

Endodontic Therapy of a Fractured Right Maxillary Canine Tooth in a Cat Using Engine Driven Rotary Instrumentation

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Introduction:

Crown fractures that result in pulp exposure occur commonly in veterinary practice. Patients with fractured teeth may be asymptomatic ¹, or they may exhibit one of many different clinical signs including but not limited to drooling, depression, difficulty chewing or eating, rubbing or pawing at the face, excessive licking and sneezing ² Therapy for such fractures should be aimed at retaining tooth structure and providing a reasonable prognosis for success while utilizing procedures that are minimally invasive. Endodontic therapy can achieve these goals. When the pulp cavity is exposed by crown fracture the pulp will eventually undergo necrosis if left untreated. Progression to periapical abscess, radicular cysts, granulomas, fistulas, osteomyelitis, pathologic fractures, periodontal disease and tooth loss are possible ³ The aim of endodontic therapy is to treat or prevent these conditions and involves removing the pulp, cleaning and shaping the root canal, sealing the canal and subsequently filling it with a semi-solid material followed by access restoration. ⁴ Case selection relies heavily on dental radiography. The size of the pulp cavity, apical continuity, root fractures, occluded canals and alterations in the root structure should be evaluated. ⁵ The experienced clinician can then make decisions based upon this evaluation regarding the best approach to endodontic therapy.

Traditionally hand instrumentation has been utilized for cleaning and shaping canals in veterinary medicine. Mechanical filing systems are also now being used by veterinarians for this purpose. The following is a case report describing the endodontic treatment of a fractured maxillary right canine tooth with pulp exposure in a 10 year old Himalayan cat using engine driven rotary instrumentation.

History:

A ten-year old 4.5 kilogram, male neutered Himalayan cat presented for oral radiography in November 2001 following the discovery of a fractured maxillary right canine tooth (104) during an annual physical examination one week prior. Dental cleaning had been performed at age eight. No other relevant history existed.

Diagnostics:

Physical examination of the patient demonstrated that it was within normal limits. Oral examination revealed a gingivitis index of I, a calculus index of II, and a plaque index of I.⁶ A Stage 4 Class 6 fracture of tooth 104 was present.⁷ The crown of the maxillary left third incisor tooth (203) appeared fractured and the space between tooth 203 and the maxillary left second incisor (202) was widened.(Figure 1)



(Figure 1)

The fractured cusp of the maxillary right canine tooth can be seen. There is an increase in the diastema between the maxillary left third incisor (203) and the maxillary left second incisor (202). Abnormal gingiva can be seen mesial to tooth 203.

Pre-anesthetic testing included a complete blood count, serum chemistry profile, urinalysis, T4 and EKG. EKG^a readings showed a normal sinus rhythm, normal complexes and a heart rate

of 196. CBC, serum chemistry profile and urinalysis were normal. Mucous membrane color, capillary refill time, pulse and chest auscultation were all within normal limits.

Butorphanol^b (1.25 mg IM) was given thirty minutes pre-operatively to aid in pre-emptive and postoperative pain relief. A twenty-two gauge intravenous catheter^c was placed in the right medial saphenous vein. General anesthesia was induced with ketamine^d (22 mg IV) and valium^e (0.9 mg IV). The patient was intubated with a 4.0 mm cuffed endotracheal tube^f and the cuff was inflated gently. The animal was maintained with isoflurane^g (2.0-2.5%) and oxygen (2.5 L/min) using a semi-closed anesthetic delivery system.^h The patient was placed on a water-circulated heating padⁱ and was connected to leads for EKG^a monitoring. A warmed balanced electrolyte solution^j was administered at 10 ml/kg/hr. Temperature, respiration, pulse and capillary refill time were regularly obtained and recorded by a monitoring technician.

