod J. 2003 Oct;36(10):653-9.

10. Lang NP Löe H. The relationship between the width of keratinized gingiva and gingival health. J Periodontol. 1972 Oct;43(10):623-7.

11. Luebke RG. Surgical endodontics. Dent Clin North Am. 1974 Apr;18(2): 379-91.

Figures:

Figure 9: Velvart P. Papilla base incision: a new approach to recession-free healing of the interdental papilla after endodontic surgery. Int Endod J. 2002 May;35(5):453-60.

Maxillary premolar with radicular cyst

Introduction

Fortyeight year old female of Persian decent.

Figure 1 - Frontal view.

Chief complaint

None.

Medical history

None.

Dental history

The patient had undergone endodontic treatment of teeth 24 and 25 in Iran several years ago. She was referred to the specialist clinic for endodontic retreatment of these teeth.

Clinical findings

Figure 2 - Occlusal view

Extra-oral examination:

Non-contributory

Intra-oral examination:

Non-contributory

Tooth	23	24	25	26
Cold	+	-	-	+
Percussion	-	+	+	-
Palpation	-	-	-	-
Mobility	I	I	I	I
PPD	Normal	Normal	Normal	Normal

Table 1 - Clinical findings.

Soft tissue:

Non-contributory

Dental:

Tooth 24: MOD composite filling.

Tooth 25: OD amalgam filling.
MO composite filling.

Figure 3 - occlusal view.

Radiographic findings:

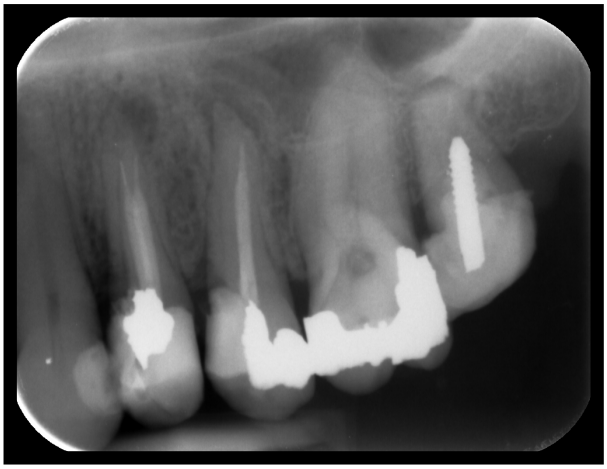


Figure 4 - Periapical radiograph.

April 2nd 2009

Tooth 23: D composite filling. Normal lamina dura. PAI 1.

Tooth 24: MOD composite filling. Amalgam filling. Root filled tooth. Widened lamina dura. PAI 3.

Tooth 25: MO composite filling. OD amalgam filling. Root filled tooth. Widened lamina dura. PAI 4.

Tooth 26: MOD amalgam filling. Normal lamina dura. PAI 1.

Tooth 27: MOD composite filling. Post in tooth. Widened lamina dura. PAI 3.

Diagnosis

Tooth 24:

Pulpal: Previously root-filled tooth (K04.1)

Apical: Chronic apical periodontitis (K04.5).

Marginal: Within normal limits.

Tooth 25:

Pulpal: Previously root-filled tooth (K04.1)

Apical: Chronic apical periodontitis (K04.5).

Marginal: Within normal limits.

Treatment plan

Nonsurgical endodontic treatment of teeth 24 and 25.

Treatment

Tooth 25:

April 2nd 2009

Clinical examination. 1.8 ml Septocaine®. Preparation of the entrance cavity. Rubber dam. Localized an extra canal.Prepared the canals using Gates-Glidden burs and hand files. The lengths of the canal was determined using by apex locator (Root ZX®) and periapical radiographs. 1% NaOCl and 17% EDTA were used for chemical root disinfection. The canals were dried with paper points and filled with a $Ca(OH)_2$-paste. An IRM restoration was placed on top.

May 5th 2009

The patient was asymptomatic. 1.8ml Septocaine®. Rubber dam. Removal of the IRM filling. The $Ca(OH)_2$ was removed using hand files, NaOCl and EDTA. 2%. The canals were dried using paper points and filled with guttapercha and AH+ sealer. The access cavity was sealed with an IRM restoration.

Tooth 24

June 2nd 2009

Clinical examination. 1.8 ml Septocaine®. Preparation of the entrance cavity. Rubber dam. Localized an extra canal.Prepared the canals using Gates-Glidden burs, ultrasonic instruments and hand files . The lengths of the canal was determined using by apex locator (Root ZX®) and periapical radiographs. 1% NaOCl and 17% EDTA were used for chemical root disinfection. The canals were dried with paper points and filled with a $Ca(OH)_2$-paste. An IRM restoration was placed on top.

August 25th 2009

Comparing the x-rays taken in June, the radiolucency on tooth 24 had grown in size. After consulting one of the specialists, it was decided to perform an apicoectomy of tooth 24.

