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Revascularization of an immature permanent tooth with apical periodontitis and sinus tract

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Abstract – A necrotic immature mandibular second premolar with periapical involvement in a 13-year-old patient was treated. Instead of the standard root canal treatment protocol and apexification, antimicrobial agents were used in the canal, after which the canal was left empty. Radiographic examination showed the start of apical closure 5 months after the completion of the antimicrobial protocol. Thickening of the canal wall and complete apical closure was confirmed 30 months after the treatment, indicating the revascularization potential of a young permanent tooth pulp into a bacteria-free root canal space.

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Key words: revascularization; immature tooth; periapical involvement; root development

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In the avulsed immature tooth with an open apex, revascularization is the most desirable healing response because the tooth continues to develop to form strong root dentin. In the infected immature tooth with periapical involvement, pulp revascularization has been considered impossible due to the presence of bacteria in the root canal space and the lack of vital pulp progenitor cells necessary for the proliferation of pulpal tissue. Such a tooth receives an apexification procedure, because revascularization of the pulp chamber is not expected. Apexification induces further development of an apex to close the foramina, but does not promote the thickness of the entire canal wall dentin. A tooth with this kind of thin root dentin and large canal lumen is prone to fracture (1).

Theoretically, when an extremely large communication from the pulp space to the periapical tissues exists, as with a very young tooth, it may be possible for periapical disease to be present when the pulp is only partially necrotic and infected. Vital pulp may still be present in the most apical part of the canal. If this were the case, successful removal and disinfection of the necrotic infected coronal pulp would still leave vital pulpal cells with the potential to proliferate new pulp into the coronal pulp space. Thus obturation of the root canal space, temporarily with a medicament or with gutta-percha, would remove the possibility for revascularization to occur and thus be counterproductive.

In this case report, we treated an immature mandibular second premolar with an intraoral sinus tract. Instead of the standard root canal treatment and apexification, the root canal was not mechanically cleaned to the apex but copious irrigation and antimicrobial agents were used in the canal. Thus necrotic and infected pulp was removed coronally, leaving residual pulp tissue apically in the canal to promote revascularization. The tooth responded to the treatment as hoped and continued root development and apical closure were confirmed.

Case report

The patient was a 13-year-old female. She had a history of swelling of the right mandibular buccal vestibule for which she received an incision for drainage at a nearby dental office in the summer of 1995. Because the periapical symptoms and swelling returned after some time, she visited Tohoku Welfare Hospital for advanced treatment in January 1996. A sinus tract was found apically on the mesiobuccal aspect of the right mandibular first molar (Fig. 1). The premolars and molars were free of caries, but fracture of the central cusp of the second premolar was noted on