A complete oral examination was performed and abnormalities were noted on the dental chart. In addition to the changes discovered during the initial oral examination tooth 203 had a mobility index of two.⁸ A periodontal probe^k was used to explore the gingiva mesial to tooth 203 revealing a tooth fragment from the buccal aspect of tooth 203. A four millimeter periodontal pocket was present on the lingual aspect of tooth 203. A dental explorer^k could be placed into the pulp cavity at the fracture site of tooth 104. Black debris was present at the tip of the explorer upon removal indicating a non-vital pulp. The mandibular left first (301) and second (302) incisors had mobility index of two.⁸ The mandibular left first molar (309) had three mm of gingival recession associated with the mesial root. No periodontal pocket or gingivitis was present.

The oral cavity was thoroughly rinsed with 0.12 % chlorhexidine^l solution to decrease the bacterial load thus protecting the operator, patient and environment from aerosolized bacteria during cleaning. Complete supragingival and subgingival scaling^m was performed to aid in elimination of existing plaque and calculus and to decrease the bacterial load in the oral cavity prior to likely extraction of teeth 203, 301 and 302 and extraction or endodontics of tooth 104. The teeth were polished using a disposable prophylaxis angleⁿ on a slow speed hand-piece^o and polishing paste^p. The oral cavity was rinsed thoroughly with saline followed again by 0.12 % chlorhexidine^l solution.

Dental radiographs^q were obtained of the affected areas using the bisecting angle technique.(Figure 2) No abnormalities other than the fractured cusp were seen on tooth 104.

The fractured fragment from tooth 203 could be seen in the interradicular space between tooth 202 and tooth 203. A lucency was present surrounding the apical portion of the root fragment. The lucency was superimposed over the roots of teeth 202 and 203. Complete stage 10 fractures of teeth 301 and 302 were present just coronal to the level of alveolar crestal bone.⁷



(Figure 2)

The fractured fragment from tooth 203 can be seen between tooth 202 and tooth 203. A lucency was present surrounding the apical portion of the root fragment.

Diagnosis:

The owner was notified that the patient had a fracture with pulp exposure of tooth 104 and a fracture of tooth 203 with a radiographic lucency surrounding a fragment from this tooth. Root fractures were also present in teeth 301 and 302.

Treatment Plan:

The treatment plan included root canal therapy of tooth 104 and extraction of teeth 203, 301 and 302 and their fractured fragments. The radiographic lucency surrounding tooth 203 would be explored and debrided with the aid of a gingival flap. A gingival flap would be used to aid in retrieval of the root tips of teeth 301 and 302.

Treatment:

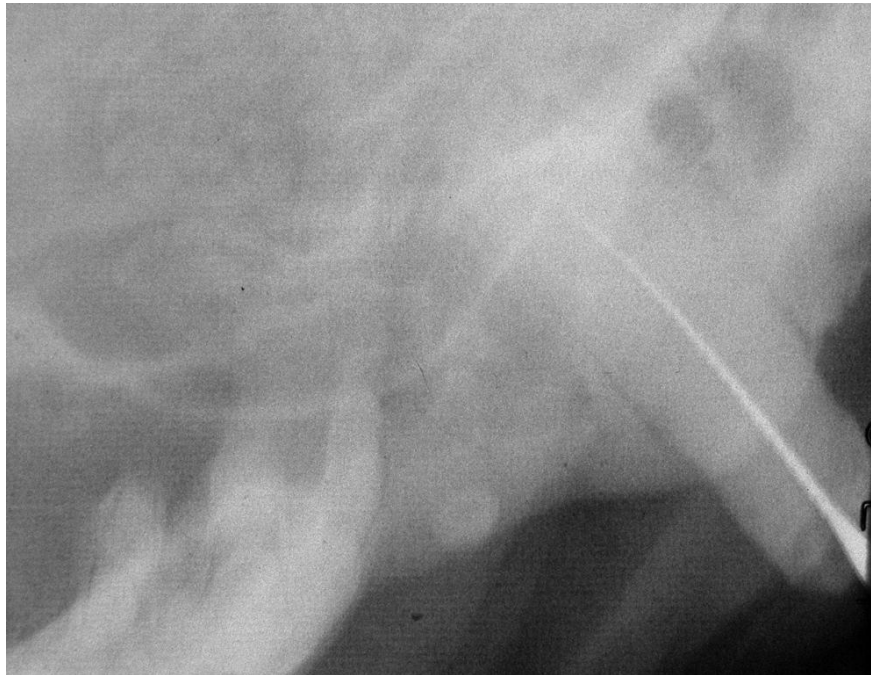
The patient was placed in dorsal recumbency. A left infraorbital nerve block was performed by injecting bupivacaine^r (1.25 mg) using a tuberculin syringe and a 25 gauge 1 inch needle^s at the entrance to the left infraorbital canal and holding digital pressure over the area for sixty seconds. Aspiration to confirm that the needle was not placed intravascularly was performed prior to injection. A right infraorbital nerve block was also performed using the dosage and technique just described. A left mental nerve block was performed by injecting an identical volume of bupivacaine at the entrance of the left middle mental nerve taking the same precautions described. In order to thoroughly debride the radiographically lucent region associated with the fragment of tooth 203 a 15 Bard Parker blade^t mounted on a No. 7 scalpel handle^u was used to make an incision starting at the line angle of the distal aspect of tooth 202 extending five millimeters into the diastema between tooth 203 and the maxillary left canine tooth (204). From this point a six-millimeter long divergent releasing incision was made. An EX-9^v periosteal elevator was used to reflect the flap apically. Tooth 203 and its fractured fragment were easily extracted with a root forcep^w. Granulation tissue was debrided with a surgical curette^x. The gingiva was sutured in a simple interrupted pattern using Mayo Hagar needle holders^y and 5-0 Monocryl® with a P-3 cutting needle.^z