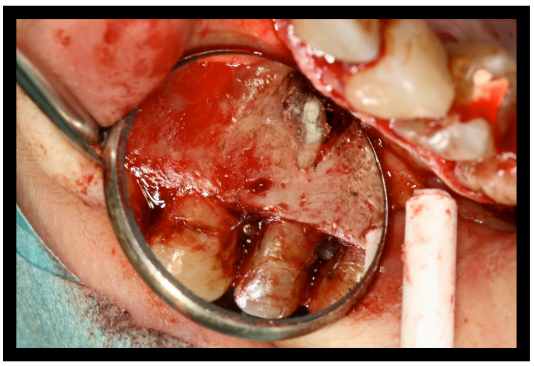
The patient was asymptomatic. 1.8ml Septocaine®. Rubber dam. Removal of the IRM filling. The $Ca(OH)_2$ was removed using hand files, NaOCl and EDTA. 2%. The canals were dried using paper points and filled with guttapercha and AH+ sealer. The access cavity was sealed with an IRM restoration.

Figure 5 - After nonsurgical treatment

August 26th 2009

Clinical examination. 4 x 1.8 ml Septocaine®. Marginal incision 26D-22M with a vertical releasing incision on 22M. Elevation of the mucoperiostal flap. Pathological fenestrations of the buccal cortical bone was observed in relation to tooth 24. Osteotomy. Curettage of granulation tissue. A tissue sample was taken for biopsy. Root-end resection. White MTA (ProRoot® MTA) was applied as retrograde filling material. The operation site was inspected and carefully rinsed with sterile saline. Suturing with seven 4-0 Supramid® sutures. Post-operative instructions.

Buccal fenestration



Retrograde filling

Figure 6 - Photos taken during the surgery.

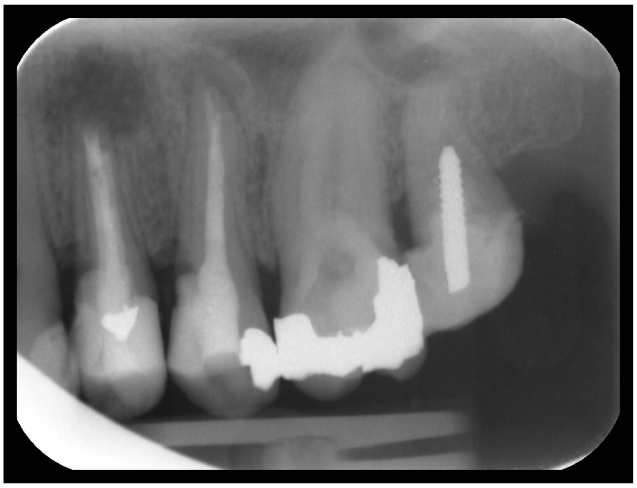


Figure 7 - Retrograde filling on tooth 24.

September 2nd 2009

Post-operative control and suture removal. The patient was asymptomatic.

Result

Evaluation

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

Biopsy result:

The result of the biopsy taken from tooth 24 showed that the periapical lesion was a radicular cyst.

Prognosis

Endodontic: good.

Tooth: good.

Follow-up examination

December 15th 2009

The patient was asymptomatic. Healing could be seen on both teeth.

Figure 8 - Follow-up examination

Discussion

In this case, it was discussed whether to perform an apicoectomy on both teeth, or to just perform an apicoectomy on tooth 24. In this case, only tooth 24 was treated surgically, since the periapical lesion on that tooth had increased in size. The lesion on tooth 25 was more or less unchanged, 3 months after the nonsurgical endodontic treatment had been completed. At the follow-up examination, the healing on tooth 25 was evident. A biopsy was taken during the surgery of tooth 24, and it revealed a radicular cyst. According to Nair[7], the recorded incidence of among apical periodontitis varies from 6-55% (table 2). He further writes that «histopathological diagnostic laboratories and publications based on retrospective reviewing of such histopathological reports sustain the notion that nearly half of all apical periodontitis are cysts».

When possible, periapical surgery to a tooth should be avoided if there is a chance that the lesion will heal by a nonsurgical treatment. Conventionally, periradicular surgery is less often the first choice of treatment in non healing periradicular pathosis. Surgery may be undertaken after unsuccessful retreatment or when retreatment is impossible or has an unfavourable prognosis[4.] Some studies have shown root canal treatments and retreatments to have a better outcome than surgery[1]. Others have found no difference / no statistical difference when comparing the long-term success rate of these two techniques[2,3]. In a study by Sjögren et al., only 62% of retreated teeth with periapical pathosis healed[4]. Tooth 25 did not have an adequate root canal filling, as only one of the root canals had been filled. Friedman writes that «in teeth with apical periodontitis undergoing retreatment, the apparent quality of the previous root canal filling may be considered as a significant outcome predictor»[6].

Non-surgical treatment in conjunction with surgical treatment may have a better outcome than either procedure alone because all possible sites of infection are treated[5].

