Michael Arnold

Palato-radicular groove associated with a bi-rooted maxillary incisor: a case report

Michael Arnold
Praxis für Endodontie und Zahnerhaltung,
Königstraße 9,
01097 Dresden,
Germany
Tel: +49 351 2721990
Fax: +49 351 2721992
Email: info@rootcanal.de

Key words *endodontic-periodontal lesion, ledges, palato-radicular groove, radicular palatal groove*

This report describes a rare palato-radicular groove in a maxillary lateral incisor with an accessory root and an atypical root canal. Failure to identify the presence of the palatal groove allowed infection to persist, which led to palatal swelling and labial fistula. During endodontic retreatment of the infected root canal, an accessory root with a second root canal was detected. Owing to the extent of the circumferential bone loss and the atypical root canal, the second root was resected.

Histological analysis of the resected root suggested there was reparative dentine in the deep groove and several accessory canals. The structure of the reparative dentine was irregular. In the apical third of the resected root, the canal was oval with a wide slit-type aperture. It was possible that the combination of the deep groove and the accessory canals with the atypical communication to the periodontal ligament was the reason for retrograde pulp inflammation and pulp necrosis.

Rapid healing after surgical treatment was observed. At the 6-month follow-up examination, the patient was symptom-free. No swelling or exudation was present. Radiographic investigation of the lateral bone defect showed the beginning of ossification and healing.

Introduction

A palato-radicular groove (PRG) is a developmental groove in the area of the central fossa of the maxillary incisor teeth that continues apically down the root. Radicular grooves are often located on the palatal aspect of maxillary lateral incisors, and rarely on the labial root surface of the central incisors. Grooves run from the beginning of the cemento-enamel junction (CEJ) and along the root surface to the apex. In most cases, the course of the grooves is straight. According to their localisation they are differentiated as distal, mesial and central patterns, with the distal position dominating, as it occurs in approximately 70% of cases[1]. In the case of a distal localisation, pathosis is often reported[2].

The grooves also vary in depth. Deep grooves with direct communications with the pulp are seldom reported[3]. With increasing depth of the groove, the thickness of the root cementum increases[3].

The aetiology of PRGs is unknown. Similar to an invagination, this seems to be a peculiarity of tooth

development accompanied by a further anomaly. Black[4] was the first to describe the PRG as a malformation during embryo development in 1908. Atkinson[5] surmised that the reason for its formation is that there is not enough space during tooth development in the maxilla, resulting in folding in the area of the Hertwig epithelial sheath. In the opinion of Goon et al[6], this could also be an attempt at a root partition. According to recent studies, PRGs may be caused by genetic changes[3].

At a morphological level, PRGs are characterised by reduced dentine thickness and an increased cement layer, with a simultaneous modification of the odontoblasts. At a histological level, irregular dentine cement junctions have typically been identified[1,3].

The localisation promotes the apposition of plaque and calculus along the groove[1,7,8]. As there is no epithelial closure, it is possible for microbes to settle in the groove. Depending on the morphology of the PRG, localised periodontitis may develop, accompanied by pathosis. Periodontal pocket depths of more than 5 mm and increased dental mobility are typical findings. Moreover, in the case of deep PRGs, a retrograde pulpitis may occur as a result of the so-called endodontic-periodontal lesion[9-11].

The prevalence of PRGs ranges between 2% and 5%[12,13], with 58% of the grooves featuring a length of more than 5 mm[12]. Most of the time PRGs are clinically overlooked so that recurring clinical symptoms are often misdiagnosed because of the pathogenesis[8,14-17]. A good prognosis for prolonged tooth preservation also depends on whether combined periodontal and endodontic therapy is necessary.

Several different procedures have been proposed for successful correction of PRG. In most cases, odontoplasty was carried out in combination with regenerative therapy. Other reported treatment procedures are careful root planing and cleaning[15], filling of the groove with amalgam[11,18] or calcium sulphate[19], and intentional replantation after root planing and the insertion of Emdogain[20,21]. In some cases, the tooth was extracted due to its high mobility or in cases of bruxism[22,23].

Case report

A 27-year-old patient complained of pain radiating over the right side of her face, which had been present for several months. Examination by the dentist revealed the tooth was caries-free and the sensitivity was normal. The preliminary diagnosis was a trigeminal neuralgia. Although medicinal treatment was started, the pain did not subside.

