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Palatal groove associated with periodontal lesions: a systematic review illustrated by a decisional tree for management

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Abstract

Background Palatal groove represents a relatively uncommon developmental root anomaly, usually found on the palatal aspect of maxillary incisors. While its origin is controversial, its presence predisposes to severe periodontal defects.

Aim This study aimed to provide a systematic review of the literature focusing on the varied diagnostic techniques and treatment modalities for periodontal lesions arising from the presence of palatal groove. Based on the existing evidence and knowledge, the study also provides a comprehensive decisional tree, guiding clinicians in the challenging decision-making process face to a palatal groove.

Methods The literature search was conducted on Medline and Cochrane databases by two independent reviewers, who also performed the screening and selection process, looking for English written articles reporting on diagnosis and management (all treatment approaches) of periodontal lesion(s) associated with a palatal groove. Based on this literature, a comprehensive decisional tree, including a standardized palatal groove evaluation and tailored treatment approaches, is proposed. Moreover, a clinical case is described to demonstrate the practical application of the developed decisional tree.

Results Over a total of 451 articles initially identified, 34 were selected, describing 40 patients with 40 periodontal lesions associated with palatal grooves. The case report illustrates a deep, large, circumferential intra-bony defect on the palatal side of the tooth #22 associated with a shallow, moderately long palatal groove in an 18-year-old male patient. Following reevaluation, a single flap surgery was deemed necessary, combined with a regenerative procedure. At 2 years post-treatment, the tooth #22 is healthy, in a functional and esthetic position. The decision-making process, based on local and systemic patient's conditions, should allow an early and precise diagnosis to prevent further complications and undertake an adequate treatment.

Conclusion Palatal grooves are relatively rare; however, they are frequently associated with severe periodontal defects. The identification, diagnosis, prompt, and tailored management of the associated lesion is essential to mitigate potential periodontal and endodontic complications related to the presence of palatal groove.

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Keywords Palatal groove, Palatal radicular groove, Tooth developmental anomaly, Periodontal lesion, Decisional tree

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Introduction

Palatal groove (PG) is defined as an anatomic anomaly characterized by the presence of a developmental groove on a dental root that, when present, is usually found on the palatal aspect of maxillary incisors [1]. Over the years, several terms have been used to describe this anomaly, including palatal or palate-gingival groove [2, 3], developmental radicular anomaly [4], distolingual groove [5], radicular lingual groove [6, 7], palatoradicular groove [8, 9], radicular groove [10], and cinguloradicular groove [11].

The origin of the PG is controversial, but it is assumed to be related to the infolding of the enamel organ or Hertwig epithelial root sheath during the tooth development [12]. Additional hypogenetic root formation [13, 14] as well as an altered genetic mechanism [15] have also been suggested.

PG is relatively rare. Everett et al. [5] reported a prevalence of PG on 2.8% of lateral incisors whereas Withers et al. [16] observed a PG on 2.3% of maxillary incisors (4.4% of maxillary laterals and 0.28% of maxillary centrals). Kogon et al. [8] examined 3168 extracted maxillary central and lateral incisors and found PG on 4.6% of them (3.4% of maxillary centrals and 5.6% of maxillary lateral incisors), with over half of the PG extending more than 5 mm apical to the cementoenamel junction leading to a localized periodontal lesion. The most recent study by Mazzi-Chevez et al. [17] observed 150 maxillary central incisors, lateral incisors, and canines with a micro-CT and found that PG affected 2% of central incisors and 4% of lateral incisors. In 100% of cases, the PG originated in the enamel.

As the term implies, PG is formed around the cingulum of the tooth and continues apically down from the cementoenamel junction, terminating at various depths and length along the root [18]. In contrast to maxillary bicuspids, incisors generally display a U-shaped groove.

This anatomic anomaly is frequently associated with a breakdown of the periodontal attachment involving the groove; a self-sustaining localized periodontal pocket can develop [4], where the PG itself provides a site for bacterial accumulation. The subsequent progressive inflammation along the PG and its apical portion may lead to periodontal and endodontic pathologic conditions [19]. Furthermore, there may be communication between the pulp canal system and the periodontium through the pulp cavity and/or accessory canals, which may also lead to combined endodontic-periodontal lesions [20]. According to the 2017 classification of periodontal and peri-implant diseases and conditions [21], PG can be classified as a localized tooth-related factor that modifies or predisposes to plaque-induced gingival diseases/periodontitis [22], and can be associated with periodontal abscess in non-periodontitis patients.

The prognosis for teeth with PG extending apically is often poor [12], highlighting the critical need for prompt and accurate diagnosis to avert further periodontal and endodontic complications, ultimately preventing tooth extraction. This study is fundamentally motivated by the scarcity of consolidated guidelines for managing such complex dental conditions. Hence, the objective of this study was to conduct a systematic review of the existing literature, focusing on the diagnosis and management of periodontal lesions linked to PG. Based on this review, the goal was to develop a comprehensive decisional tree, thereby proposing a standardized treatment protocol to aid in the clinical decision-making. This study also includes a clinical case report to demonstrate the practical application of the developed decisional tree, reinforcing its clinical relevance and utility.

Material and methods

Development of the systematic review protocol

A protocol covering all aspects of the systematic review methodology was developed before starting the review. The protocol included the definition of: a focused question; the literature search strategy; the study selection criteria; the outcome measures; the screening methods; the data extraction; and the data synthesis. The protocol was registered in PROSPERO (CRD42022363194).