Reference	Cysts (%)	Granuloma (%)	Others (%)	Total lesions (*n*)
Sommer *et al.* (1966)	6	84	10	170
Block *et al.* (1976)	6	94	–	230
Sonnabend & Oh (1966)	7	93	–	237
Winstock (1980)	8	83	9	9804
Linenberg *et al.* (1964)	9	80	11	110
Wais (1958)	14	84	2	50
Patterson *et al.* (1964)	14	84	2	501
Nair *et al.* (1996)	15	50	35	256
Simon (1980)	17	77	6	35
Stockdale & Chandler (1988)	17	77	6	1108
Lin *et al.* (1991)	19	–	81	150
Nobuhara & Del Rio (1993)	22	59	19	150
Baumann & Rossman (1956)	26	74	–	121
Mortensen *et al.* (1970)	41	59	–	396
Bhaskar (1966)	42	48	10	2308
Spatafore *et al.* (1990)	42	52	6	1659
Lalonde & Luebke (1968)	44	45	11	800
Seltzer *et al.* (1967)	51	45	4	87
Priebe *et al.* (1954)	55	45	–	101

Table 2 - The incidence of radicular cysts among apical periodontitis lesions.

References

1. Allen RK, Newton CW, Brown CE. A statistical analysis of surgical and nonsurgical endodontic retreatment cases. J Endod. 1989 Jun;15(6): 261-6.

2. Kvist T, Reit C. Results of endodontic retreatment: a randomized clinical study comparing surgical and nonsurgical procedures.J Endod. 1999 Dec; 25(12):814-7.

3. Danin J, Strömberg T, Forsgren H, Linder LE, Ramsköld LO. Clinical management of nonhealing periradicular pathosis. Surgery versus endodontic retreatment. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1996 Aug;82(2):213-7.

4. Sjögren U, Hagglund B, Sundqvist G, Wing K (1990) Factors affecting the long-term results of endodontic treatment.J Endod. 1990 Oct;16(10): 498-504.

5. Molven O, Halse A, Grung B (1991) Surgical management of endodontic failures: indications and treatment results.Int Dent J. 1991 Feb;41(1): 33-42.

6. Friedman S. Expected Outcomes in the Prevention and treatment of Apical Periodontitis. In: Ørstavik D, Pitt Ford TR (eds). Essential Endodontology: Prevention and Treatment of Apical Periodontitis, 2nd Ed Blackwell Munksgaard, Oxford 2008, pp 408-454.

7. Nair PN. On the causes of persistent apical periodontitis: a review. Int Endod J. 2006 Apr;39(4):249-81.

Tables

Apicoectomy on a medically compromised patient

Introduction

Eightysix year old caucasian male.

Figure 1 - Frontal view.

Chief complaint

None.

Medical history

The patient had recently been hospitalised, and given intravenous antibiotics for six weeks.. He was diagnosed with acute and subacute infectious endocarditis, ICD-10: I33.0.

Dental history

The patient has a PFM bridge in his second quadrant, from tooth 23 to 26. This had been made over 10 years ago (according to his regular dentist). The referring doctors suspect the teeth as possible foci of infection, and the patient was referred to the specialist clinic for treatment of this PFM bridge.

Clinical findings

Figure 2 - Occlusal view.

Extra-oral examination:

Non-contributory

Intra-oral examination:

Tooth 26 has a deep, broad palatial pocket which extends to the apex of the tooth.

Tooth	23	26
Cold	-	-
Percussion	-	-
Palpation	-	-
Mobility	I	I
PPD	Normal	10 mm

Table 1 - Clinical findings.

Soft tissue:

Non-contributory

Dental:

Tooth 23: Abutment in a PFM bridge.

Tooth 26: Abutment in a PFM bridge.

Radiographic findings:

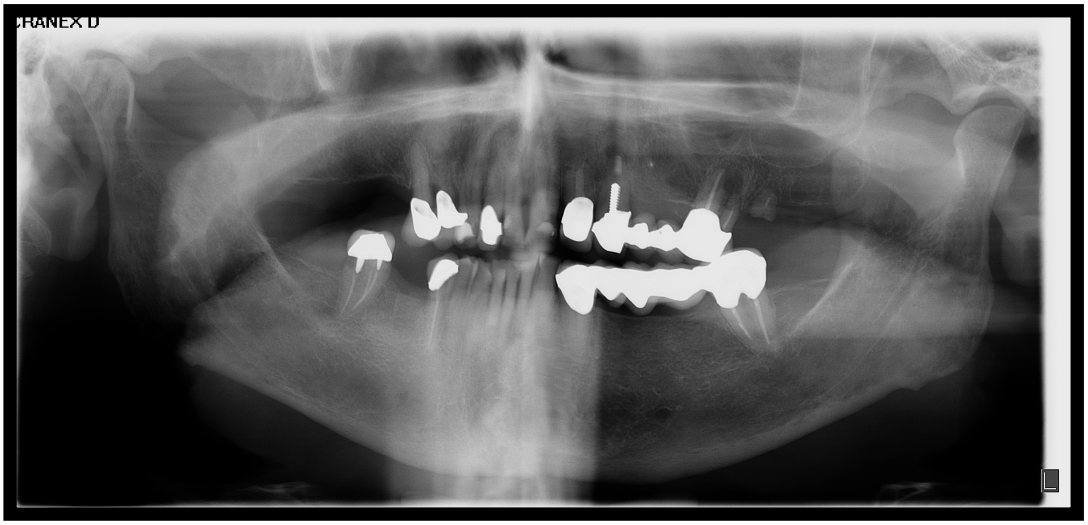


Figure 3 - OPG radiograph taken at the TAKO centre

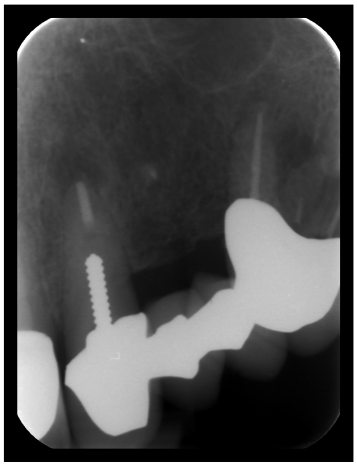


Figure 4 - Periapical radiograph

November 4th 2009

Tooth 23: Abutment. Previously root-filled tooth. Post in canal. Widened lamina dura. PAI 4.

Tooth 26: Abutment. Previously root-filled tooth. Widened lamina dura. PAI 4.

Diagnosis

Tooth 23:

Pulpal: Previously root-filled tooth (K04.1)

Apical: Chronic apical periodontitis (K04.5).

Marginal: Within normal limits.

Tooth 26:

Pulpal: Previously root-filled tooth (K04.1)

Apical: Chronic apical periodontitis (K04.5).

Marginal: Within normal limits, with the exception of the palatal pocket.

Treatment plan

Apicoectomy of tooth 23.

Split the PFM bridge distally for tooth 23.

Extraction of tooth 26 + root fragment distally.

Treatment

November 4th 2009

The patient was instructed to take antibiotics (Amoxicillin, 2g) one hour prior to the surgery. Clinical examination. 4 x 1.8 ml Septocaine®. Marginal incision 26-22M with a vertical releasing incision on 22M. Elevation of the mucoperiostal flap. Osteotomy. Curettage of granulation tissue. Root-end resection. Retrograde preparation using ultrasonic instruments. White MTA (ProRoot® MTA) was applied as retrograde filling material. The operation site was inspected and carefully rinsed with sterile saline. Suturing using eight 4-0 Supramid® sutures. Post-operative instructions.

November 10th 2009

Post-operative control and suture removal. The patient was asymptomatic.

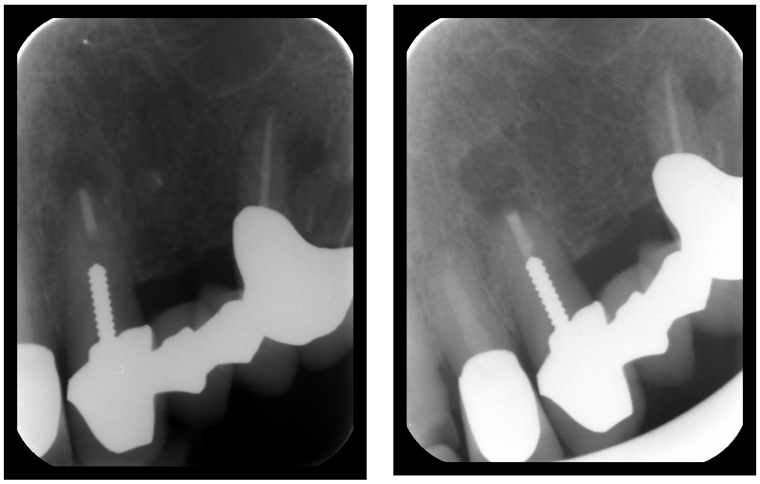


Figure 5 - Pre- and postoperative radiographs.

Result

Evaluation

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

At the time of surgery, the patient did not want to remove tooth 26 He was informed that the tooth had a bad prognosis, and that the best treatment would be to have this extracted during the surgery. He wanted to some time to think before the extraction, and would contact his regular dentist for further treatment.

Prognosis

Endodontic: good.

Tooth: good.

Follow-up examination

February 24th 2010

The patient was asymptomatic. He had made an appointment with a dentist in Iceland to replace the bridge in the second quadrant with implants. Radiographically, healing could be observed, although not complete healing.

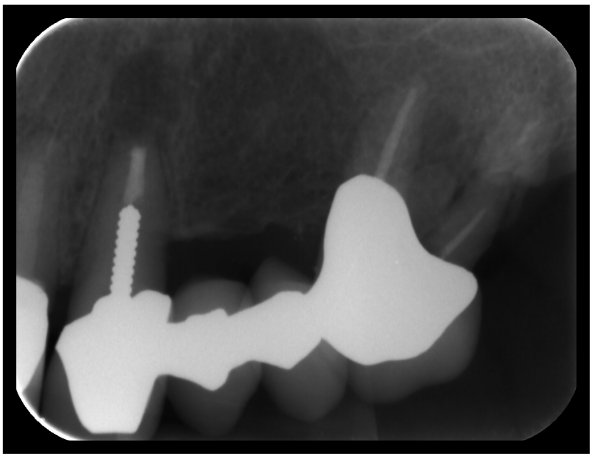


Figure 6 - Follow-up examination.