The extraction of teeth 301 and 302 were begun following extraction of tooth 203. A 15 Bard Parker blade^t mounted on a No. 7 scalpel handle^u was used to make an incision starting at the mesial line angle of tooth 401 extending to the mesial line angle of tooth 301. From this point a five-millimeter long divergent releasing incision was made. An EX-9^v periosteal elevator was used to reflect the flap apically. Teeth 301 and 302 and their fractured fragments were extracted with a root forcep^w. The gingiva was sutured as previously described.

The area surrounding 104 was again thoroughly rinsed with 0.12 % chlorhexidine¹ solution. A sterile surgical glove^{aa} was used as a dental dam to protect the surrounding oral tissue from the caustic compounds used during the endodontic procedure, to increase visibility and to aid in maintaining a clean surgical field.⁹ Sterile surgical gloves^{aa} were worn by the operator.

The crown of tooth 104 was reduced to remove unsound tooth structure, to improve visibility and to eliminate the possibility of debris carriage into the canal during the procedure.⁹ Removal of diseased tooth was sufficient to allow direct access through the fracture site. A sterile ISO

size 15 Hedstrom (H) file^{bb} was compared to a radiograph to determine the approximate working length. An endodontic stop was placed sixteen millimeters from the file tip which was radiographically two millimeters short of the apical extent of the canal.¹⁰ The file was placed in the canal and advanced to the endodontic stop then gently advanced further until slight resistance was detected. A radiograph was taken and confirmed a working length of eighteen millimeters. (Figure 3)



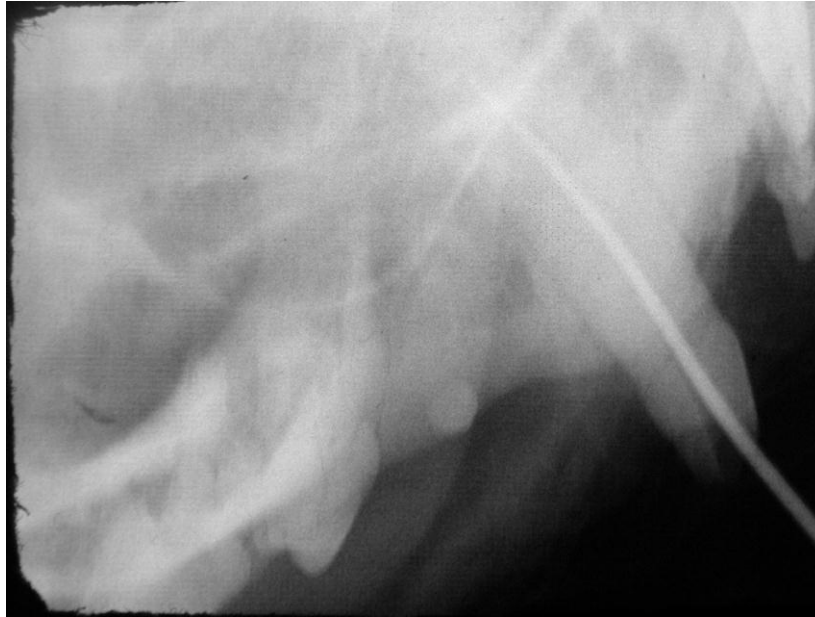
(Figure 3)

