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Multidisciplinary considerations for the management of palatogingival grooves on incisor teeth: a literature review

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Abstract

A palatogingival groove is just one of the many morphological abnormalities that may affect the 'embryologically hazardous' region of the maxillary lateral incisor tooth. Although reports of their prevalence are inconsistent, they are not an uncommon finding in clinical practice. Palatogingival grooves may predispose a tooth to localised periodontal attachment loss and/or endodontic pathology. Morphological variations associated with the grooves may complicate treatment from a periodontal, endodontic or prosthodontic perspective. Thus, the management of a palatogingival groove may necessitate a multidisciplinary approach. This article will provide an overview of the morphology, development and prevalence of palatogingival grooves, and an update on the diagnosis and numerous therapeutic options available.

Introduction

Palatogingival grooves on incisor teeth have been known by many names, including palatal, radicular, palato-radicular, longitudinal, developmental, dento-gingival, cingulo-radicular and radicular-lingual grooves. The groove begins in the central fossa, crosses the cingulum and may terminate at the cemento-enamel junction, or extend for a variable distance onto the root, usually in a disto-apical direction (Everett and Kramer, 1972; Withers et al., 1981). Palatogingival grooves also vary in their depth, and may be associated with an accessory root (Peikoff et al., 1985; Wei et al., 1999). They predominantly affect maxillary lateral incisors, but may also be found on maxillary central incisors (Pécora and da Cruz Filho, 1992). Grooves are most commonly located on the palatal surface, although they infrequently occur on the labial surface (Kozlovsky et al., 1988; Goon et al., 1991; Kerezoudis et al., 2003). The diagnosis and management of palatogingival grooves can be complicated and often requires a multidisciplinary approach.

Morphology

The morphology of palatogingival grooves has been studied using various techniques, and is variable and complex. One study, which investigated the macro- and microscopic features of extracted teeth with palatogingival grooves, found that nine out of the 13 teeth studied had grooves which extended into the apical third of the root (Lara et al., 2000). Deformities of the pulp chamber and thinning of the overlying enamel and dentine were also noted in the majority of specimens. More recently, using micro-computed tomography (micro-CT), the anatomy of palatogingival grooves and their associated root canals were studied and classified (Gu, 2011). Type I grooves remained within the coronal third of the tooth, Type II were shallow grooves extending past the coronal third, and Type III grooves also extended past the coronal third, but were deep and associated with complex root canal anatomy. Of 11 lateral incisor specimens, six had a groove on the distal surface, three on the mesial surface, one with both mesial and distal grooves, and one with a medial groove (Gu, 2011).

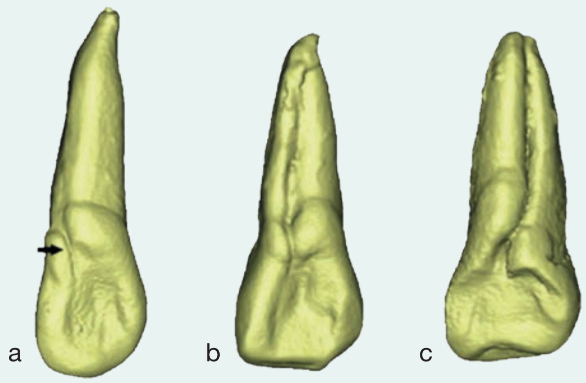

Figure 1. Three-dimensional reconstructions of micro-CT images of extracted maxillary lateral incisor teeth with palatogingival grooves (Gu, 2011).

Specimen A has a Type I groove located on the mesial aspect of the tooth; Specimen B has a Type II groove that extends to the apex on the mesial aspect of the tooth; Specimen C has a deep Type III radicular groove extending to the apex on the medial surface of the tooth, which was associated with a C-shaped canal.

Development

The maxillary lateral incisor region was termed an 'embryological hazard' due to its susceptibility to a variety of developmental defects, including dens-in-dente; diminutive, supernumerary, or congenitally missing teeth; and globulomaxillary cysts (Everett and Kramer, 1972). The palatogingival groove is a developmental anomaly formed by an in-folding of

Hertwig's epithelial root sheath and the internal enamel epithelium (Matthews and Tabesh, 2004). The tooth-germ of the maxillary lateral incisor is thought to be susceptible to folding due to its position during maxillary growth, surrounded by teeth at a more advanced stage of development (Lara et al., 2000). Nevertheless, the aetiology of the palatogingival groove is not well understood: it may be a mild form of dens invaginatus (Lee et al., 1968; Everett and Kramer, 1972) or an incomplete attempt to form an additional root (Peikoff et al., 1985). More recently, the folded tooth-germ theory has been called into question, as Ennes and Lara (2004) claimed the cellular mediators released during maxillary growth would induce bone resorption, allowing enough space for the growing tooth-germ. In addition, these authors conducted a morphological comparison between palatogingival grooves and root developmental grooves (a normal anatomical feature), and reported several ultrastructural similarities between the two. This led to the suggestion that an alteration of genetic mechanisms may influence the development of a palatogingival groove (Ennes and Lara, 2004).