Defining the focused question

The research question was formulated according to the PICOS (Population, Intervention, Comparison, Outcome, Study) strategy, which identify the search and selection criteria as follows:

P: Patients with periodontal lesion(s) associated with a PG
I: PG identification (diagnosis) and management. All treatment approaches (non-surgical, surgical, with or without the adjunctive use of potentially regenerative materials, i.e. barrier membranes, grafting materials, growth factors/proteins and combinations thereof) were considered.
C: alternative treatment approach or no comparison.
O: periodontal parameters, including clinical attachment level (CAL, measure in mm), probing pocket depth (PPD, measured in mm), recession (REC, measured in mm), plaque index (PI, any validated clinical score), bleeding on probing (BOP) or other inflammatory indexes, radiographic bone loss.
S: Any type of human studies including case reports, with a minimum of 6 weeks follow-up after treat-

ment. Only studies published in English were considered. Studies written in languages other than English, review articles, cell and/or animal studies, letters, editorials, conference summaries, commentaries, and studies considering PG with only an endodontic involvement or that used self-report assessment of treatment outcomes were not considered.

So, the focused question was formulated as follows: what is the efficacy of treatments for periodontal lesions associated with PG?

Search strategy

The literature was searched for articles published up to June 2022 on MEDLINE and Cochrane databases. Multiple combinations of pertinent search terms were employed (Supplemental Table 1). The reference lists of the included studies were also evaluated in order to identify additional articles. To ensure its reproducibility, the PRISMA guidelines were followed [23], and the PRISMA flowchart was filled [24] (Fig. 1).

Literature screening and data extraction

The titles and abstracts of the initially identified studies were screened by two independent reviewers (Y.G. and V.G.). Then, the pre-selected studies underwent a full text evaluation to assess the final inclusion or not. All records for which inclusion was obtained "uncertain" for on reviewer, disagreement was solved by discussion between authors. Whenever needed, the authors of the selected studies were contacted to provide missing data.

Study screening and selection was carried out by using the Rayyan online software [25], which assisted the reviewers in the different step of the literature review process. Duplicate references were removed automatically using Mendeley software. Data extraction was carried out on a dedicated excel spreadsheet. The risk of bias assessment was carried out by using the Joanna Briggs Institute (JBI) scale [26, 27].

Results

The literature search resulted in 451 potentially relevant publications (Fig. 1). After the first selection step, based upon the title and abstract, 88 articles were pre-selected. After full-text evaluation, 34 articles were included and

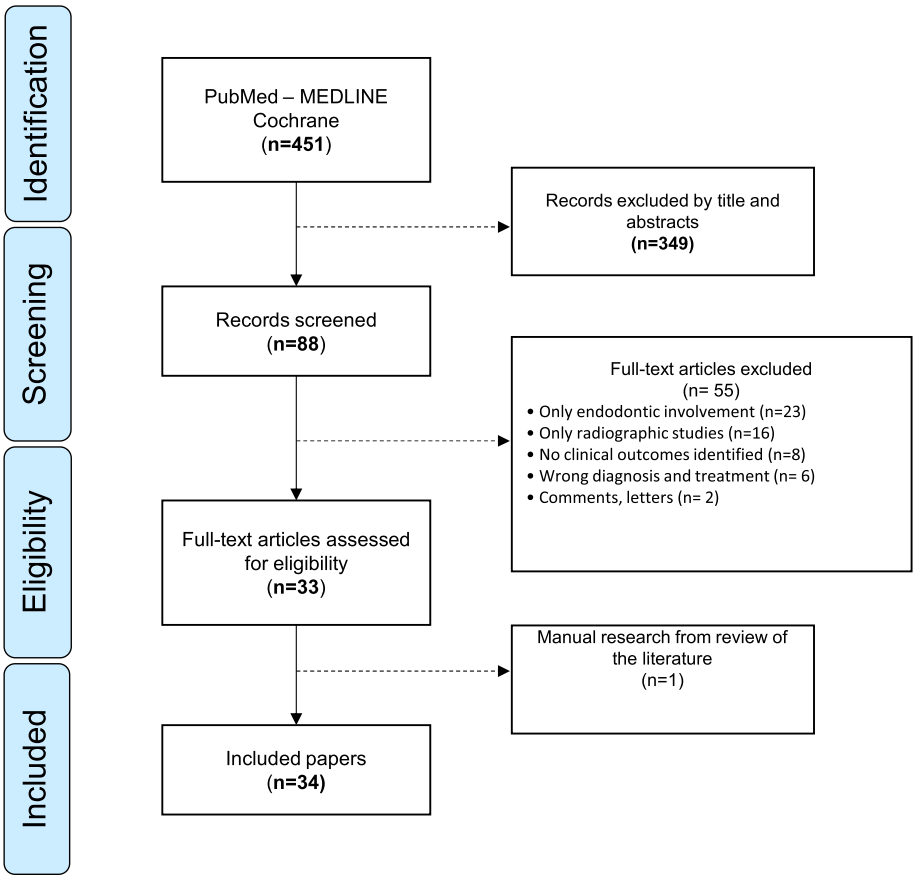

Fig. 1 PRISMA flow diagram on the selection process of the studies included in the systematic review

analyzed. All of them were case series and case reports. A total of 40 patients were described, of which 23 women (57.5%). The characteristics of the selected studies are presented in Table 1. Their quality assessment is reported in Table 2.

Qualitative synthesis of the literature

Among those 40 clinical cases, 12 cases report failed to provide a clinical description of the PG. Four studies described the PG depth alone, 17 studies described the PG length alone, and 7 studies provided a combined description of depth and length of the PG. From a periodontal point of view, the periodontal lesion morphology was correctly described (depth and width) in only 4 cases, 2 of which also reported the number of bony walls. Among the 22 cases reporting a diagnosis, 17 (77.3%) described combined endo-periodontal lesions, whereas 5 were purely periodontal lesions.

Endodontic involvement was present in 29 cases: 22 cases presented with a pulp necrosis, and 7 cases with an endodontic treatment. Pulp vitality was present in 10 cases and 1 case failed to report the endodontic status.