An ISO #15 H file is placed to confirm a working length of 18 millimeters

The coronal portion of the canal was flared using the ISO size 15 file to facilitate the introduction of subsequent files.¹¹ This was chosen over a Gates-Glidden drill due to the small size of the coronal access site to avoid the removal of excessive tooth structure. Canal debridement was begun using the same ISO size 15 H file. When the file fit easily to working length the canal was lavaged with 1% sodium hypochlorite.^{cc} Higher concentrations have been used in human dentistry however they do not enhance the elimination of bacteria over the 1% concentration and are more detrimental to tissue.¹² Subsequent instrumentation was completed using a cordless mechanical handpiece^{dd} and nickel-titanium rotary files,^{ee} according to manufacturer's recommendations starting with ISO size 20.

Each file was coated with an endodontic chelating agent^{ff} prior to introduction into the canal. Chelating agents aid in canal preparation by acting as an instrument lubricant and by softening dentin and emulsifying soft tissue to aid in removal of each.¹³

Completion of filing with each size was determined when a light pecking motion was required to reach working length in less than 12 pecks. One peck is described as a down cut and a slight withdrawal. Following cleaning with each file the canal was lavaged with 1% sodium hypochlorite.^{cc} Each subsequent file size was increased in half file size increments proceeding with ISO 22.5, ISO 25 and so on until at least 12 pecks are required to reach working length. The file that required at least 12 pecks for tooth 104 was ISO size 40. This file is termed the Master Apical Rotary (MAR). Starting with an ISO size 42 ½ file a one, two, three and four millimeter step-back technique was used to complete the apical preparation using sequentially larger file sizes at four to eight pecks each.. The midroot instrumentation was completed in a similar manner until an ISO size 70 file naturally stepped back into the flared coronal portion of the canal. At this point the canal was recapitulated using an ISO size 40 file to ensure no debris was retained at the apex and complete debridement was achieved.¹⁴ The canal was flushed again with 1% sodium hypochlorite.^{cc} followed by thorough lavage with sterile saline. The canal was then dried with sterile paper points.^{gg} A size 40 gutta percha point^{hh} was grasped with college pliersⁱⁱ nineteen millimeters from its apex and sterilized by immersing it in 5.25% sodium hypochlorite^{cc} for one minute.¹⁵ A trial placement of the master gutta percha cone into the canal demonstrated tug-back indicating good fit.¹⁶ One millimeter remained between the crown and the endodontic stop indicating that the tip of the gutta percha cone had reached the apex. A radiograph was taken and confirmed placement of the gutta percha cone at the apex. (Figure 4) A single cone gutta percha technique was chosen as the method of canal obturation due to adequate canal filling at the trial fit, ease and efficiency in placement thus decreasing anesthesia time, and the lack of shrinkage of the core material when using this technique.¹⁶



(Figure 4)

The master gutta percha cone is placed following final canal preparation to confirm tug-back and radiographically good canal accommodation from crown to apex.