Prevalence

The reported prevalence of palatogingival grooves varies widely, and they may affect between 2.9-30.2% of maxillary lateral incisors (Everett and Kramer, 1972; Hou and Tsai, 1993). A summary of papers reporting on the prevalence of palatogingival grooves is presented in Table 1. There is considerable heterogeneity between these studies and differences in study design may account for much of this variation. Different diagnostic criteria were used, and those studies which only included grooves extending past the cemento-enamel junction (CEJ) (Withers et al., 1981; Bačić et al., 1990; Pécora and da Cruz Filho, 1992; Hou and Tsai, 1993) generally reported a lower prevalence than those studies which included all discernible grooves. Furthermore, some studies were conducted in vivo with various clinical detection methods, others in vitro, all with differences in sample size, age and racial origin of patients. The highest prevalence was reported by Hou and Tsai (1993) who found palatogingival grooves in 30.2% of maxillary lateral incisor teeth in a Chinese sample, suggestive of a possible racial predilection.

The direct interpretation and comparison of prevalence data is further impeded by differences in the reporting of results. The prevalence of palatogingival grooves has been reported either as a proportion of all lateral incisors; of all maxillary incisors, including central incisors; or per patient. In addition, studies which examined extracted teeth may be biased, as periodontal or endodontic complications associated with the groove may have predisposed the teeth to early removal. Clinical diagnostic methods such as visual examination, microscopy and probing were frequently used, often

Table 1. Comparison of prevalence data on palatogingival grooves

Study	Reported prevalence	Method of detection	Diagnostic criteria	Sample
Everett and Kramer, 1972	2.9% of maxillary lateral incisors 0.5% extended to apex	Inspection of extracted teeth	Any coronal or radicular grooving	625 extracted maxillary lateral incisors
Withers et al., 1981	8.5% of patients 4.4% of maxillary lateral incisors 2.3% of maxillary incisors	Clinical exam only	Only grooves at or past the CEJ included	531 patients
Kogon, 1986	5.6% of maxillary lateral incisors 4.6% of maxillary incisors	Inspection of extracted teeth with magnification	Any coronal or radicular grooving	3168 extracted maxillary incisors 1786 laterals, 1382 centrals
Bačić et al., 1990	1.01% of young males 0.79% of incisors in adults with periodontitis	Clinical exam and radiograph	Only grooves extending past the CEJ included	1081 young males 634 adult periodontal patients
Hou and Tsai, 1993	30.2% of maxillary lateral incisors 18.1% of maxillary incisors	Clinical exam, probing, flap operation, and magnification	Only grooves at or past CEJ included	101 patients 404 incisors
Pécora and da Cruz Filho, 1995	3.9% of patients 3% of maxillary lateral incisors	Clinical exam, probing, and magnification	Only grooves extending past the CEJ included	642 patients
Storrer et al., 2006	9.6% of maxillary lateral incisors	Inspection of extracted teeth, digital contour measurement	Not stated	73 extracted maxillary lateral incisors
Arslan et al., 2014	2.3% of maxillary lateral incisors 1.4% of maxillary incisors	Inspection of CBCT images	Any grooving (classified according to Gu, 2011)	1969 CBCT images of maxillary anterior teeth (651 lateral incisors)

together with adjunctive radiography. To date, only one study has used cone-beam computed tomography (CBCT) to determine the prevalence of palatogingival grooves. This retrospective study by Arslan et al. (2014) examined 1969 CBCT images taken in a Turkish hospital for various other dental or maxillofacial reasons. Palatogingival grooves were identified in 2.3% of maxillary lateral incisors and 0.6% of maxillary central incisors. The majority (68.4%) of grooves identified were Type I (Gu, 2011), and bilateral grooves of the maxillary lateral incisors were found in just two patients. Three-dimensional imaging has benefits for the accurate detection of palatogingival grooves and it is likely that it will be utilised in future research to obtain more accurate estimates of their prevalence.