The patient suffered from a recurrence of acute pain, so a sensitivity test was carried out on the maxillary lateral incisor. Thereafter, root canal treatment was initiated under anaesthesia. According to the dentist, the extirpated pulp was partially necrotic and smelled fetid. Although the acute pain subsided with the conclusion of the root canal treatment, the gingiva was still red and swollen. Intermittently, pus escaped labially from a fistula.

There was no medical history of relevance. From the age of 7 to 9, the maxilla had been treated orthodontically. There was no further information on the treatment. The patient could not remember an accident or a dental trauma.

Tooth 12 had an inconspicuous mucous membrane, was discoloured, and there was swelling and

Fig 1 Palatal view of tooth 12: a palato-radicular groove and muco-gingival swelling.

reddening of the approximal papillas. In addition, the marginal gingiva was slightly swollen and palatally livid. The palatal tooth surface was filled with composite. At the CEJ, a deep disto-palatal groove (Fig 1) with a pocket depth of 5 mm was found. Furthermore, a 3-mm-long horizontal enamel fracture line, situated paramarginally, was evident. After palatal probing, pus and blood drained from the wound. Contralaterally, there was a disto-palatal retraction on tooth 22 associated with localised gingivitis (Figs 2 and 3). In contrast to tooth 12, the sulcus probing depths were not elevated.

The radiograph showed vertical, interproximal bone loss of approximately 4 mm between teeth 12 and 13. There were voids in the root canal filling of tooth 12 in the apical part, but without apical pathosis (Fig 4).

Tooth 12 was accessed following isolation with rubber dam. On reaching the root canal filling, a fetid smell was discernible. Using a dental microscope, liquid was seen leaking from the root canal during probing. In addition, an untreated, severely narrowed root canal was evident in the disto-palatal area of the access cavity (Fig 5).

Treatment

The clinical and radiological findings supported a diagnosis of an infected root canal system. The accessory untreated root canal suggested a rare malformation of the tooth that was diagnostically different from an invagination, gemination, or the formation of an additional root and a PRG. After

Fig 2 Palatal view of the contra-lateral tooth 22: only a minor disto-palatal groove.

Fig 3 Radiograph of tooth 22.

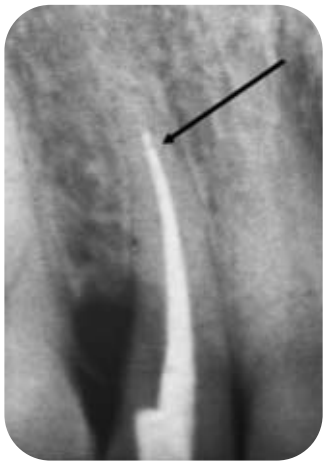

Fig 4 Radiograph of tooth 12 from the referring dentist. The apical third of the root canal filling material consisted only of sealer without any gutta-percha. A void can be seen (arrow). Distal loss of bone is evident.

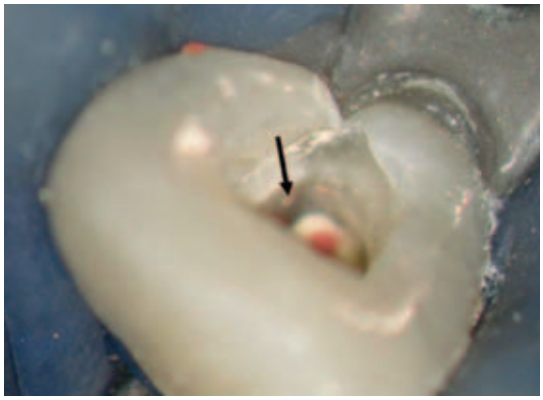

Fig 5 After removal of the coronal filling material, an untreated, narrow root canal was detected (arrow).

inspection of the pulp chamber and the coronal root canal third, a vertical fracture was excluded.

During the removal of the root canal filling, a labially oriented ledge was found in the apical part. At the same time, a radiograph angled eccentrically confirmed the existence of a second separate root (Fig 6). The ledge could be bypassed after micro-abrasive ultrasonic preparation under the dental microscope[24]. Further preparation was carried out under electrometric control, using rotary nickel-titanium instruments. The probing of the second untreated root canal with a K-file (ISO size 06) resulted in an electrometrically verifiable contact with the periodontium after approximately 3 mm. After minimal enlargement up to ISO size 20, a diagnostic root canal filling was performed to check the presumed atypical root canal course. The radiograph of the root canal filling clearly showed direct connection between the pulp cavity and the periodontium. The presumed course of the root canal of the accessory root did not correspond to the minimally prepared and filled root canal. The sealer overflow marks the bifurcation of the root division (Fig 7).