Following radiographic confirmation of adequate fit the master gutta percha cone was used to fill the canal with sealant^{jj}. To mix the sealant, equal volume units of Paste A and Paste B were placed on a glass slab according to manufacturer's recommendations. A metal spatula was then used to mix the pastes to a homogeneous consistency. The master gutta percha cone was then dipped in the sealant and placed in the canal to the apex to completely fill the canal. This was repeated three times until the canal was adequately filled as evidenced by overflow of the sealant^{jj}. At this point the master gutta percha cone was coated again with sealant and reintroduced into the canal to the apex again confirming adequate tug-back. A radiograph was taken and confirmed adequate obturation. Vertical compaction of the master cone with an endodontic plugger^{kk} was then performed to create a dense three-dimensional obturation.

A heated endodontic spreader^{ll} was used to cut off the gutta percha cone that extended beyond the crown tip. Vertical compaction was then repeated. Alcohol soaked cotton pellets were used to clean excess sealant from the access area. A radiograph was taken to confirm good obturation prior to the final restoration. (Figure 5)



(Figure 5)

A radiograph was taken to confirm good obturation of the entire canal prior to access site restoration.

The restoration was begun by creating an undercut in the dentin using a #330 pear shaped bur^{mm} to ensure mechanical retention of the composite.¹⁷ Care was taken to ensure that only dentin was cut leaving no unsupported enamel rods that could have resulted in loss of the restoration.¹⁷ The access site was again rinsed with sterile saline and dried with paper points. Next a 37% phosphoric acid gelⁿⁿ was applied for 15 seconds according to manufacturer's recommendations to selectively remove the enamel smear layer in order to create micromechanical retention for the better adherence of the restorative materials.⁽¹⁸⁾ The access site was rinsed thoroughly with saline then blotted with a paper point and left moist. A thin layer of primer^{oo} was placed on the enamel and dentin and gently dried with a hair dryer for 5 seconds in order to assure an oil-free air source. A thin layer of adhesive^{pp} was then placed and then light cured^{qq} for 10 seconds. The final composite^{rr} resin was applied in two separate two-millimeter layers and each light cured^{qq} for 40 seconds. No more than two millimeters of composite was placed at one time to ensure adequate light penetration for curing. The margin was examined to ensure proper fill and the restoration was contoured with a white stone bur^{ss}, smoothed with a finishing disc^{tt} and then polished using composite polishing material.^{uu} The final layer of sealant^{vv} was then applied to ensure a marginal seal and prevent microleakage. A radiograph was taken to confirm an adequate final restoration and document extraction of tooth 203.(Figure 6)

The mouth was rinsed with the air/water syringe and a digital image taken of the final restoration and extraction site.(Figure 7) Ketoprofen^{ww} (9 mg SQ) was administered for pain control. ^{19 20} Ketoprofen^{ww} is approved for use in Europe and Canada (19) and has proven to be effective for postoperative pain relief. ^{19 21}



(Figure 6)

The final radiograph shows complete obturation of the canal and good access site restoration.



(Figure 7)

The final restoration of tooth 104 and the surgical extraction site for tooth 203 and its fractured fragment are pictured here.

Post-Operative Care:

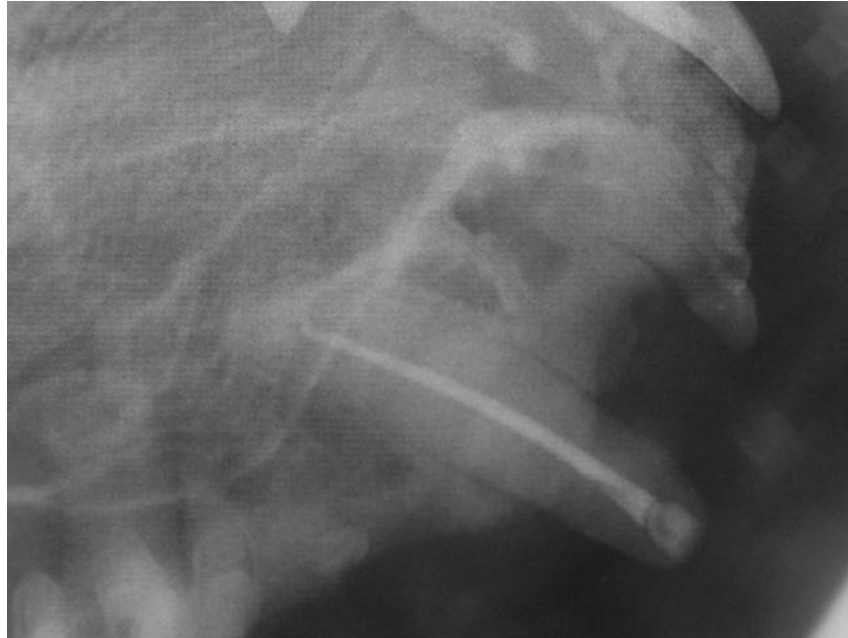
The patient was placed on a blanket in recovery and carefully monitored. At the first sign of swallowing the endotracheal tube^g was deflated and removed. The patient was monitored until sternal recumbency was achieved. Prior to discharge, the IV catheter^d was removed and a light pressure bandage placed over the catheter site to aid in hemostasis. Ketoprofen^{ww} was dispensed in a flavored oral suspension with instructions to give 4.5 mg every twenty-four hours for three days starting twenty-four hours post-operative.^{19 20} The owners were instructed to discontinue administration if vomiting occurred.