The endodontic treatment consisted in either a temporary filling (calcium hydroxide) later replaced by a definitive filling (gutta percha), or directly with a definitive filling (gutta percha) when indicated. Among those 29 endodontically treated teeth, 9 underwent an apicoectomy (using mineral trioxyde aggregate) at the surgical phase.

PG sealing was performed in 16 cases using mainly glass-ionomer cement but also mineral trioxide aggregate (MTA), tricalcium silicate cement, composite flow and amalgam. In 5 cases, an extra-oral filling of the groove was performed before the tooth reimplantation. In all cases, radiculoplasty was performed either for groove removal when it was shallow or by saucerization to allow a proper filling when grooves were deep.

To treat the PG associated periodontal defect, several different intervention types were described, using: allogenic bone, xenogeneic bone, alloplastic materials, barriers, growth factors and biological factors (and combinations thereof). These surgical regenerative procedures were reported in 25 cases. Only 2 cases [3, 40], justified the use of biomaterials and flap designs in relation to the analysis of the associated periodontal lesion after PG management.

All cases reported clinical healing except for 2 cases of failures following tooth reimplantation due to external root resorption leading to tooth removal after 36 months [33] and 2 failures after 6 months following a surgery without regeneration or root filling [29]. The case with the longest follow-up (324 months) indicated that following an endodontic treatment with a periodontal regeneration and an orthodontic treatment, a recurrent periodontal breakdown occurred 11 years, leading to tooth extraction and implant placement [35].

Case-report

We describe the case of an 18-year-old male patient referred to the periodontics department of the Rothschild Hospital (AP-HP) in Paris. Written informed consent was obtained for the publication of clinical data and images included in this article. The patient was experiencing pain due to the inflammation on the palatal side of tooth #22 with intermittent suppuration. The clinical examination revealed a central, shallow, and of moderate length (up to 70% of the root length) PG on the tooth #22, with a probing pocket depth of 12 mm on the palatal side associated with a tooth mobility 3 (Mühlemann 1951). The tooth responded positively to electrical test. At the radiographic evaluation, bone loss could be noted mesially and distally of #22 (Fig. 2).

A slight bony bridge could be distinguished between #21 and #22 in the coronal portion. Thus, a localized periodontal defect due to the presence of subgingival PG was diagnosed.

The periodontal treatment first consisted in a non-surgical debridement performed in one session. Tooth splinting was performed from #21 to #23 to minimize mobility (Fig. 3).

At the re-evaluation 8 weeks later, the tooth presented no superficial inflammation, but a persistent periodontal pocket of 12 mm deep on the palatal side. Surgery was indicated due to the presence of a large, deep, 3-wall intra-bony defect around tooth #22 (Fig. 4).

A SFA (Single Flap Approach) was designed with a surgical access limited on the palatal side for esthetic reason and optimal visualization. A full periosteal flap was raised, and the granulation tissue was removed. The aberrant local anatomy was corrected up to the most apical part and a regenerative procedure combining enamel matrix derivates with a bone substitute was applied to avoid soft tissue shrinkage and collapse. Sutures with a non-resorbable monofilament 6/0 were made using U-crossed and single points. A postoperative radiograph was taken (Fig. 4f). An antibiotic therapy with amoxicillin (1 g twice a day for 7 days) was administered. Paracetamol was prescribed as a painkiller and a mouthwash containing 0.12% chlorhexidine gluconate were prescribed for 2 weeks postoperatively. Healing was uneventful and sutures were removed 10 days postoperatively.

At the 6 months reevaluation, the periodontal pocket was no deeper than 4 mm on the palatal side with no bleeding on probing. A recession of 1 mm was observed.

Table 1 Studies identifying palatal groove with associated periodontal lesion(s) and their management

Author, year, country	Study design, number of participants,	Tooth number, Clinical parameters at baseline (CAL, PPD,BoP, REC)	Endodontic status at baseline	Groove characteristicss	Periodontal lesion morphology	Radiography	Diagnosis	Treatments	Treatment outcomes	Duration of follow-up (in months)
Hungund 2010 India [28]	Case series Case 1: 20 yo female Case 2: 35 yo male	Case 1: tooth #12, PPD 5 mm Case 2: tooth#12, PPD 7 mm	Case 1: Pulp + Case 2: Pulp -	Case 1: groove extend until CEJ Case 2: shallow groove extends until the CEJ	NR	NR	NR	Case 1: surgery with subgingival scaling and root planning + sealing conventional glass ionomer restorative material Case 2: endodontic treatment with gutta percha + surgery with groove filling (glass ionomer cement) + additive osseous surgery involving placement of a bone graft	Case 1: PPD 2 mm Case 2: No periodontal pocket + radiographic bone healing	Case 1: 2 months Case 2: 6 months
Mayne 1990 Australia [29]	Case series 2 patients: Case 1: 19 yo female Case 2: 26 yo male	Case 1: tooth #12, PPD 6 mm Case 2: tooth #12, PPD 8 mm + pain	Case 1: pulp + Case 2: pulp -	Case 1: NC Case 2: deep groove extending from the cingulum to the root apex	NR	2D: Case 1: groove superimposed over the root canal Case 2: radiolucency apically + dual root	NR	Case 1: Surgery: root planning + saucerization + tooth removal (persistence of symptoms) Case 2: endodontic treatment with gutta percha + surgery with root planning + tooth removal (persistence of symptoms)	Persistence of symptoms	Case 1: 6 months
Corbella 2019 Italy [30]	Case series Case 1: 49 yo female Case 2: 36 yo female	Case 1: tooth #12, PPD 13 mm + abcess Case 2: tooth #12, PPD 10 mm + pain	Case 1: pulp + Case 2: Endo treated	NR	Case 1: deep intrabony defect distal to 12 Case 2: no visible intrabony defect	NR	NR	Case 1 and 2: Surgery: horizontal incision preserving papilla + radiculoplasty + conditioning + EMD	Case 1: NR Case 2: < 4 mm PPD	Case 1: NR Case 2: 12 months
Cho 2017 Korea [31]	Case series Case 1: 41 yo female Case 2: 40 yo male Case 3: 45 yo female	Case 1: tooth #12, PPD 9 mm disto palatal + pain Case 2: tooth #12, PPD 9–10 mm palatal Case 3: tooth #22, PPD 9–13 mm palatal	Case 1: pulp -Case 2: Endodontically treated Case 3: Endodontically treated	NR	NR	2D Case 1: periapical lesion Case 2: apical radiolucency and irregular root shape Case 3: severe bone defect in mesial	Combined periodontal-endodontic lesion caused by a PG	Case 1: Endodontic treatment + odontoplasty + GTR (Bone substitute + collagen membrane) Case 2: Endodontic treatment + odontoplasty + apicoectomy (MTA) + GTR (Bone substitute + collagen membrane) Case 3: Odontoplasty + Minocycline gel	Case 1: PPD 3–4 mm Case 2: No PPD reported Healing Case 3: PPD 3–4 mm	Case 1: 20 months Case 2: 15 monthsCase 3: 16 months