The renewed dissection of the second root canal with a hand file (ProFinder size 17) during surgery confirmed the lateral course and the leak in the area of the root division and groove (Figs 8 and 9). After the access cavity was sealed with a resin composite, the

Fig 6 An eccentrically angled radiograph reveals the existence of an accessory root (arrow).

Fig 7 A check radiograph showed the existence of a second root canal. The bifurcation of the two root canals (arrow) is discernible by the small amount of sealer.

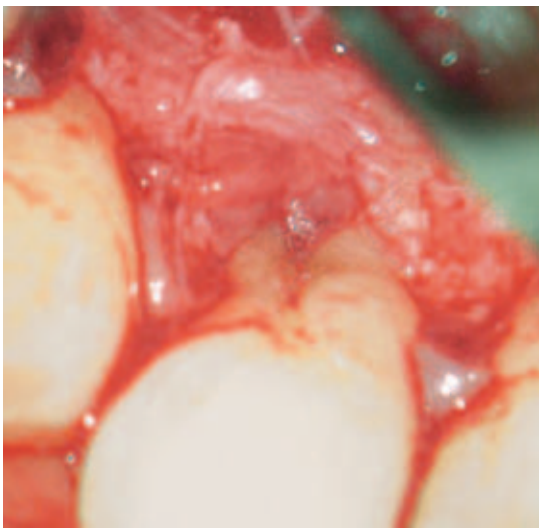

Fig 8 Palatal view of tooth 12 when flap raised showing two separate roots.

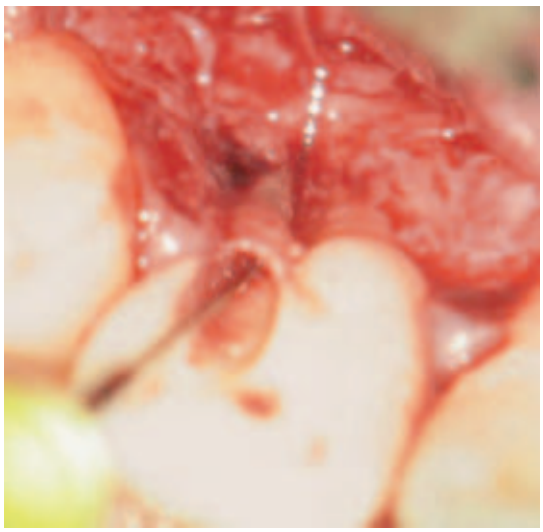

Fig 9 A file in the second root canal showing endodontic-periodontal communication.

rudimentary root was separated using fine burs (Fig 10). This was followed by the removal of the granulation tissue, substance-preserving root planing, and disinfection with 1% chlorhexidine digluconate solution. The mucoperiosteal flap was reset and fixed with retention sutures 7.0 without strain (Fig 11). Five days after the surgery, the sutures were removed.

At the follow-up examinations at 2 weeks, 4 weeks, 8 weeks, 3 months and 6 months after the surgery, the patient had no complaints. The swelling and reddening of the palatal gingiva completely healed. Six months after the conclusion of the treatment, the sulcus probing depths were without pathosis (Figs 12 and 13).

The amputated root was fixed in 4% formalin solution for further histological study.

Macroscopic evaluation

The amputated root was 6.5 mm in length with a mesio-lateral root canal. Assessment was carried out under a Leica MZ 12 reflected-light microscope (Leica, Heerbrugg, Switzerland) at 15–100x magnification. On the apical foramen, a wide slit-type extension was noticeable that continued coronally on the palatal root surface. The groove was later closed with calcified tooth substance (Figs 14 and 15).

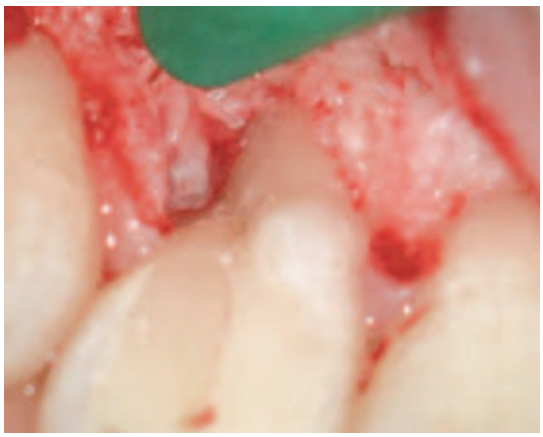

Fig 10 The access cavity was sealed with composite resin after the accessory root was resected.