Follow-up examination #2

The patient was contacted for a second follow-up examination. He told the dentist that the tooth had been extracted, as it «did not have any bone left on the buccal side of the tooth», as the Icelandic dentist had informed him. One can only speculate why this had happened, but a root fracture can be suspected.

Discussion

Infective endocarditis is a form of endocarditis caused by infectious agents. The agents are usually bacterial, but other organisms can also be responsible[1]. The pathogenesis is that bacteria, most often streptococci, adhere to non-bacterial thrombotic vegetations. This leads to a shift from a non-bacterial thrombotic endocarditis to an infective endocarditis. An infected vegetation can embolize, decrease cardiac output or induce congestive cardiac failure[2].

In 2008, the American Heart Association updated their recommendations for the prevention of infective endocarditis[3]. Their conclusions are:

a. Only an extremely small number of cases of IE might be prevented by antibiotic prophylaxis for dental procedures even if such prophylactic therapy were 100 percent effective.

b. IE prophylaxis for dental procedures should be recommended only for patients with underlying cardiac conditions associated with the highest risk of adverse outcome from IE.

c. For patients with these underlying cardiac conditions, prophylaxis is recommended for all dental procedures that involve manipulation of gingival tissue or the periapical region of teeth or perforation of the oral mucosa.

d. Prophylaxis is not recommended based solely on an increased lifetime risk of acquisition of IE.

e. Administration of antibiotics solely to prevent endocarditis is not recommended for patients who undergo a genitourinary or gastrointestinal tract procedure.

This patient had a history of endocarditis, for which he had previously been hospitalised. This would put the patient in the group of patients described above, under section b. The routine at the Department of Endodontics when treating these patients is to prescribe either 2 grams of Amoxicillin or 600mg of Clindamycin, depending on whether the patient has an allergy to penicillin or not.

However, in a study by the Cochrane Library[4], the authors found no evidence on the effect of penicillin to prevent bacterial endocarditis in patients who are at risk and who are to undergo an invasive dental procedure. Their recommendation is that «ethically practitioners need to discuss the potential benefits and harms of antibiotic prophylaxis with their patients before a decision is made about administration.»

In this case, leaving tooth 23 as a single abutment on the bridge was not something the operator wished to do, but the patient insisted on keeping the bridge. The preferred treatment would have been to have 26 removed. tooth 23 had a post placed. In a study by Trope et al[5], they found that the preparation of a post space would significantly weaken the resistance of the teeth to fracture (table 2). Their conclusion was that a post preparation would weaken the tooth, and strengthen it.

Groups of teeth, 8 teeth in each group.	Post-preparation	Mean resistance to fracture (lbs).
Group 1	No	318.1
Group 2	No	326.5
Group 3	No	333.8
Group 4	Yes	182.1
Group 5	Yes	201.1
Group 6	Yes	264
Group 7	Yes	295
Group 8	Yes	269

Table 2 - After Trope et al.

References

1. Wikipedia. Infective endocarditis.

2. da Silva RM. Antibiotic Prophylaxis for Dental Treatment of Patients with Cardio-vascular Disease: When and Why? 2006. University of Oslo.

3. Wilson W, Taubert KA, Gewitz M, Lockhart PB, Baddour LM, Levison M, Bolger A, Cabell CH, Takahashi M, Baltimore RS, Newburger JW, Strom BL, Tani LY, Gerber M, Bonow RO, Pallasch T, Shulman ST, Rowley AH, Burns JC, Ferrieri P, Gardner T, Goff D, Durack DT; American Heart Association. Prevention of infective endocarditis: guidelines from the American Heart Association: a guideline from the American Heart Association Rheumatic Fever, Endocarditis and Kawasaki Disease Committee, Council on Cardiovascular Disease in the Young, and the Council on Clinical Cardiology, Council on Cardiovascular Surgery and Anesthesia, and the Quality of Care and Outcomes Research Interdisciplinary Working Group. J Am Dent Assoc. 2008 Jan;139 Suppl:3S-24S.

4. Oliver R, Roberts GJ, Hooper L, Worthington HV. Antibiotics for the prophylaxis of bacterial endocarditis in dentistry. Cochrane Database of Systematic Reviews 2008, Issue 4.

5. Trope M, Maltz DO, Tronstad L. Resistance to fracture of restored endodontically treated teeth. Endod Dent Traumatol. 1985 Jun;1(3):108-11.

Tables:

Table 2 Trope M, Maltz DO, Tronstad L. Resistance to fracture of restored endodontically treated teeth. Endod Dent Traumatol. 1985 Jun;(3):108-11.

Surgical crown lengthening of two maxillary canines

Introduction

Sixtythree year old caucasian female.

Figure 1 - Frontal view.

Chief complaint

23 was tender to percussion.

Medical history

Non-contributory.