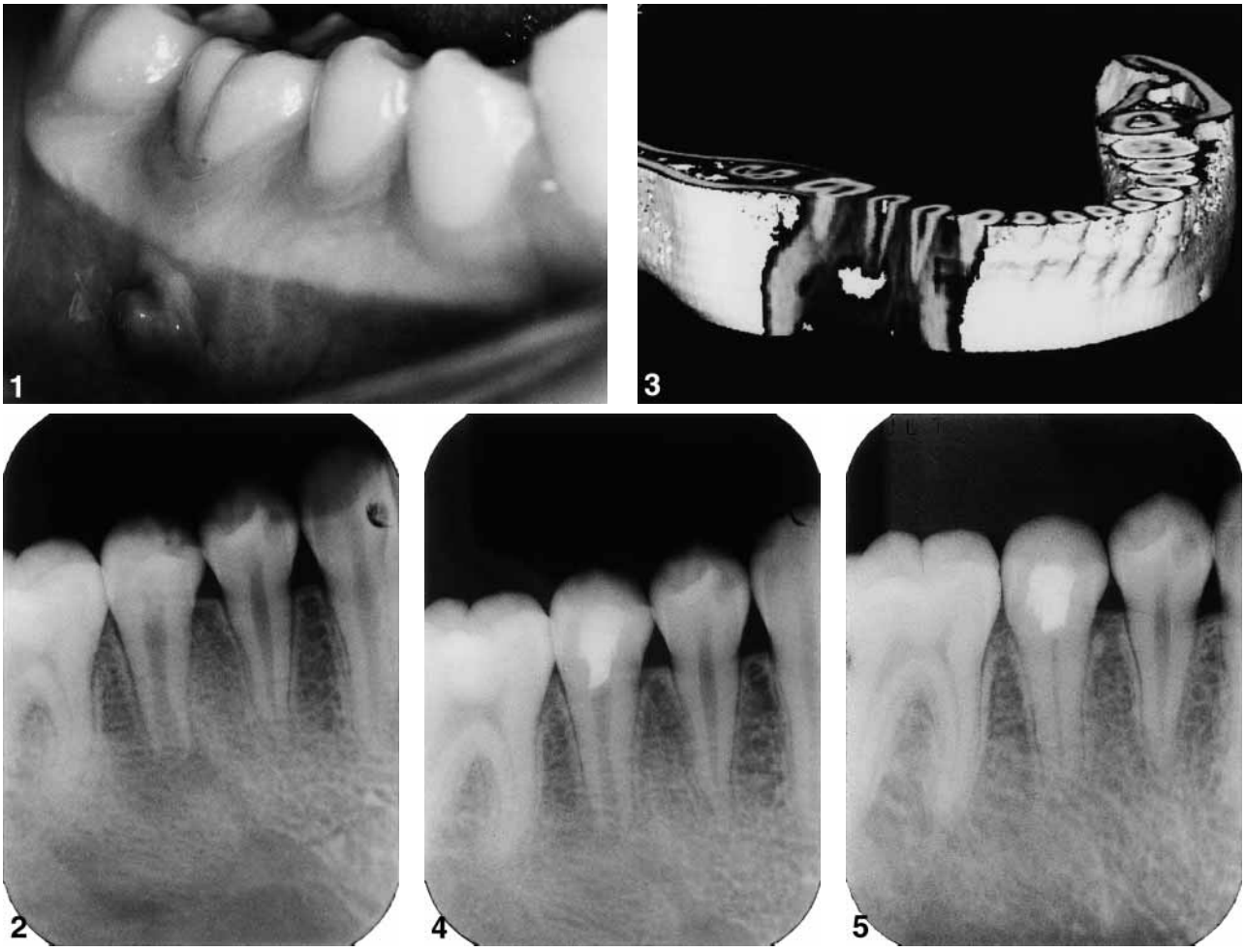

Fig. 1. Preoperative clinical view showing intraoral fistula at the apical gingiva in the mesiobuccal side of tooth 46.

Fig. 2. Preoperative radiography of tooth 45. Incomplete apex formation and periapical radiolucency in tooth 45 were revealed.

Fig. 3. Three-D CT image of involved tooth and its periapical legion taken 15 days after the initial treatment. A periapical legion is expressed as radioopacity by computer image processing.

Fig. 4. Radiography of tooth 45 taken 5 months after the application of calcium hydroxide. Dentin bridge formation is observed.

Fig. 5. Thirty-month postoperative radiography of tooth 45. Completion of the root apex and increase in the thickness of the canal wall was revealed.

visual inspection. Periapical radiographic examination (Figs. 2, 3), revealed that the second premolar had an incomplete apex and a periapical radiolucency 10 mm in diameter. Positive response to thermal (Pulper Dental Coolant, GC, Tokyo, Japan) and electric (Pulp Tester, AT Analytic Technology, Redmond, USA) sensitivity testing was noted from the right mandibular first premolar and molar but not from the second premolar. The diagnosis of apical periodontitis with sinus tract was made for the second mandibular premolar.

When the access cavity was prepared on the offending tooth, bloody and purulent exudate discharged from the pulp chamber. The patient had a slight sensation of pain when the access cavity was prepared and also when a smooth broach was inserted into the canal. As it was thought that there might have been some vital pulp tissue in the canal, the root canal was not mechanically cleaned to its full length. The tooth was left open until the next visit to achieve drainage through the canal.