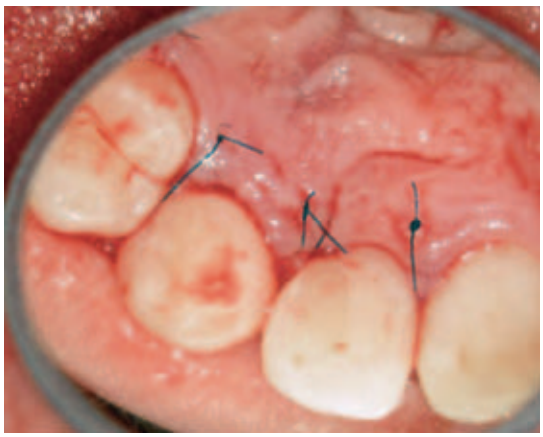

Fig 11 The flap was fixed with single sutures 7.0 without strain.

Fig 12 Palatal view at 6 months follow-up.

Fig 13 Radiograph of tooth 12 at 6 months follow-up demonstrating the lack of apical pathosis.

Fig 14 Macroscopic view of the resected root. The groove can be found along the root surface, partially closed by hard tissue.

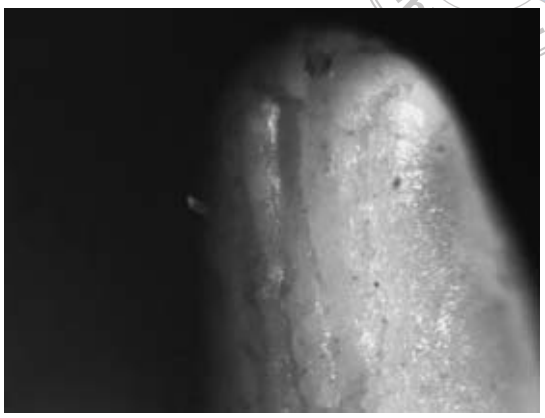

Fig 15 The apical foramen showing a wide slit-type extension.

Microscopic evaluation

After dehydration in an anodic alcoholic solution, the root was embedded in paraffin. Using a sliding microtome (HM 400R, Microm; RM2115, Leica-Microsystems, Bensheim, Germany) from apical to coronal, sections of 3–6 µm were cut every 1 mm and placed on slides. The sections were dried overnight in an incubator at 37°C, stained with haematoxylin and eosin (HE), and mounted.

Observation and photography of the histological results were performed using an Olympus BX-61 microscope (Olympus, Hamburg, Germany).

The sections showed the lateral position of the root canal. The root canal had an oval form in the vestibulo-palatal direction (Fig 16a). Necrotic pulp tissue with the apposition of tertiary dentine was found inside the root canal (Fig 16b).

On the palatal surface, the root contour was interrupted. While the apical specimen revealed an open root canal (Figs 16c and 16d), the more coronal parts contained a deposition of an amorphous calcified tooth substance (Fig 16e). The side opposite the groove also showed apposition of irregular dentine (Figs 16a and 16b).

The histological findings confirm the existence of an accessory root with an independent root canal system. The atypical position of the root canal and the form of the original root canal indicate a broad and direct contact of pulp and periodontium that was only closed with irregular dentine by the regenerative performance of the pulp after the formation of the root. Several side canals of different sizes can be seen in the area of the hard tissue closure (Figs 16a to 16c, 16e).

Discussion

With a prevalence of 2–5%, the PRG is one of the rare anomalies in tooth development[2,17,25,26]. The clinical relevance of PRG is the danger of microbial colonisation and a subsequent endodontic-periodontal lesion[10,11,15,27]. The reason for microbial colonisation is the missing epithelial and desmodontal tissues and the presence of irregular calcified tooth tissue. The depth and the extension of the groove do not seem to be important. The existence of a groove with a connection to the gingival sulcus facilitates the microbial colonisation of irregular hard tissue structures. The frequent existence of accessory canals[27] and the partially unclosed groove allow microbial penetration and the retrograde infection of the pulp.