Dental history

The patient was referred to the specialist clinic from the Department of Prosthodontics for treatment of tooth 13 and 23. The patient was being treated at their specialist clinic, and was scheduled to have a bridge in maxillary front remade.

Clinical findings

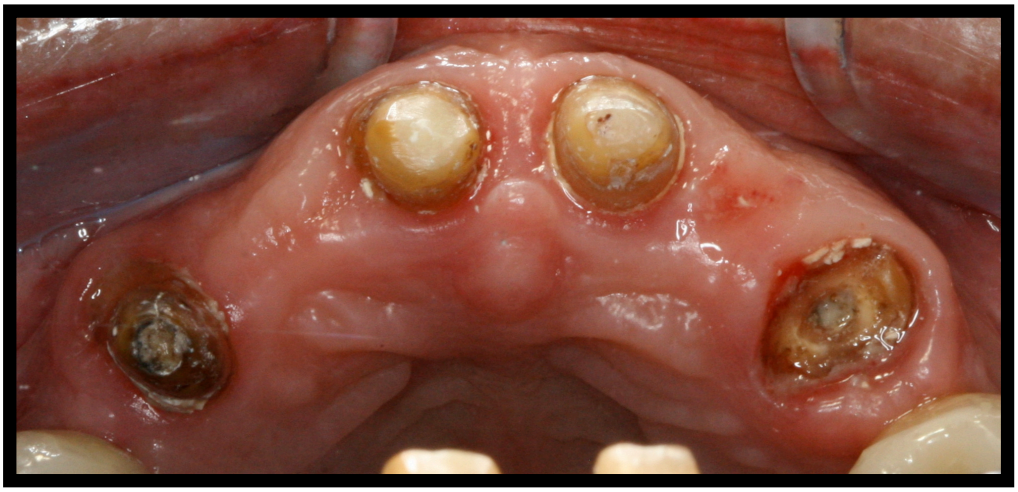


Figure 2 - Occlusal view - PFM removed

Figure 3 - Frontal view - PFM bridge removed

Extra-oral examination:

Non-contributory

Intra-oral examination:

Fractured tooth 13.

Tooth	11	21	23
Cold	-	-	+
Percussion	-	-	+
Palpation	-	-	-
Mobility	I	I	I
PPD	Normal	Normal	Normal

Table 1 - Clinical findings.

Soft tissue:

Non-contributory

Dental:

Tooth 13: Exposed root canal filling.

Tooth 11: I composite filling.

Tooth 21: I composite filling.

Radiographic findings:

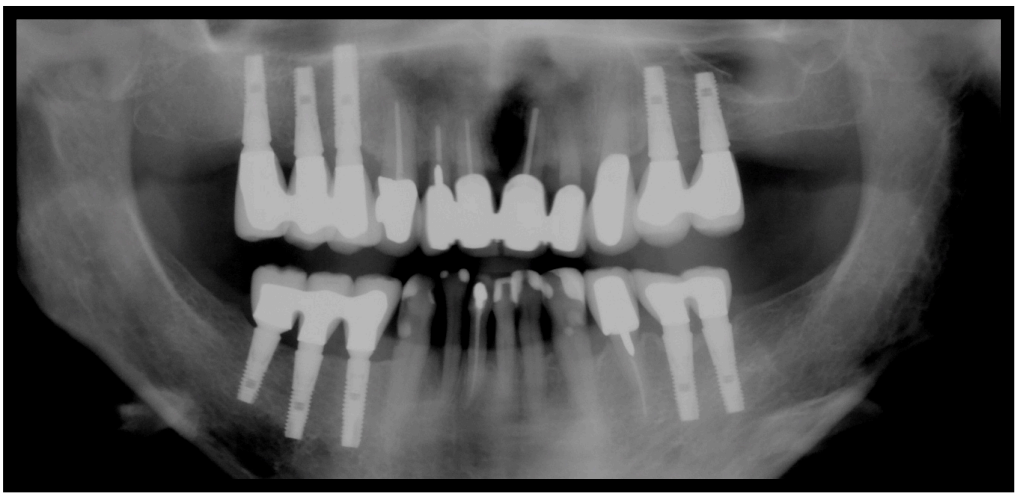


Figure 4 - OPG radiograph taken at the Departement of Prosthodontics in 2007.

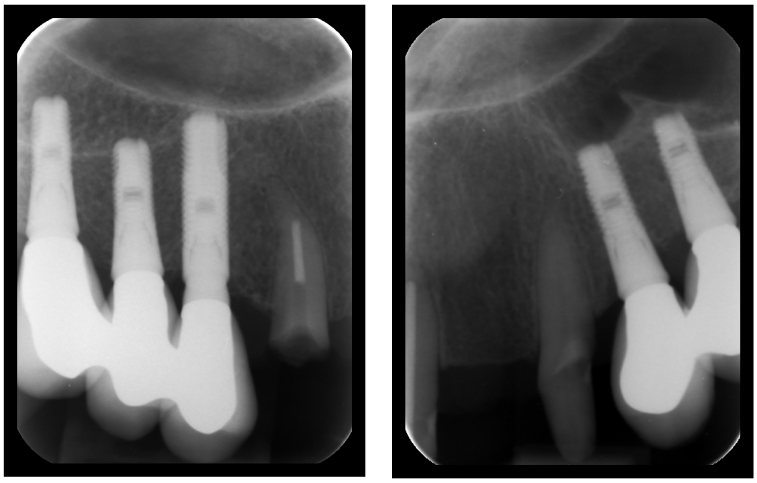


Figure 5 - Periapical radiographs

February 7th 2008

Tooth 13: Previously endodontically treated tooth. Normal lamina dura. PAI 1.