Long Term Follow Up:

An appointment was made for two weeks post-op to examine the extraction and restoration sites. The day following discharge the owner was contacted by phone for follow-up. The patient had eaten the evening of the surgery and no problems were detected.

The patient returned for a two-week follow up examination. Complete healing of the extraction site was present with no change in the restoration. An appointment was made for six months later for radiographic evaluation of the root canal procedure. A toothpaste^{ww} was dispensed and the owner was instructed to brush the pet's teeth daily for the life of the pet.

The patient returned six months postoperative. Radiography showed no changes associated with the root canal procedure. An appointment was made for twelve months postoperative for radiographic evaluation of the root canal procedure and complete dental prophylaxis. The appointment was delayed to seventeen months postoperative per owner request. Radiography showed no evidence of periapical pathology. (Figure 8) No clinical signs were noted by the owner. There were no gross changes visible on either site. The maxillary right third incisor (103) had a mobility index of two.⁸ Radiographs revealed a stage 10 fracture just coronal to the alveolar crest. Extraction was performed in a manner similar to that described for tooth 203. Postoperative radiographs documented complete extraction. A gingivitis index of I, a calculus index of II, and a plaque index of I⁶ was observed and recorded. Again a complete supragingival and subgingival scaling^m was performed. An appointment was made for one year to repeat the prophylaxis and radiography of 104 to confirm the success of the procedure. Radiographs taken fifteen months postoperative showed no evidence of root pathology.



(Figure 8)

A radiograph was taken fifteen months following the initial root canal therapy. No abnormalities were seen.

Discussion:

Historically attempts to use steel files with engine driven rotary instruments for root canal instrumentation have failed.¹⁸ The introduction of Nickel-Titanium (NiTi) files have led to the development of safe and effective rotary file systems.¹⁸ NiTi provides the flexibility needed to maneuver curved canals without causing file stress leading to fracture.¹⁸ The flexibility also provides safety from the possibility of canal wall perforations which were problems previously.¹⁸

The use of engine driven systems generally requires hand instrumentation to complete the apical canal preparation due to lack of adequate file size.¹⁸ The engine driven rotary system used in this case has been shown to be the only system to provide file sizes that can properly prep the apical canal in teeth with slightly curved root canals.¹⁸ Comparisons show apical preparations whose diameters exceed that achievable with hand instrumentation alone.²² Advantages over hand instrumentation include better canal shape^{22, 23, 24} less transportation^{18, 22, 24} and cleaner canals.²² Engine driven rotary instrumentation is not without problems. File separation is still an issue.^{18, 24, 25} However with careful attention to manufacturers recommendations¹⁸) and familiarization with the equipment and technique used (24) instrument fracture can be minimized.^{18, 23}

Postoperative radiographs of extraction sites are ideal. Radiographs of the mandibular extraction sites were not taken due to neglect stemming from time issues and not lack of intent. In retrospect, thought should be concentrated and time taken to complete radiography of extraction sites.