Diagnosis

Diagnosis of a palatogingival groove is primarily made by visual inspection of the tooth for the coronal aspect of the groove, in combination with periodontal probing (Arslan et al., 2014). Probing of the area may reveal a narrow, localised periodontal pocket of varying depth, although this can be difficult to detect (Withers et al., 1981). Clinical probing will only detect a groove where attachment loss has already occurred, and therefore it is less useful for the diagnosis of shallow grooves or those in young patients where periodontal destruction has not yet occurred. Palatogingival grooves are usually asymptomatic unless advanced periodontal destruction or pulpal involvement has occurred (Attam et al., 2010). Where attachment loss is severe, a lesion associated with a palatogingival groove may be misdiagnosed as a periodontal abscess.

The clinical diagnosis may be supplemented by a radiographic examination. Conventional periapical radiography may show periodontal attachment loss and/or periapical pathology, and when taken in the correct plane, the palatogingival groove may appear as a thin vertical line, mesial or distal to the pulp space, known as a parapulpal line (Everett and Kramer, 1972). This may have a similar radiographic appearance to a vertical root fracture or an additional root canal, so careful diagnosis is required (Attam et al., 2010). Case studies have advocated the use of spiral computed tomography (Rachana et al., 2007; Gandhi et al., 2011) and cone-beam computed tomography (CBCT) (Rajput et al., 2012; Castelo-Baz et al., 2015) in the detection and characterisation of palatogingival grooves, although the higher radiation dose should be considered before using this type of imaging for routine diagnosis.

Figure 2. Periapical radiograph of a maxillary lateral incisor showing a parapulpal line adjacent to the pulp chamber and an associated periapical radiolucency (Rajput et al., 2012).

Implications

Periodontal

A palatogingival groove is a local tooth-related predisposing factor, which encourages the accumulation of bacterial plaque and calculus, and thus predisposes a tooth to localised periodontitis (Kornman and Löe, 1993). The palatogingival groove is an important contributing factor to localised periodontal disease, as its funnel-like shape offers a niche for plaque accumulation, which is difficult for the patient and clinician to access for oral hygiene.

An association between palatogingival grooves and poorer periodontal health was demonstrated by Withers et al. (1981), where maxillary incisor teeth with palatogingival grooves were associated with greater plaque accumulation, bleeding on probing and loss of attachment. Further research confirmed this relationship, and Bačić et al. (1990) reported the mean pocket probing depth was more than twice as deep in the region of the groove (8.8 mm) than around the other anterior teeth (4.0 mm) in patients with periodontitis. Deeper grooves and those located at a more mesial or distal position have been associated with greater pocket probing depths (Hou and Tsai, 1993). The localised periodontal destruction associated with a palatogingival groove may be overlooked until such time that severe periodontal attachment loss and/or pulpal involvement has developed (Attam et al., 2010).

Endodontic

Palatogingival grooves may communicate with the pulp space which can lead to endodontic pathology (Peikoff et al., 1985). This may occur via direct pulpal extension of the groove, extension of periodontal attachment loss to the apical foramen, or through accessory canals present along the length of the groove (Pack and Chandler, 1996). One scanning electron microscope study found accessory foramina to be present in nearly all samples of maxillary lateral incisors with a palatogingival groove, and proposed that these were the main pathway of communication between the pulp and the periodontium (Gao et al., 1989). Communications may lead to a combined endodontic-periodontal lesion, which may be misdiagnosed as a primary endodontic lesion (Attam et al., 2010). The primary lesion is usually periodontal, although in some cases it may be endodontic, or the endodontic and periodontal lesions may exist independently of each other (Rotstein and Simon, 2004; Castelo-Baz et al., 2015).

Maxillary incisor teeth with palatogingival grooves may also present with abnormal root canal anatomy, such as a teardrop or C-shaped canal (Schwartz et al., 2006), transverse canal, apical delta, or secondary canal (Gu, 2011). Although the use of 3-D imaging such as CBCT assists in the detection of complicated root canal anatomy, failure to identify and negotiate these canals may preclude endodontic success (Gu, 2011). Thinner enamel and dentine corresponding to the location of the groove was reported by Lara et al. (2000), who suggested the shorter dentinal tubules may promote bacterial penetration and subsequent pulp involvement. The reduced dentinal thickness in the region of the palatogingival groove should be borne in mind during endodontic treatment of incisors with palatogingival grooves in order to prevent perforation. Where there is evidence of apical periodontitis and/or the affected tooth is non-responsive to vitality testing, endodontic treatment forms an important aspect of the management of a tooth with a palatogingival groove. Nevertheless, root canal treatment in itself is futile unless the local factor and primary periodontal pathology are also treated appropriately (Lara et al., 2000).