Table 1 (continued)

Author, year, country	Study design, number of participants,	Tooth number, Clinical parameters at baseline (CAL, PPD,BoP, REC)	Endodontic status at baseline	Groove characteristicss	Periodontal lesion morphology	Radiography	Diagnosis	Treatments	Treatment outcomes	Duration of follow-up (in months)
Karunakaran 2017 India [32]	Case series Case 1: 24 yo male Case 2: 26 yo female	Case 1: tooth #22, PPD 6 mm + pain Case 2: tooth #21, PPD 7 mm + pain	Case 1: pulp – Case 2: pulp -	Case 1: NR Case 2: Groove extending 5 mm on the root	Case 1 and 2: NR	2D Case 1: Radiographic examination revealed periodontitis Case 2: bone loss between 21 and 11	Case 1 and 2: severe localized periodontitis with necrotic pulp secondary to palatal groove	Case 1 and 2: Endodontic treatment: calcium hydroxide + gutta percha Surgery: Kirkland flap + debridement + groove sealing (Tricalcium silicates) + bone graft + PRF + membrane	Case 1 and 2: PPD 3 + radiographic healing	Case 1: 6 months Case 2: 12 months
Han 2020 China [33]	Case series Case 1: 27 yo male Case 2: 24 yo female	Case 1: tooth #22, PPD 12 mm + BoP Case 2: tooth #12, PPD 9 mm + BoP + pus	Case 1: pulp – Case 2: endodontically treated	Case 1: extend from the coronal third to the apical third of the root Case 2: NC	Case 1: serious bone defect Case 2: extensive bone defect	Case 1 and 2: 2D and 3D, extensive peri-radicular radiolucency	Case 1 and 2: severe endodontic-periodontal lesion associated with a PRG	Case 1 and 2: scaling and root planning Endodontic treatment with gutta percha Surgery: intentional replantation with radiculoplasty + apicoectomy + groove filling (MTA)	Case 1and 2: root resorption requiring tooth removal	Case 1: 24 months Case 2: 36 months
Hans 2010, India [34]	Case report, 28 yo male	Tooth #22, PPD 7 mm distopalatal + pus	Pulp -	Up to the middle of the root	Shallow bony defect	2D: Radiolucency at the apex + radiolucent line adjacent to the canal	NR	Endodontic treatment Surgery: Radiculoplasty + sealing with glass ionomer cement	PPD 2 mm + No BoP	6 months
Mathews 2021 USA [35]	Case report 8 yo male	Tooth #11, PPD 12 mm + pus	Pulp -	Deep tight groove	3 walls defects, 3 mm wide and extending from the mesial to distal line angles	2D: radiographic lesion	NR	Endodontic treatment: calcium hydroxide then gutta percha Initial TTT: radiculoplasty + root planning Surgery: DFDBA + resorbable membrane Orthodontic treatment for 2 years After 11 years: implant placement because of periodontal breakdown	at 6 months PPD 4 mm no BoP the sinus tract resolved	324 months
Kishan 2014 India [36]	Case report 18 yo female	Tooth #12, PPD 8 mm palatal + pus + pain	Pulp -	deep PG extending deep into the apical region	NR	2D: well-defined radiolucency in relation to 12 extending until the apical region of 11	pulp necrosis, suppurative periradicular periodontitis and moderate localized periodontitis secondary to the PG	Endodontic treatment: calcium hydroxide then gutta percha Surgery: Root planning + sealing glass-ionomer cement + A resorbable membrane	absence of signs and symptoms + no PPD + Radiographic bone healing	6 months

Table 1 (continued)

