Retrospective Evaluation of Perforation Repairs in 6 Private Practices

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Abstract

Introduction: The purpose of this study was to investigate retrospectively the clinical outcome of 70 perforation repairs performed by 6 endodontic specialists. **Methods:** Endodontic specialists performed a total of 70 perforation repairs (69 patients) between 1998 and 2010 using a nonsurgical or combined nonsurgical/surgical approach. Treatments were performed with the aid of a dental operating microscope. Recalls of at least 6 months were obtained on 49 patients (50 teeth). Two calibrated observers evaluated the radiographic results on recalls up to 116 months, with a mean of 37 months. Pre-, intra-, and postoperative data were evaluated with respect to treatment outcomes and possible prognostic factors. **Results:** Successful results were obtained in 45 of 50 perforation repairs, a success rate of 90%. Significant prognostic factors included the location of the perforation, sex of the patient, and restorative status of the tooth before perforation repair. The overall success rate of this study was higher than reported in other studies. **Conclusions:** Perforation repairs can be performed with a high level of success at least in the short- to medium-term. *(J Endod 2013;39:1346–1358)*

Key Words

Mineral trioxide aggregate, perforation repair, root perforation, treatment outcome

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The occurrence of perforations during endodontic treatment is reported to range from 2.3%–12% (1, 2). Kvinnsland et al (2) reported an increased risk for perforations in the upper jaw (73%) compared with lower teeth, whereas Tsesis et al (3) reported that 55% of perforations occurred in lower molar teeth.

Crown-root angulations, calcifications of the pulp chamber and orifices, anatomic variations, and excessive removal of coronal dentin may contribute to perforations in the coronal part of the tooth (4). Excessive flaring and overzealous instrumentation of curved roots may result in coronal or midroot perforations. Apical perforations may be the consequence of inappropriate cleaning and shaping techniques and are sometimes initiated by blocked and transported canal systems (5). These may be the most challenging to repair because of limited visibility and access (6). Oversized and poorly angulated post space preparations may also result in root perforations (4).

Perforations lead to inflammation and the destruction of periodontal fibers and alveolar bone and can cause a periodontal defect (7). It is important to diagnose and repair perforations immediately if possible.

Existing perforations are often identified during the diagnostic phase on radiographs taken from different angles and during the periodontal assessment of the tooth. Cone-beam computed tomographic imaging may be helpful to determine whether a perforation exists, to localize the perforation, and to decide on treatment options (8). Perforation repair may be accomplished nonsurgically, from inside the tooth, or with a surgical approach (6, 9).

Factors reported to affect the prognosis of repair include immediacy, location, size, and previous microbial contamination (10). The location of the perforation is probably the most critical prognostic factor. Perforations in the apical or middle third of the root have a better prognosis than those in the cervical third or floor of the chamber. Root perforations at the alveolar crest exhibit the poorest prognosis because of potential microbial contamination and periodontal breakdown (10).

Mineral trioxide aggregate (MTA) is reported to be the material of choice for perforation repair (4, 11, 12). MTA is composed of calcium, silica, and bismuth. Its biocompatibility is well documented (13). It possesses some antibacterial and antifungal properties, is a bioactive material that modulates cytokine production, and encourages the differentiation and migration of hard-tissue producing cells. MTA releases calcium ions for cell attachment and proliferation and creates an antibacterial environment because of its alkaline pH. It forms $Ca(OH)_2$ on its surface and provides a "biologic" seal (14), meaning that under ideal conditions cementum will grow over it.

MTA has some disadvantages. It has a long setting time of about 4 hours, which makes it inappropriate for exposure to the oral cavity (6). MTA can cause discoloration and should not be used in the aesthetic zone (15).

Perforations are reported to lower the prognosis of endodontic treatment to 54%–56% (16, 17). In a study by Mente et al (18), 86% success was reported. However, this study was based on a very small sample size (21 teeth) and short recall periods (13–65 months). Therefore, the long-term prognosis for perforations cannot be determined from this study.

There are case reports on successful perforation repairs up to 13 years (19, 20), but there are no studies with adequate sample sizes and long-term data. These data would be valuable for decision making and treatment planning when deciding whether to repair or extract.

There is a dearth of studies in the endodontic literature that evaluate the outcome of clinical procedures, including perforation repair, with evaluation periods longer than 1 or 2 years. The purpose of this retrospective study was to evaluate the healing outcome of perforation repairs performed by endodontic specialists in 6 private practices.

Materials and Methods

Seventy intra-alveolar perforations in 69 patients were identified that had been repaired by 6 endodontic specialists in their private practices between 1998 and 2010. The perforations were diagnosed clinically by visualization, bleeding spots on paper points, with an electronic apex locator, and radiographically. The location and extent of the perforations were determined.