Prosthodontic

Fixed prosthodontic treatment for teeth with palatogingival grooves requires careful planning and execution. A tooth with a deep or extensive groove, or an associated periodontal pocket, may not be a suitable abutment for a fixed prosthodontic restoration (Pécora and da Cruz Filho, 1995). In cases where a crown is deemed appropriate, the relationship between the groove and the planned margin of the restoration must be considered. Where a deep or tubular groove is present, fabrication of a crown which completely seals the defect may not be possible (Kogon, 1986). Shallower grooves are less likely to impact on the provision of fixed prosthodontic treatment. However, palatogingival grooves which cross the cemento-enamel junction may be associated with localised displacement of the junction (Kogon, 1986). The crown preparation should be thoroughly examined to ensure that no unsupported enamel remains in this region as a consequence of the altered position of the cemento-enamel junction.

Extraction may be the treatment of choice in cases where a palatogingival groove has caused severe periodontal attachment loss and/or loss of pulpal vitality (Everett and Kramer, 1972). This may be followed by a conventional tooth replacement option, such as a resin-bonded bridge or implant-supported restoration. A palatogingival groove, once exposed, acts as a reservoir for further plaque accumulation, which perpetuates attachment loss. It is therefore preferable that the affected tooth is extracted before the periodontal lesion causes extensive destruction of the alveolar bone. The planned prosthodontic rehabilitation may be compromised if there has been a significant loss of alveolar bone volume. A bridge may require a longer pontic to account for the loss of bone, which would impair the aesthetic outcome. Discrepancies in the alveolar bone height compared with the adjacent teeth may complicate implant placement and/or require extensive bone grafting if an implant-supported restoration is selected. This may also compromise the aesthetic success (Darby et al., 2009).

Management

The prognosis of a palatogingival groove depends on its depth, location, extent and pulp involvement (Lara et al., 2000). However, treatment success depends largely on the ability to manage the associated periodontal defect (Schwartz et al., 2006). Root canal treatment is indicated when the pulp is infected, and is required in a majority of cases (Brunsvold, 1985). The management of palatogingival grooves has not been appraised by a controlled investigation, but a number of case reports have been published detailing various successful methods of treatment (Bačić et al., 1990; Andreana, 1998; Castelo-Baz et al., 2015).

In cases where a coronal groove can be detected but there is no associated attachment loss, regular scaling, oral hygiene and a close observation period is recommended to monitor for the development of periodontal pocketing (Everett and Kramer, 1972). Shallow coronal grooves may be removed by odontoplasty (saucerisation) with scaling and debridement of the associated minor periodontal defect (Jeng et al., 1992).

Where the attachment loss is moderate, a surgical flap is usually required to gain access for thorough debridement of the area. This is usually done in conjunction with odontoplasty and/or sealing of the groove with a restorative material (Castelo-Baz et al., 2015). Amalgam, composite, glass ionomer, Biodentine and mineral trioxide aggregate (MTA) have been used for this purpose (Brunsvold, 1985; Attam et al., 2010; Mittal et al., 2013; Johns et al., 2014; Garrido et al., 2016). Although MTA has good biocompatibility and the ability to set despite the presence of moisture, its handling can be problematic and it may be washed out from grooves which span the gingival margin (Attam et al., 2010). Glass ionomer has been advocated due to its good sealing ability, antibacterial action, and evidence which suggests that it may be conducive to the formation of epithelial and connective tissue attachment during periodontal healing (Maldonado et al., 1978; Dragoo, 1997; Vermeersch et al., 2005).

In the past, teeth with more complex periodontal defects were considered to have a hopeless prognosis and were extracted (Withers et al., 1981). However, periodontal regeneration procedures have improved the outlook for these teeth, by use of a mechanical barrier which excludes unwanted epithelial and connective tissue cells to encourage the repopulation of periodontal ligament, cementum and bone cells (Melcher, 1976). Anderegg and Metzler (1993) published a report of ten cases whereby palatal grooves on maxillary lateral incisors were treated with root planing and placement of a non-resorbable membrane. All cases showed improvements, and a mean attachment gain of 5 mm was reported after six months of follow-up. Many other case reports have reported successful outcomes using a variety of guided tissue regeneration techniques, including bone grafting (Schwartz et al., 2006; Attam et al., 2010), platelet-rich fibrin (Johns et al., 2014), and enamel matrix proteins (Zucchelli et al., 2006; Castelo-Baz et al., 2015).