Tooth 23: Sound tooth. Prepared as an abutment for a bridge. Normal lamina dura. PAI 1.

Diagnosis

Tooth 13:

Pulpal: Previously root-filled tooth (K04.)

Apical: Within normal limits.

Marginal: Within normal limits.

Tooth 23:

Pulpal: Chronic irreversible pulpitis (K04.0)

Apical: Within normal limits.

Marginal: Within normal limits.

Treatment plan

Nonsurgical endodontic retreatment of teeth 13, 23.

Surgical crown lengthening of teeth 13,23.

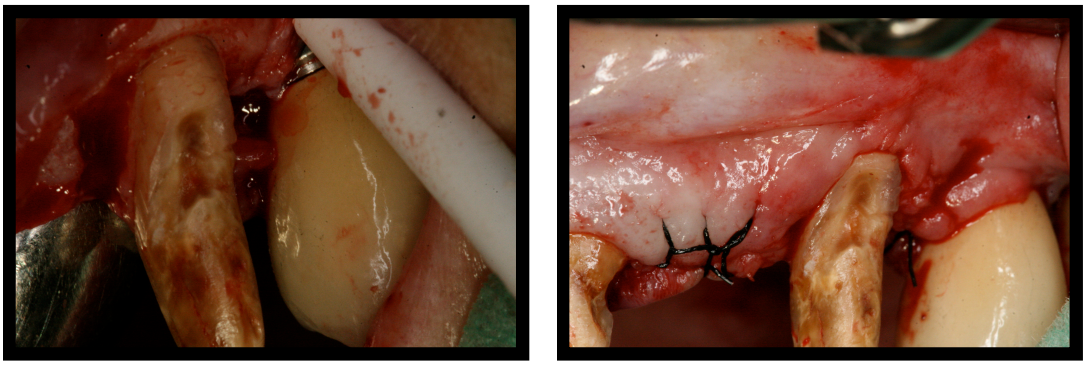
Treatment

February 7th 2008

Clinical examination. 1.8 ml Citanest Octapressin®. Preparation of the entrance cavity. Rubber dam. Prepared the canal using Gates-Glidden burs and hand-files. The length of the canal was determined using by apex locator (Root ZX®) and periapical radiographs. 1% NaOCl and 17% EDTA were used for chemical root disinfection. The canal was dried with paper points and filled with gutta-percha and AH+ sealer. An IRM restoration was placed on top.

May 28th 2008

The patient was asymptomatic. 4x 1.8ml Citanest Octapressin®. Marginal incision 23 with a distal releasing incision. Elevation of the mucoperiostal flap. Osteotomy around tooth 23. Repositioned the flap. Suturing with 3 4-0 Supramid® sutures.



Crown lengthening After suturing

Figure 6 - Photos taken during crown-lengthening procedure of tooth 23.

June 11th 2008

The patient was asymptomatic. Suture removal.

September 23rd 2008

Clinical examination. 1.8 ml Citanest Octapressin®. Preparation of the entrance cavity. Rubber dam. Prepared the canals using Gates-Glidden burs and hand files. The length of the canal was determined using by apex locator (Root ZX®) and periapical radiographs. 1% NaOCl and 17% EDTA were used for chemical root disinfection. Chloroform was used to remove the old root canal filling. The canals were dried with paper points and filled with a $Ca(OH)_2$-paste. An IRM restoration was placed on top

October 23rd 2008

The patient was asymptomatic. 1.8ml Citanest Octapressin®. Rubber dam. Removal of the IRM filling. The $Ca(OH)_2$ was removed using hand files, NaOCl and EDTA. The canals were dried using paper points. The canal was filled with guttapercha and AH+ sealer. $Ca(OH)_2$-paste was placed between the root filling and IRM filling. The access cavity was sealed with an IRM restoration.

October 21st 2008

The patient was asymptomatic. 4x 1.8ml Citanest Octapressin®. Marginal incision 13 with a distal releasing incision. Elevation of the mucoperiostal flap. Osteotomy around tooth 13. Repositioned the flap. Suturing with 2 4-0 Supramid® sutures.

June 11th 2008

The patient was asymptomatic. Suture removal.

Result

Figure 7 - Frontal view after crown-lengthening.

Evaluation

The root-fillings appeared dense and good. No complications during the treatment. Removal of bone around teeth 13 and 23 made it possible for the specialist candidate in prosthodontics to prepare the teeth properly.