The prognosis for the preservation of the tooth depends on an early diagnosis of the malformation, adequate treatment and prophylaxis. An incorrect or delayed diagnosis decreases the prognosis and could result in the extraction of the tooth[8,14-17].

In the present case, a root resection was intended because of the continued patient complaints and the persisting fistula. The PRG and the rudimentary root had been overlooked for several years so the

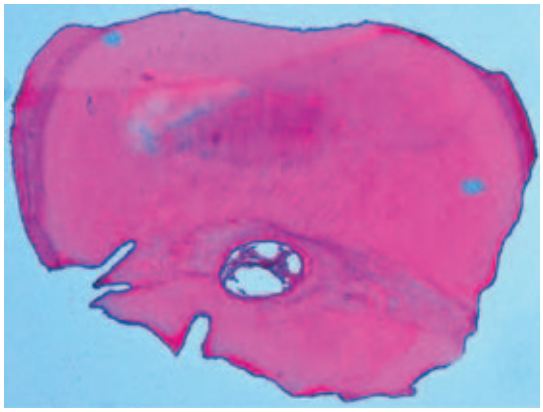

Fig 16a Histological overview of the resected root in the coronal third. The root canal has an atypical lateral position (haematoxylin and eosin staining, original magnification 10x).

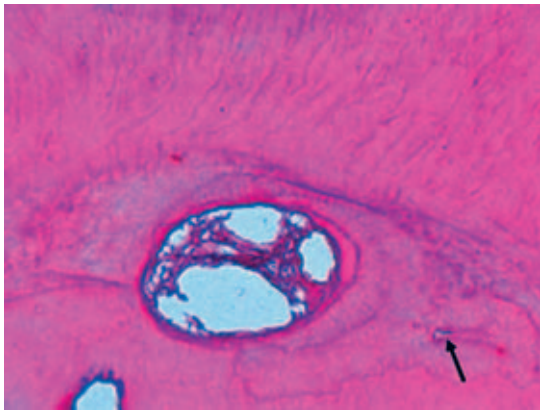

Fig 16b Soft tissue, erythrocytes and tertiary dentine were located inside the root canal. An accessory canal can be seen (arrow) (haematoxylin and eosin staining, original magnification 40x).

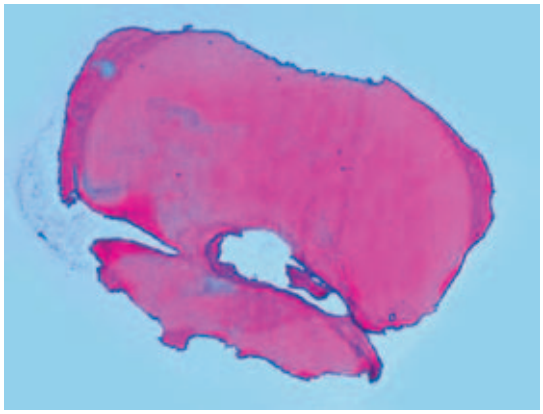

Fig 16c Section of the end of the middle third. The root canal has an expended oval form. The zone of closure with irregular dentine is smaller than in the coronal third (haematoxylin and eosin staining, original magnification 10x).

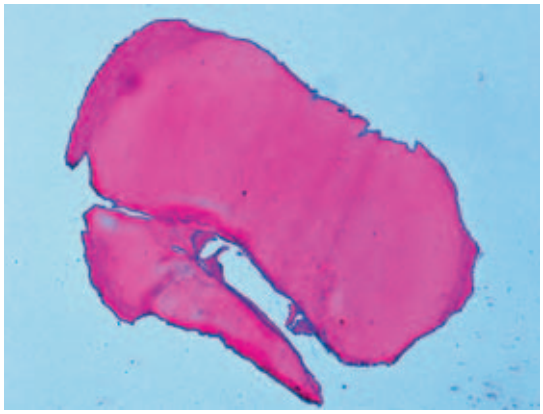

Fig 16d At the end of the root, the canal is open (haematoxylin and eosin staining, original magnification 10x).