Products:

- a) EKG analyzer, Vetronics, Lafayette, IN
- b) Torbugesic, Fort Dodge Animal Health, Fort Dodge, IA
- c) Surflo intravenous catheter, Terumo Medical Corp, Elkton, MD
- d) Ketaset, Fort Dodge Animal Health, Fort Dodge, IA
- e) Valium, Abbott Laboratories, N Chicago, IL
- f) 5-0 Endotracheal Tube, Rusch, Deluth, GA
- g) IsoFlo, Abbott Laboratories, N Chicago, IL
- h) VMS Anesthesia Machine, Matrix Medical, Inc., Orchard Park, NY
- i) T Pump, Gaymar Industries, Orchard Park, NY
- j) Lactated Ringer's solution, Abbott Labs, N Chicago, IL
- k) P2 Probe/Explorer Combination, Cislak Manufacturing Inc., Glenview, IL
- l) Chlorhexidine, First Priority, Elgin, IL
- m) Neosonic, Amdent, Cherry Hill, NJ
- n) Disposable prophylaxis angle, Carlile Labs, Rockwell Centre, NY
- o) High Speed Delivery System, Beaverstate Dental, Tualatin, OR
- p) Prophylaxis Paste, Carlile Labs, Rockville Centre, NY
- q) DentX Image Vet X70, AFP Imaging, Elmsford, NY
- r) Bupivacaine 0.5 %, Abbott Laboratories, N Chicago, IL
- s) Tuberculin syringe and needle, Nipro Medical Corp, Miami, FL
- t) No. 15 surgical blade, Carlile Labs, Rockville Centre, NY
- u) Scalpel handle, Spectrum, Stow, OH
- v) EX-9 periosteal elevator, Cislak Manufacturing Inc., Glenview, IL
- w) #4658 Root Forcep, Cislak Manufacturing Inc., Glenview, IL
- x) EX-2 Surgical Curette, Cislak Manufacturing Inc., Glenview, IL
- y) Mayo-Hagar needle holders, Spectrum, Stow, OH

- z) 5-0 Monocryl®, Ethicon, Inc. Somerville, NJ
- aa) Sterile surgical gloves, Ansell Healthcare, Glen Waverly, Australia
- bb) Sterile ISO size 15 H, United Dental Manufactureres, Palm Beach, FL
- cc) Chlorox Bleach, The Clorox Company, Oakland, CA
- dd) Cordless Handpiece, Lightspeed Inc., San Antonio, TX
- ee) Nickel-Titanium Files, Lightspeed Inc., San Antonio, TX
- ff) RC Prep Root Canal Preparation Cream, Premier Dental Products Co, King of Prussia, PA
- gg) Paper points, Darby Dental Supply, Westbury, NJ
- hh) Parallax gutta percha points, Dr. Shipps Laboratories, Beverly Hills, CA
- ii) Collage pliarⁱ, Henry Schein, Melville, NY
- jj) AH Plus, Dentsply Tulsa Dental, Tulsa, OK
- kk) Finger plugger, Darby Dental Supply, Westbury, NJ
- ll) Touchn'Heat, EIE/Analytic Technology, Orange, CA
- mm) #330 pear-shaped bur, Carlile Labs, Rockville Centre, NY
- nn) Scotchbond etchant, 3M Company, St. Paul, MN
- oo) Scotchbond multipurpose primer, 3M Company, St. Paul, MN
- pp) Scotchbond multipurpose adhesive, 3M Company, St. Paul, MN
- qq) Light Cure, Carlile Labs, Rockville Centre, NY
- rr) Restorative Z-100, 3M Company, St. Paul, MN
- ss) White Stone bur, Carlile Labs, Rockville Centre, NY
- tt) Fini-Discs, Pentron, Wallingford, CT
- uu) High Gloss Polishing Paste, Henry Schein, Melville, NY
- vv) Protect-It, Pentron, Wallingford, CT
- ww) Ketofen, Fort Dodge Animal Health, Fort Dodge, IA
- xx) CET toothpaste, Virbac, Fort Worth, TX

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