All participating offices were using TDO practice management software (The Digital Office for Endodontists, Inc, San Diego, CA), which standardized the documentation of the evaluation, treatment, and recalls. The documentation included pulp status, electronic working length, reference point, actual working length, apical curvature, master apical file, taper of gutta-percha cone used, sealer, obturation technique, extension of the root canal filling in relation to the canal terminus, interappointment medication, and buildup materials. The following information was recorded about the perforations: canal, location of the perforation (supracrestal, crestal, and subcrestal), size, type (furcal, lateral root, and strip), cause (post, bur, endodontic instrument, internal/external resorption, and caries), prior perforation repair, time until repair, and repair material. Teeth that revealed root fractures, inadequate remaining tooth structure, or severe periodontitis were excluded a priori.

Specialist A (Germany) repaired 46 teeth; specialist B (United States, 12 teeth), specialist C (The Netherlands, 5 teeth), specialist D (Italy, 3 teeth), specialist E (Jamaica, 3 teeth), and specialist F (Ireland, 1 tooth) performed the clinical procedures between January 1998 and March 2010 using their standard clinical techniques. Nonsurgical (63 teeth) or combined nonsurgical/surgical repairs (7 teeth) were performed. A total of 70 perforation repairs were completed in the 6 practices during the time period. After considerable effort, the clinicians were able to recall 50 of the patients. Twenty patients were not available for recall. The basic data for the recalls are presented in Table 1.

All 70 patients provided informed consent for endodontic treatment, and the 50 recall patients consented to the potential use of the outcome data for publication. The patients who were included were not known to be pregnant or medically compromised.

All treatments were performed using a dental operating microscope, local anesthesia, and rubber dam isolation. Patency was confirmed in all cases with small hand files in combination with an electronic apex locator device and radiography. Cleaning and shaping were performed according to Schilder's biological and mechanical objectives (5) using stainless steel hand instruments and nickel-titanium rotary files. Irrigation was performed with 3% sodium hypochlorite (NaOCl) and 17% EDTA for smear layer removal. Calcium hydroxide was applied as an intra-canal dressing in cases associated with chronic apical periodontitis (periapical index [PAI] score 3 or above). Pure grade $Ca(OH)_2$ powder (compounding pharmacy) was freshly mixed with sterile saline in 27 cases, and the slurry was placed with a Lentulo spiral. In 21 cases, UltraCal XS was applied using a NaviTip (Ultradent Products Inc, South Jordan, UT). Ledermix (Riemser Pharma, Greifswald, Germany) was applied in 3 cases. Root canal systems were obturated with vertical compaction of warm gutta-percha (5). MTA was used for most of the perforation repairs according to the manufacturer's protocols (21).

Pre- and postoperative clinical evaluations were performed by the treating clinicians after 6 to 116 months (mean = 37 months, inclusion rate = 71.4 %). The time interval between perforation repair and recall was at least 6 months. Two calibrated investigators who were not involved in the clinical treatment graded preoperative, immediate postoperative, and recall radiographs. The images were viewed progressively over time and rated by each of the evaluators after recall appointments. In cases in which no consensus was reached, a third investigator was included to obtain a consensus score. Potential bias was reduced by blinding and random investigation of the radiographs.

Perforations were classified based on the following criteria:

1. Number of roots
2. Location of the perforation (osseous crestor sub- or supracrestal)
3. Size
4. Type (lateral, furcal, or strip)
5. Source of the perforation (bur, post, file, external or internal resorption, or caries)
6. Prior repair (yes or no)
7. Repair material
8. Time since perforation

Recall examinations included the following data:

1. Presence or absence of coronal restoration
2. Presence or absence of coronal leakage
3. Symptoms (tooth asymptomatic, functional, or symptomatic)
4. Size (increase, decrease, or stable)
5. Appearance of periodontal ligament space (normal or abnormal)
6. Palpation soreness (0–3)
7. Percussion sensitivity (0–3)
8. Tooth mobility (0–3)
9. Presence or absence of a sinus tract
10. Periodontal probing depths
11. Periapical and periradicular diagnosis according to the PAI index and root perforation index scoring system (described later)

Preoperative, postoperative, and recall radiographs were analyzed according to the following criteria:

1. *Radiologic coronal score* (Hommez et al, 2002 (22)): Score 1: intact restoration without signs of leakage (acceptable), score 2: restoration with open margin (unacceptable), and score 3: restoration with recurrent decay (unacceptable)
2. *Length of root canal filling score* (Hommez et al, 2002 (22)): Score 1: root filling terminating 0–2 mm from the radiographic apex, score 2: root filling terminating >2 mm from the radiographic apex, and score 3: root filling extending beyond the radiographic apex
3. *Homogeneity of root canal filling* (Hommez et al, 2002 (22)): Score 1: homogeneous root filling, good condensation, and no voids visible and score 2: inhomogeneous root filling, poor condensation, and voids visible
4. *PAI score* (Ørstavik et al, 1986 (23)): Score 1: no structural changes in the periapical area, score 2: disorganization of the bone texture in the periapical area, score 3: structural changes in the periapical area with loss of mineral, score 4: radiolucency in the periapical area, and score 5: radiolucency with elements indicating expansion of the lesion
5. *Root perforation index (RPI) score* (introduced by Roggendorf and Pontius, 2011): Score 1: no structural changes at the site of perforation, score 2: disorganization of the bone texture at the site of perforation, score 3: structural changes at the site of perforation