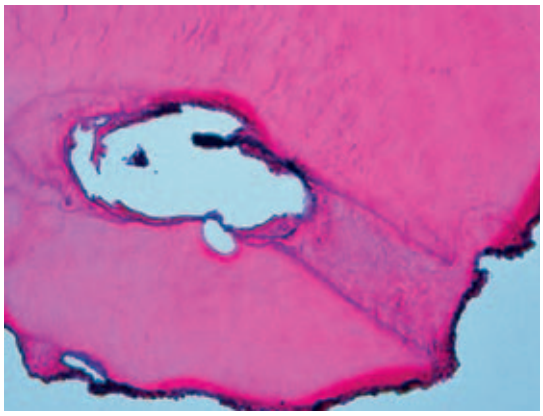

Fig 16e Section of the coronal third. The groove is filled with irregular dentine-like material (haematoxylin and eosin staining, original magnification 40x).

preservation of the tooth was endangered due to the unsettled pathogenesis. In the present case, a rare PRG was found on a maxillary bi-rooted lateral incisor. The deep groove extended as far as the apex of the rudimentary root and was filled with dentine-like material. On the whole course of the groove, single communications between the root canal and the periodontium were macroscopically and microscopically visible. During the surgical procedure, it was found that an unusual communication of the root canal with the periodontium existed approximately 2 mm below the furcation. The histological examination confirmed the macroscopic impression of an incomplete additional root.

The aetiology is not yet clarified. The closure with irregular dentine could confirm that a defect of the Hertwig's sheath is responsible for the formation of the groove. Due to the different growth patterns of the front and back dental lamella, it is presumed that a folding of the tooth bud took place during root formation.

On the basis of the described pain symptoms radiating from the caries- and filling-free tooth 12, with simultaneous swelling and fistula formation in the area of the marginal gingiva, a retrograde pulpitis and subsequent pulp necrosis is assumed. Re-infection of the root canal system, after the primary root canal treatment along the palatal groove, occurred in the present case, resulting in a persisting extra-radicular infection. This explains the fetid smell perceived during the retreatment, despite the fact that the access cavity was tightly sealed with a composite filling. Morphological studies confirm that grooves are often associated with lateral canals[3,6].

Before initiating periodontal surgery, retreatment of the primary root canal filling was required due to the re-infection of the root canal system. The complete course of the second root canal could not be found by orthograde access or with surgical treatment procedures. The lack of periodontal anchorage up to the apex and the peri-radicular bone loss were further reasons to remove the accessory root. With shortened accessory roots and a completely formed furcation, the amputation of the root is recommended as the therapy of choice[9].

After conditioning of the root surface, the periodontal defect is often filled with bone substitute materials[19,20,25,28]. This minimally invasive procedure combined with cement-preserving root planing may also be successfully applied, as shown in the present case[15].

On a macroscopic level, the degree and course of the groove could only be estimated. Only the histological examination clearly revealed that the groove extended up to the pulp chamber. Although an increased apposition of cement and a reduced dentine thickness[1,3] in the groove cannot be confirmed in the present case, a deformation in the pulp chamber was noticeable. The communication between the periodontium and the pulp tissue resulted in an apposition of secondary and irregular dentine and led to repaired closure of the open root canal.

Conclusions

Root retractions and grooves can favour the development of local periodontal diseases. Understanding the morphology and the possible malformations of maxillary lateral incisors is essential for early diagnosis of PRG[7,9]. Owing to the genetic disposition discussed above, first-degree relatives should be included in the early diagnosis. Regular check-ups with a magnifying glass or dental microscopes, and the application of a special prophylaxis, reduce the risk of periodontal and subsequent endodontic treatments[1,26].

Differential diagnoses of a PRG are: vertical root fracture, consecutive symptoms after a dental trauma, marginal periodontitis, apical periodontitis, and endodontic-periodontal lesions. These clinical pictures should be taken into consideration during the diagnosis. Understanding of the pathogenesis of a PRG allows for successful causal therapy.

In the case of a PRG with a direct communication to the periodontal tissues, it is possible to preserve the tooth with a combined endodontic and periodontal treatment. The application of the dental microscope during the differentiation of additional root canals facilitates the endodontic diagnosis and therapy. Surgery can be carried out in a minimally invasive fashion, thereby allowing rapid healing with a reduced risk of post-operative complications. Close follow-up examinations should be arranged for plaque control and local disinfection.

Acknowledgements

The author wishes to thank Prof Dr W Klimm (Department of Operative Dentistry and Endodontology), Dr Ing Gert Richter (Department of Prosthetic Dentistry) and Mrs Kleiber (all University of Dresden, Germany) for the histological evaluation.