The sinus tract had healed and the discharge of exudate had stopped by the 2nd visit. At the 2nd to 5th weekly visits, the access cavity was opened to the canal orifice and the upper part of the root canal was irrigated using 5% sodium hypochlorite and 3% hydrogen peroxide. Antimicrobial agents (metronidazole and ciprofloxacin) were placed into the root canal. The root canal was not mechanically cleaned during the treatment period. At the 5th visit, the exist-

ence of vital tissue approximately 5 mm apical to the canal orifice was confirmed by visual inspection. Insertion of a smooth broach into the canal elicited a painful response. At the 6th visit, a thin layer of calcium hydroxide paste (Vitapex, Neo Dental Chemical Products, Tokyo, Japan) was placed in contact with the soft tissue in the root canal, and the access cavity was sealed with glass-ionomer cement followed by adhesive composite resin.

A radiograph taken 5 months after permanent closure of the access cavity revealed the first signs of apical closure. A slight increase of the thickness of the root canal wall was also observed (Fig. 4). Fifteen months after the initial treatment, the canal was opened, and the formation of dentin bridge was found at the level of the orifice (adjacent to the filling material) using an explorer. There was a positive response to electric pulp testing on the surface of newly formed dentinal bridge. The access was again restored. Radiographic examination 30 months after the initial treatment confirmed complete closure of the apex and thickening of the root wall due to a diminished pulp space (Fig. 5).

Discussion

It has been demonstrated in immature reimplanted and autotransplanted dog teeth that necrotic pulp tissue can be replaced by tissue proliferated from the periapical area (2–4). In this patient, the 30-month recall clinical and radiographic examination was consistent with an immature tooth that had successfully revascularized after a luxation injury (5). Most of the pulp tissue in the canal was devitalized and infected but some pulp tissue may have survived apically, as suggested by the pain sensation elicited by a smooth broach insertion at the initial treatment. In order to preserve this pulp tissue, the canal was not mechanically debrided, but a mixture of metronidazol and ciprofloxacin was applied as the intracanal antibacterial dressing. As a result, the bacteria in the coronal pulp were presumably removed, allowing the vital, well nourished apical pulp cells to proliferate into the open space as in the usual, successful revascularization procedure.

The most effective disinfection of the infected root canal is in general attained by the mechanical debridement and chemical irrigation of the canal with the addition of an intracanal dressing. However, in an immature permanent tooth, excessive instrumentation and dressing using cytotoxic antiseptics may remove pulp tissue that can survive in the wide, well nourished apical area (6, 7). By removing this tissue, the cells capable of forming pulp and dentin are lost. In addition, when an apexification procedure is attempted, the canal is filled with an interim material (usually calcium hydroxide) until the hard tissue barrier forms at the apex. Because the canal space is filled, there is no space available for vital tissue to proliferate into. Thus the chance of revascularization is eliminated. To allow successful revascularization, therefore, as in this case, it would be necessary to first remove the bacterial challenge from the coronal pulp, leave the pulp space empty and finally provide a sufficient coronal seal to prevent additional bacteria from entering the space provided.

The bactericidal efficacy of a mixture of ciprofloxacin, metronidazole and minocycline in the infected root canal has been confirmed in studies using extracted human teeth (8). Thus it is reasonable to expect that the coronal pulp space was free of bacteria after three applications of the medicament. The canal space was then left empty so that new tissue was able to grow into it. Lastly, the coronal seal consisted of a glass-ionomer base followed by a bonded resin material, which apparently provided a bacteria-tight seal. It is also interesting to note that a hard tissue barrier did form against the filling material, indicating that a solid surface may be necessary for the formation of a hard tissue barrier.

Although it is premature to generalize from the treatment procedure in this report, revascularization in an immature tooth with periapical involvement was possible in this case. We suggest that the healing potential of the pulp tissue in young permanent tooth reported here merits further investigation.

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