Author, year, country	Study design, number of participants,	Tooth number, Clinical parameters at baseline (CAL, PPD,BoP, REC)	Endodontic status at baseline	Groove characteristicss	Periodontal lesion morphology	Radiography	Diagnosis	Treatments	Treatment outcomes	Duration of follow-up (in months)
Friedman 1988 Israel [37]	Case report 28 yo male	Tooth #22, PPD 8 mm + swelling	Pulp -	Extending from the crown into the gingival sulcus	NR	2D: large radiolucent area on the distal coronal aspect of the root + periapical rarefaction + radiolucent thin vertical line distally to the root canal	pulp necrosis associated with a chronic apical periodontitis + periodontal abscess, all resulting from the radicular palatal groove	Endodontic treatment: gutta percha Surgery: root planning + radiculoplasty + filling zinc-free amalgam	Recessions + no exudate from the sulcus + Radiographic bone healing	24 months
Sooratgar 2015 Iran [38]	Case report 27 yo female	Tooth #22, PPD 12 mm + pus	pulp -	deep groove	NR	2D: peri-radicular radiolucency involving the apical one-third of the root and a para pulpal radiolucent line	primary periodontal lesion with secondary endodontic involvement because of a PG	Endodontic treatment: gutta percha Surgery: Root planning + 3 mm apicoectomy + radiculoplasty + sealing glass ionomer cement + GTR using DFDBA + collagenous membrane	PPD 3 mm	24 months
Schafer 2000 Germany [39]	Case report 32 yo female	Tooth #12, PPD 7 mm + pain	pulp -	complex radicular groove separating accessory root from the main root trunk	NR	2D: non-homogenous root canal filling, vertical bone loss and a radiolucent area at the apex	NR	Endodontic treatment: calcium hydroxide Surgery: scaling and root planning alone Endodontic treatment: gutta percha	PPD 4 mm + no BoP	12 months
Zucchelli 2006 Italy [40]	Case report 38 yo male	Tooth #22, PPD 10 mm with BoP and pus presenting a fistula	pulp+	Localized at the distal line angle of the palatal surface and reached the apical 2/3 of the root surface	Circular palatal bony defect around the entire groove up to the buccal bone plate. The interdental bone crest was preserved: a very thin bone bridge still connected 21 and 22	2D: circular radiolucency localized at the distal surface of the lateral incisor This lesion started about 3 mm below the interdental bone crest, which appeared intact	Localized periodontal defect due to the presence of subgingival PG	Initial treatment: root scaling + removal/flattening of the radicular groove Surgery: Papilla Amplification Flap (PAF) + removal/flattening of the radicular groove + EDTA conditionning + EMD gel	PPD 2 mm CAL gain 8 mm	12 months
Schwartz 2006 USA [3]	Case report 28 yo male	Tooth #12, PPD 6 mm	pulp -	Deep groove	narrow palatal bony defect extending 10 mm from the adjacent bony crest	2D: peri-radicular radiolucency involving the apical 2/3 of the root	necrotic pulp, suppurative peri-radicular periodontitis and moderate localizedperiodontitis secondary to the PG on tooth #7	Endodontic treatment: calcium hydroxide then gutta percha Surgery: radiculoplasty + freeze-dried bone allograft + EMD + collagen membrane	PPD 2 mm no BoP	6 months

Table 1 (continued)

Author, year, country	Study design, number of participants,	Tooth number, Clinical parameters at baseline (CAL, PPD,BoP, REC)	Endodontic status at baseline	Groove characteristicss	Periodontal lesion morphology	Radiography	Diagnosis	Treatments	Treatment outcomes	Duration of follow-up (in months)
Rankow 1996 USA [41]	Case report NC	Tooth #12, PPD to the apex	NR	Deep groove the entire length to the apex	NR	NR	NR	Endodontic treatment: gutta percha Surgery: apicoectomy + radiculoplasty + root planning + DFDBA + resorbable membrane	No PPD + radiographic healing	12 months
Castelo 2015 Spain [42]	Case report 40 yo female	Tooth #12, PPD 10 mm	pulp -	10 mm groove depth	NR	2D: Two radiolucent lesions: one at the apical level and the otherat the middle distolateral level3D: CBCT lesions of endodontic and periodontalorigin were independent and withoutcommunication	post-traumatic pulp necrosis and asymptomatic apical periodontitis	Endodontic treatment: calcium hydroxide then gutta percha Surgery: scaling and root planning + radiculoplasty + EMD + membrane	Radiographic healing	12 months
Hasan 2018 Pakistan [43]	Case report 20 yo female	Tooth #22, PPD 5 mm + pain	pulp -	shallow groove	NR	2D: poorly obturated canal associated with aperiapical radiolucency and an untreated accessory root with a patent canal	NR	Endodontic treatment: calcium hydroxide then gutta percha Surgery: osteotomy + allograft + collagen membrane	Reduced PPD + Radiographic healing	24 months
Garrido 2016 Spain [44]	Case report 50 yo female	Tooth #12, PPD "to the apex of disto-palatal region" + pus	pulp -	Type II PG extended beyond the middle third of the root apex + communication between the radicular groove and the pulp chamber	NR	2D: peri-radicular radiolucency involving the apical two thirds of the root	combined endodontic-periodontal lesion with periodontal breakdown associated with a PG and concomitant pulpal necrosis	Endodontic treatment: gutta percha Surgery: intentional replantation with apicoectomy + groove removal + groove sealing self-adhesive composite flow	PPD < 4 mm Radiographic healing	12 months
Sucheta 2012 India [45]	Case report 23 yo female	Tooth #12, PPD 10 mm palatal + pain	pulp+	extended up to 5 mm on the root surface Moderate type (Schafer 2000)	deep intrabony defect	2D: angular bone loss in relation to the distal aspect of 12	NR	Initial phase: scaling + root planning Surgery (6 weeks): odontoplasty + citric acid + hydroxyapatite graft material + collagen membrane	PPD 3 mm	12 months
Mittal 2013 India [15]	Case report 37 yo male	Tooth #12, PPD 8 mm palatal + pain + pus	pulp -	NR	NR	2D: radiolucency measuring 5 × 7 mm in diameter at the apex	chronic apical abscess	Endodontic treatment Surgery: groove sealing with MTA + apicoectomy + DFDBA	progressive healing	6 months

Table 1 (continued)