In tooth 13, it was not possible to negotiate the root canal completely, as the old root canal filling / treatment had made a step. It was decided not to try to negotiate this canal any further, as there was no periapical lesions, and it was important not to weaken the root.

Prognosis

Endodontic: good.

Teeth: good.

Follow-up examination

Figure 8 - Frontal view after placement of PFM bridge.

April 8th 2010:

The PFM bridge had been fitted. The patient was satisfied with the result.

Discussion

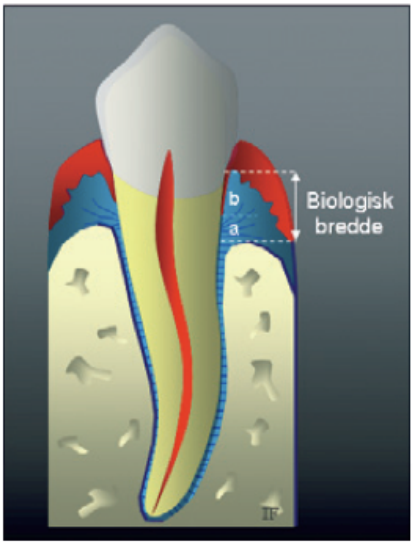


Figure 1 - Biologic width (a+b)

Surgical lengthening of the tooth is performed before prosthetic treatments to increase the retention of restorations in where the clinical crowns are too short[1].

In a study from 1961, the authors found that the gingival biological width (figure 1)(biologic membrane, dentogingival attachment) is the area of gingiva attached to the surface of the tooth coronary from the alveolar bone . It is the width necessary for gingiva to attach to the tooth[4]. Other studies found the same results, and stated that the mean value of the gingival biological width is 2mm, and that the value of connective tissue attachement is almost constant[5]. Because it is impossible to perfectly restore a tooth to the precise coronal edge of the junctional epithelium, the roughly 1 mm depth of the sulcus is often included together with the biologic width when leaving a certain amount of tooth structure remaining, thus establishing a margin of safety[7].

In time, bad quality restorations will alter periodontal tissues. Direct or indirect restorations with margins located within the gingival biological width area could induce gingival inflammation, loss of connective tissue attachment and unpredictable bone loss. Clinically it could be manifested as gingival bleeding, periodontal pocket formation or gingival retraction. Valderhaug found that in teeth whose crown margins were placed sub-gingivally, an increase in the gingival index scores were seen[9].

Several studies have studied the importance of keeping this 2mm distance to prevent gingival retraction and bone loss[2,3]. If the distance is less, the gingival biologic width would be altered. Bone resorption may sometimes take place to create the space for gingival attachment between the restoration and alveolar bone. In a study by Bräger et al., it was shown that after six weeks, the attachment level and probing depth did not change. The level of marginal gingiva established during the operation was almost the same as the marginal gingiva after healing. They found that between six weeks and six months, there were no or minimal changes of the marginal gingiva level in 85% of the cases[6].

The advantage of performing a surgical crown lengthening is that the following prosthetic preparation can be performed supragingivally, as the retention has already been secured prior to the preparation. Surgical crown lengthening makes it possible to secure healthy gingival margins after the restauration has been finished[8].

References

1. Planciunas L, Puriene A, Mackevicienem G. Surgical lengthening of the clinical tooth crown. Stomatologija. 2006;8(3):88-95.

2. Tal H, Soldinger M, Dreiangel A, Pitaru S. Periodontal response to long-term abuse of the gingival attachment by supracrestal amalgam restoratiotions.J Clin Periodontol. 1989 Nov;16(10):654-9.

3. Günay H, Seeger A, Tschernitschek H, Geurtsen W. Placement of the prepartion line and periodontal health-a prospective 2- year clinical study. Int J Periodontics Restorative Dent. 2000 Apr;20(2):171-81.

4. Gargiulo AW, Wentz F, Orban B. Dimensions and relations of the dentogingival junction in humans. J Periodontol 1961; 32: 261-7.

5. Vacek JS, Gerhr ME, Asad DA, Richardson AC, Giambarresi LI. The dimensions of the human dentogingival junction. Int J Periodontics Restorative Dent. 1994 Apr;14(2):154-65.

6. Brägger U, Launchenauer D, Lang NP. Surgical crown lengthening of the clinical crown. J Clin Periodontol. 1992 Jan;19(1):58-63.

7. Wikipedia; «Crown lengthening».

8. Byberg R, Wathne Å, Nesse H, Leknes KN. Crown lengthening – when is this a necessary pre-prosthetic therapy. Nor Tannlegeforen Tid 2008; 118: 368–74.

9. Valderhaug J, Birkeland JM. Periodontal conditions in patients 5 years following insertion of fixed prostheses. Pocket depth and loss of attachment. J Oral Rehabil. 1976 Jul;3(3):237-43.

Figures:

Figure 1 Byberg R, Wathne Å, Nesse H, Leknes KN. Crown lengthening – when is this a necessary pre-prosthetic therapy Nor Tannlegeforen Tid 2008; 118: 368–74.