References

1. Lara VS, Consolaro A, Bruce RS. Macroscopic and microscopic analysis of the palato-gingival groove. J Endod 2000;26:345-350.
2. Hou GL, Tsai CC. Relationship between palato-radicular grooves and localized periodontitis. J Clin Periodontol 1993;20:678-682.
3. Ennes JP, Lara VS. Comparative morphological analysis of the root developmental groove with the palato-gingival groove. Oral Dis 2004;10:378-382.
4. Black GV. Operative dentistry: pathology of the hard tissues of teeth. Chicago: Medico-Dental Publishing, 1908.
5. Atkinson SR. The permanent maxillary lateral incisor. Am J Orthodont 1943;29:685-688.
6. Goon WW, Carpenter WM, Brace NM, Ahlfeld RJ. Complex facial radicular groove in a maxillary lateral incisor J Endod 1991;17:244-248.
7. Paul BF. Surgical management of the palato-radicular groove and associated periodontal lesion: a case presentation. Pract Periodont Aesthet Dent 1993;5:25-28.
8. August DS. The radicular lingual groove: an overlooked differential diagnosis. J Am Dent Assoc 1978;96: 1037-1039.
9. Wei PC, Geivelis M, Chan CP, Ju YR. Successful treatment of pulpal-periodontal combined lesion in a birooted maxillary lateral incisor with concomitant palato-radicular groove. A case report. J Periodontol 1999;70:1540-1546.
10. Kerezoudis NP, Siskos GJ, Tsatsas V. Bilateral buccal radicular groove in maxillary incisors: case report. Int Endod J 2003;36:898-906.
11. Friedman S, Goultschin J. The radicular palatal groove: a therapeutic modality. Endod Dent Traumatol 1988;4: 282-286.
12. Kogon SL. The prevalence, location and conformation of palato-radicular grooves in maxillary incisors. J Periodontol 1986;57:231-234.
13. Withers JA, Brunsvold MA, Killoy WJ, Rahe AJ. The relationship of palato-gingival grooves to localized periodontal disease. J Periodontol 1981;52:41-44.
14. Mauro S, Orlando L, Panzoni R, Orlando PF. Groove associated periodontitis: classification proposal and clinical case report. Minerva Stomatol 2005;54:79-89.
15. Schäfer E, Cankay R, Ott K. Malformations in maxillary incisors: case report of radicular palatal groove. Endod Dent Traumatol 2000;16:132-137.
16. Fabra-Campos H. Failure of endodontic treatment due to a palatal gingival groove in a maxillary lateral incisor with talon cusp and two root canals. J Endod 1990;16:342-345.
17. Brunsvold MA. Palato-gingival grooves: hidden etiologic factors of periodontitis. Tex Dent J 1991;108:27-31.
18. Brunsvold MA. Amalgam restoration of a palatogingival groove. Gen Dent 1985;33:244-246.
19. Andreana S. A combined approach for treatment of developmental groove associated periodontal defect. A case report. J Periodontol 1998;69:601-607.
20. Simon JH, Dogan H, Ceresa LM, Silver GK. The radicular groove: its potential clinical significance. J Endod 2000;26:295-298.
21. Al-Hezaimi K, Naghshbandi J, Simon JH, Oglesby S, Rotstein I. Successful treatment of a radicular groove by intentional replantation and Emdogain therapy. Dent Traumatol 2004;20:226-228.
22. Estrela C, Pereira HL, Pecora JD. Radicular grooves in maxillary lateral incisor: case report. Braz Dent J 1995;6:143-146.
23. Brooks JK, Tiwary R. Bizarre pathologic tooth migration. Gen Dent 2006;54:123-124.
24. Arnold M. Das Dentalmikroskop: Grundlage für bewährte und neue Verfahren bei der Wurzelkanalbehandlung. Endodontie 2007;16:105-114.
25. Schwartz SA, Koch MA, Deas DE, Powell CA. Combined endodontic-periodontic treatment of a palatal groove: a case report. J Endod 2006;32:573-578.
26. Klimm W. Endodontologie: Grundlagen und Praxis. Dtsch Zahnärzteverlag 2003:73.
27. Gao ZR, Shi JN, Wang Y, Gu FY. Scanning electron microscopic investigation of maxillary lateral incisors with a radicular lingual groove. Oral Surg Oral Med Oral Pathol 1989;68:462-466.
28. Jeng JH, Lu HK, Hou LT. Treatment of an osseous lesion associated with a severe palato-radicular groove: a case report. J Periodontol 1992;63:708-712.