Author, year, country	Study design, number of participants,	Tooth number, Clinical parameters at baseline (CAL, PPD,BoP, REC)	Endodontic status at baseline	Groove characteristicss	Periodontal lesion morphology	Radiography	Diagnosis	Treatments	Treatment outcomes	Duration of follow-up (in months)
Sharma 2015 India [19]	Case report 34 yo female	Tooth #12, PPD > 5mm palatal + fenestration	Endodontically treated	groove was classed as moderate	NR	2D: radiolucency on the mid mesial aspect of 12	NR	Re-endodontic treatment (MTA)Surgery: saucerization and groove filling with glass ionomer cement + apicoectomy + bone filler hydroxyapatite and β tricalcium phosphate + collagen membrane	no PPD at 1 month	6 months
Ferreira 2000 Brazil [46]	Case report 49 yo female	Tooth #12, PPD 8 mm palatal	pulp+	NR	deep bony defect	2D: deep bony defect between 11 and 12	NR	Initial phase: scaling and root planning Surgery: radiculoplasty + DFDBA and collagen membrane	Reduced PPD + CAL gain	36 months
Andreana 1998 USA [47]	Case report 32 yo female	Tooth #22, PPD 8 mm + pus	pulp+	blackish line penetrating 1 mm into the root passing the middle third of the root, toward the apex	NR	NR	severe periodontal defect localized around 12 but extending toward 11	Surgery: radiculoplasty + tetracycline locally applied + calcium sulfate bone filler	CAL gain of 9 mm	18 months
Al-Hezaimi 2009 Saudi Arabia [48]	Case report 15 yo female	Tooth #22, PPD 13 mm + pus	Pulp -	NR	NR	2D: large peri-radicular radiolucency	Pulp necrosis with suppurative apical periodontitis	Endodontic treatment: calcium hydroxide then gutta percha Surgery: intentional reimplantation + radiculoplasty + EMD	Normal PPD + radiographic healing	48 months
Forero 2015 Colombia [49]	Case report 25 yo male	Tooth #12, PPD 12 mm + BoP +	Pulp+	NR	NR	2D: radiolucent area on the distal surface of the crown + 10 mm radiolucent image at the apical 1/3 of the root	Apical periodontitis associated to a PRG	Endodontic treatment: antibiotic medication then gutta percha Surgery: intentional reimplantation with + radiculoplasty + filling glass ionomer cement	Asymptomatic + no periodontal pocket + no apical lesion	3 months
Guruprasad 2012 India [50]	Case report 36 yo female	Tooth #22, PPD 7 mm + REC 2 mm + pain	Pulp -	Deep PRG from the cingulum and extending apically	3-walled intra-bony defect	2D: periapical radiolucency and intra-bony defect mesial to 12	Endosseous defect mesial to 12 of purely periodontal origin and a periapical lesion	Endodontic treatment: gutta percha Surgery: modified papilla preservation technique + debridement + filling glass ionomer cement + PRP + Hydroxy apatite	PPD 2 mm + 2 mm REC + radiographic bone healing	12 months

Table 1 (continued)

Author, year, country	Study design, number of participants,	Tooth number, Clinical parameters at baseline (CAL, PPD,BoP, REC)	Endodontic status at baseline	Groove characteristicss	Periodontal lesion morphology	Radiography	Diagnosis	Treatments	Treatment outcomes	Duration of follow-up (in months)
Jeng 1992 Taiwan [51]	Case report 50 yo male	Tooth #12, PPD 10 mm + pain + swelling + pus	Pulp +	PRG terminated in the middle portion of the root	Advanced circumferential angular bony defect on distal and palatal to the root apex	2D: advanced bony defect extending to the apical portion	NR	Root planning + radiculoplasty + Hydroxy apatite + non-resorbable membrane	No sign of inflammation + CAL gain 7 mm + radiographic healing	14 months
Kerezoudis 2003 Greece [52]	Case report 60 yo female	Tooth #21, PPD to the apex + pain + swelling	Pulp -	Extending to the apex	NR	2D: vertical bone loss on mesial 21	Combined periodontal-endodontic lesion with periodontal breakdown associated with a radicular groove	Endodontic treatment with gutta percha and root planning Surgery: apicoectomy + radiculoplasty + EMD	PPD 2 mm + REC 3 mm + radiographic healing	24 months
Kozlovsky 1988 Israel [53]	Case report 25 yo female	Tooth #11, PPD 10 mm + pain	Pulp +	Extending apically to the level of bone crest	Bony dehiscence-like on buccal and vertical bone loss mesial 11	2D: vertical bone loss on mesial 11	NR	Surgery: modified Widman flap + root planning	Satisfactory clinical and esthetic results	1,5 months
Ling 2022 China [54]	Case report 40 yo male patient	Tooth #12, PPD 14 mm + + abcess	Pulp -	Extending up to the apical part	Large bone defect	3D: radiolucency distal and palatal	Type II PRG with combined endodontic-periodontal lesion on 12	Endodontic treatment with gutta percha and root planning Surgery: Radiculoplasty + sealing MTA + bovine bone substitute + resorbable membrane	PPD 3 mm + no BoP + radiographic healing	24 months
Meister 1983 USA [7]	Case report 32 yo female	Tooth #12, PPD 8 mm + pain	Endodontically treated	NR	Osseous defect extending to 3 mm from the apex	2D: no evident pathosis	NR	Surgery: saucerization + root planning + osseous recontouring	PPD 3 mm + healthy gingiva	24 months
Narmatha 2014 India [55]	Case report 27 yo patient	Tooth #22, PPD 9 mm + us	Pulp -	Complete apical extent	NR	2D: circumscribed periapical radiolucency + para-pulpal radiolucent line	Endodontic periodontal lesion with PG with pulpal necrosis and chronic apical periodontitis	Endodontic treatment: calcium hydroxide then gutta percha Surgery: root planning + radiculoplasty + sealing MTA + bovine bone substitute	CAL gain 6 mm + radiographic healing	12 months
Wei 1999 Taiwan [56]	Case report 13 yo male	Tooth #22, PPD 6 mm + swelling + pain	Pulp -	Ran apically and distally to terminate in the bifurcation area	Osseous fenestration on the facial surface 3 to 4 mm above the interproximal bone crest between 22 and 23	2D: a vertical radiolucent line from the middle of cingulum to the middle third of the distal root surface	Pulpal-periodontal combined lesion occurring on a birooted 22 with concomitant PRG	Endodontic treatment: gutta percha Surgery: amputation of the accessory root + debridement and root planning + radiculoplasty + FDBA	PPD 3 mm + radiographic healing	84 months