Other authors have documented cases of intentional replantation of teeth affected by palatogingival grooves. Al-Hezaimi et al. (2009) published follow-up data of a maxillary lateral incisor, which was root filled then subsequently extracted. The groove was removed and treated with an enamel matrix protein derivative, before the tooth was re-implanted and splinted. At four years, the tooth was asymptomatic, with no periapical pathology, and the periodontal probing depth had reduced from 13 mm to 3 mm. A similar case was recently published which did not use an enamel matrix protein derivative, but reported successful resolution of both the deep, narrow periodontal pocket and the periapical radiolucency at 12 months (Garrido et al., 2016). The authors suggest that intentional replantation is a predictable and reliable procedure, which should be considered as an option for the management of teeth with palatogingival grooves.

Summary

Palatogingival grooves are not an uncommon finding in maxillary lateral incisor teeth. An awareness among dentists is important to aid early detection and prevent the development of destructive sequelae. Once a groove becomes exposed, it may act as a niche for plaque accumulation and thus predispose a tooth to localised periodontal attachment loss. Communication between the palatogingival groove and the pulp chamber may lead to development of a combined periodontal-endodontic lesion. Endodontic and prosthodontic therapy may be challenging due to anatomical variations associated with the groove. The successful management of a tooth with a palatogingival groove requires an understanding of the factors contributing to the disease process, and often requires a multidisciplinary approach. The depth and extent of the palatogingival groove and the associated periodontal lesion dictates the management, and a range of treatment strategies have been documented in the literature.

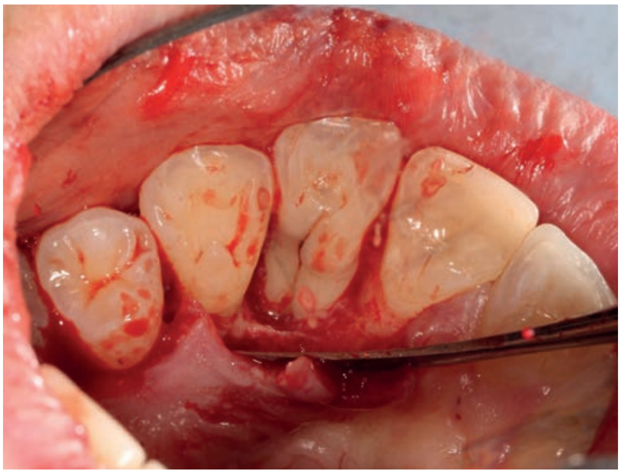

Figure 3a: Intra-operative photograph of a maxillary lateral incisor with a palatogingival groove.

The palatal flap reflection shows the apical extension of the groove and the corresponding alveolar bone defect.

(Courtesy of Dr Jenny Liu, Periodontist, Auckland).

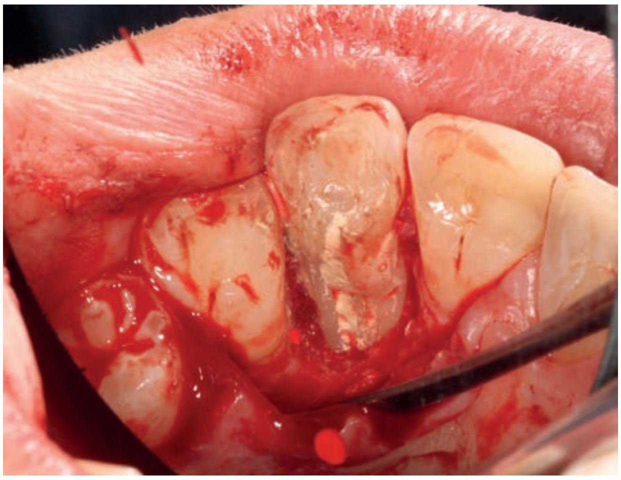

Figure 3b: Intra-operative photograph of a palatogingival groove following saucerisation, placement of a biodentine restoration, and recontouring of the alveolar bone defect.

Initially, probing depth measurements of 8-10mm were recorded on the palatal surface, with associated suppuration and bleeding. At 1 year follow-up, the probing depths had reduced to 2-3mm and no bleeding or suppuration was noted. This tooth remains stable and functional, more than 5 years post-operatively.

(Courtesy of Dr Jenny Liu, Periodontist, Auckland).

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