Table 1 (continued)

Author, year, country	Study design, number of participants,	Tooth number, Clinical parameters at baseline (CAL, PPD,BoP, REC)	Endodontic status at baseline	Groove characteristicss	Periodontal lesion morphology	Radiography	Diagnosis	Treatments	Treatment outcomes	Duration of follow-up (in months)
Gandhi 2012 India [57]	Case report 30 yo female	Tooth #22, PPD 6 mm + pus	Pulp -	Terminate at the middle third of the root	NR	2D: large periapical radiolucency	Endo-perio lesion of 22 associated with PRG	Endodontic treatment: gutta percha Surgery: apicoectomy + root planning + saucerization + filling (glass ionomer cement) + equine bone graft	Normal PPD + radiographic healing	24 months

Abbreviations: *MTA* Mineral Trioxyde Aggregate, *DFDBA* Demineralized Freeze-Dried Bone Allograft, *FDBA* Freeze-Dried Bone Allograft, *EMD* Enamel Matrix Derivatives, *PRP* Platelet Rich Plasma, *PRF* Platelet Rich Fibrin, *EDTA* EthyleneDiamine Tetraacetic Acid, *GTR* Guided Tissue Regeneration

Table 2 Risk of bias assessment of the included studies according to the Joanna Briggs Institute (JBI) [45, 46]

Study	Items	1	2	3	4	5	6	7	8	Score
Hungund 2010 [28]										5
Mayne 1990 [29]										2
Corbella 2019 [30]										8
Cho 2017 [31]										6
Karunakaran 2017 [32]										6
Han 2020 [33]										7
Hans et al. 2010 [34]										3
Mathews 2021 [35]										7
Kishan 2014 [36]										7
Friedman 1988 [37]										3
Sooratgar 2015 [38]										8
Schafer 2000 [39]										6
Zucchelli 2006 [40]										8
Schwartz 2006 [3]										8
Rankow 1996 [41]										3
Castelo 2015 [42]										7
Hasan 2018 [43]										7
Garrido 2016 [44]										7
Sucheta 2012 [45]										6
Mittal 2013 [15]										7
Sharma 2015 [19]										7
Ferreira 2000 [46]										8
Andreana 1998 [47]										6
Al-Hezaimi 2009 [48]										5
Forero 2015 [49]										7
Guruprasad 2012 [50]										7
Jeng 1992 [51]										5
Kerezoudis 2003 [52]										8
Kozlovsky 1988 [53]										4
Ling 2022 [54]										8
Meister 1983 [7]										4
Narmatha 2014 [55]										6
Wei 1999 [56]										7
Gandhi 2012 [57]										7

Table 2 (continued)

Study	Items	1	2	3	4	5	6	7	8	Score
P. The Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Case Reports (last amended in 2017)										
Website: https://joannabriggs.org/critical_appraisal_tools										
https://wiki.joannabriggs.org/display/MANUAL/Appendix+7.4+Critical+appraisal+checklist+for+case+reports										
Major Components		Response options								
1. Were patient's demographic characteristics clearly described?		Yes			No			Unclear		Not applicable
2. Was the patient's history clearly described and presented as a timeline?		Yes			No			Unclear		Not applicable
3. Was the current clinical condition of the patient on presentation clearly described?		Yes			No			Unclear		Not applicable
4. Were diagnostic tests or assessment methods and the results clearly described?		Yes			No			Unclear		Not applicable
5. Was the intervention(s) or treatment procedure(s) clearly described?		Yes			No			Unclear		Not applicable
6. Was the post-intervention clinical condition clearly described?		Yes			No			Unclear		Not applicable
7. Were adverse events (harms) or unanticipated events identified and described?		Yes			No			Unclear		Not applicable
8. Does the case report provide takeaway lessons?		Yes			No			Unclear		Not applicable

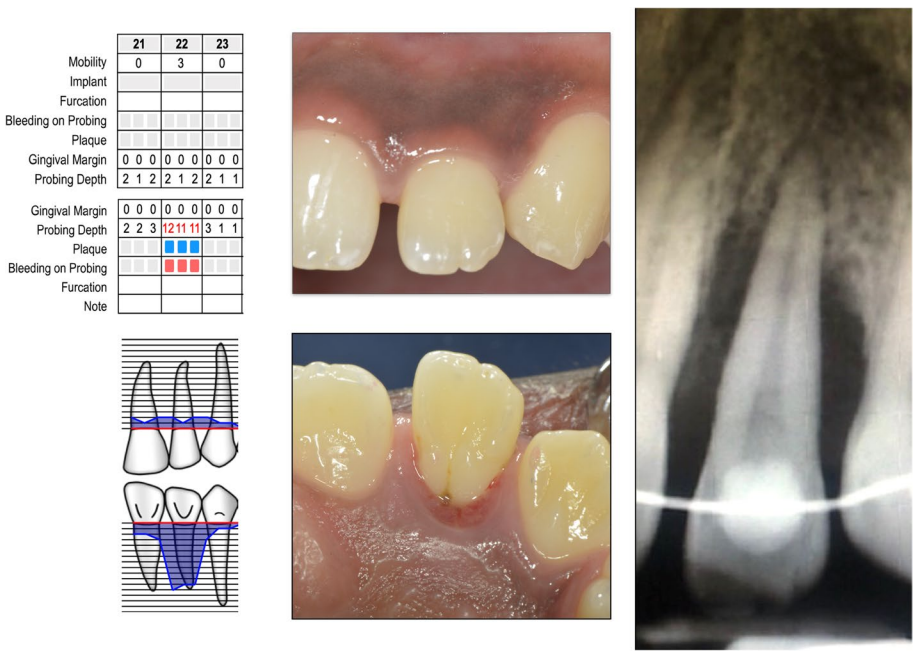

Fig. 2 Case report. Clinical and radiographical initial situation of the tooth #22 presenting with a palatal groove. The periodontal charting showed deep periodontal pockets on the palatal probing sites associated with bleeding and plaque accumulation

Fig. 3 Root planning and flattening of PG on tooth #22: initial occlusal view of #22 (**a**); Manual scaling 22 (**b**); flattening of PG 22 in the coronal part (**c**)

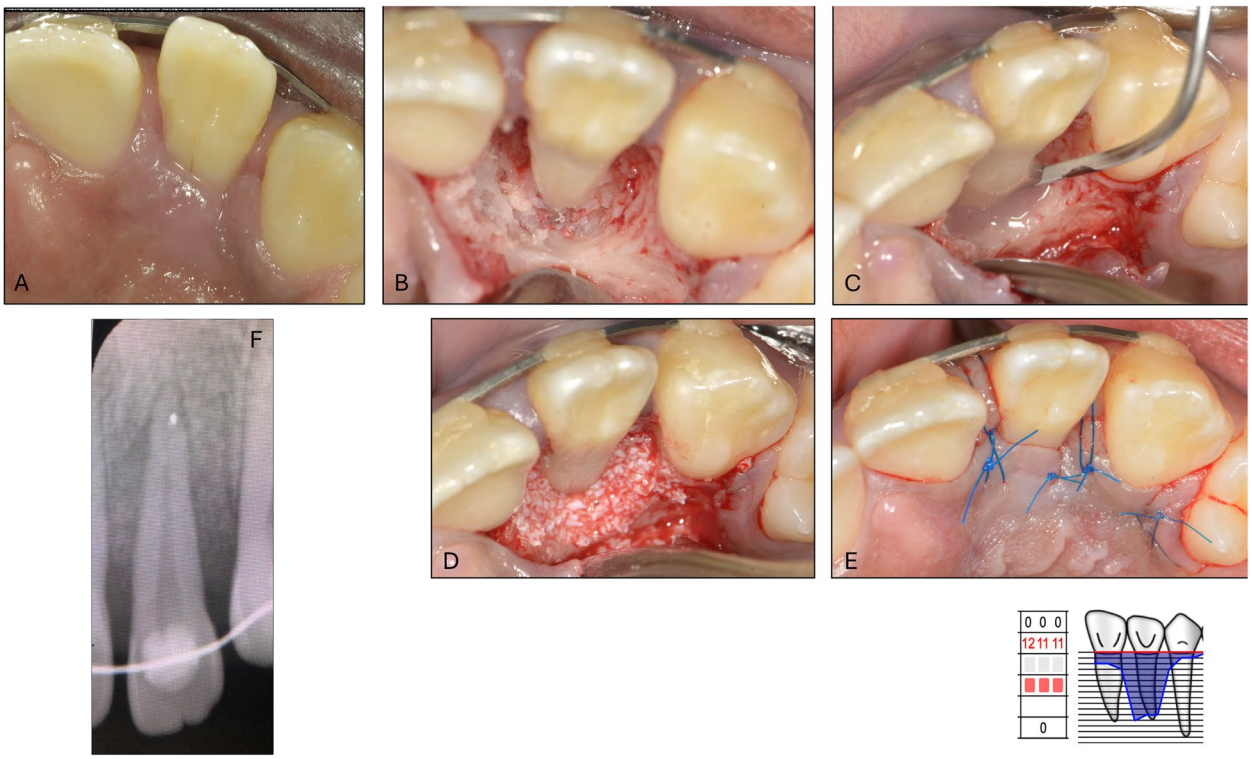

Fig. 4 Regenerative therapy: view at the periodontal re-evaluation, 2-months after the initial treatment (**a**); large and deep 3-walls intra-bony defect (**b**); application of EMD (**c**); application of DBBM (soft tissue support, osteoconductive) (**d**); sutures (**e**); radiographic image at the 2-month follow-up (**f**)

Radiographically, a mineralized tissue could be observed up to both bony peaks mesially and distally to #22 (Fig. 5).

At the 1-year follow-up, periodontal health was maintained and an orthodontic treatment was undertaken. After 2 years of treatment, tooth #22 is still healthy with a CAL gain of 7 mm, a functional and esthetic position resulting in the patient's satisfaction. These results support that periodontal regeneration can be effectively carried out also for deep intra-bony defect associated with PG, once the local risk factor has been adequately managed.

Discussion

The results of the present systematic review indicate that PG are relatively uncommon root anomaly, but they are frequently associated with periodontal lesion that require treatment. The selected studies showed that PG can be managed concomitantly with periodontal regeneration, with or without associated endodontic treatment. It must be noted that the presence of a PG may play a significant role in exacerbating periodontal lesions. This could be explained, at least partly, by the mediation role of inflammatory factors like the TGF-B1, which is involved in the regulation of the inflammatory response and in the remodeling of periodontal tissues, as highlighted by recent studies [58, 59]. These findings necessitate a nuanced and well-defined diagnostic and therapeutic approach, which should consider not only on the anatomical challenges linked to the presence of a PG but also on the underlying inflammatory mechanisms, in order to ensure an effective treatment and prevent potential endodontic complications.

A variety of treatments approaches has been described in case reports and case series and summarized in the present review. The appreciation of the morphology and origin of PG on maxillary incisors may be challenging and thus delay the diagnosis and treatment planning. Therefore, developing a standardized approach based on the available literature is advisable.

A PG can be classified according to its location, length along the root, and depth of the groove towards the pulp cavity [60]. The analysis of the associated periodontal lesion is also a key parameter to consider. Based on the work of Kim et al. [60], a simplified version including the groove description and the periodontal parameters has been suggested. Such a classification (Table 3) would provide the clinician with precise criteria to justify the therapeutic approach.

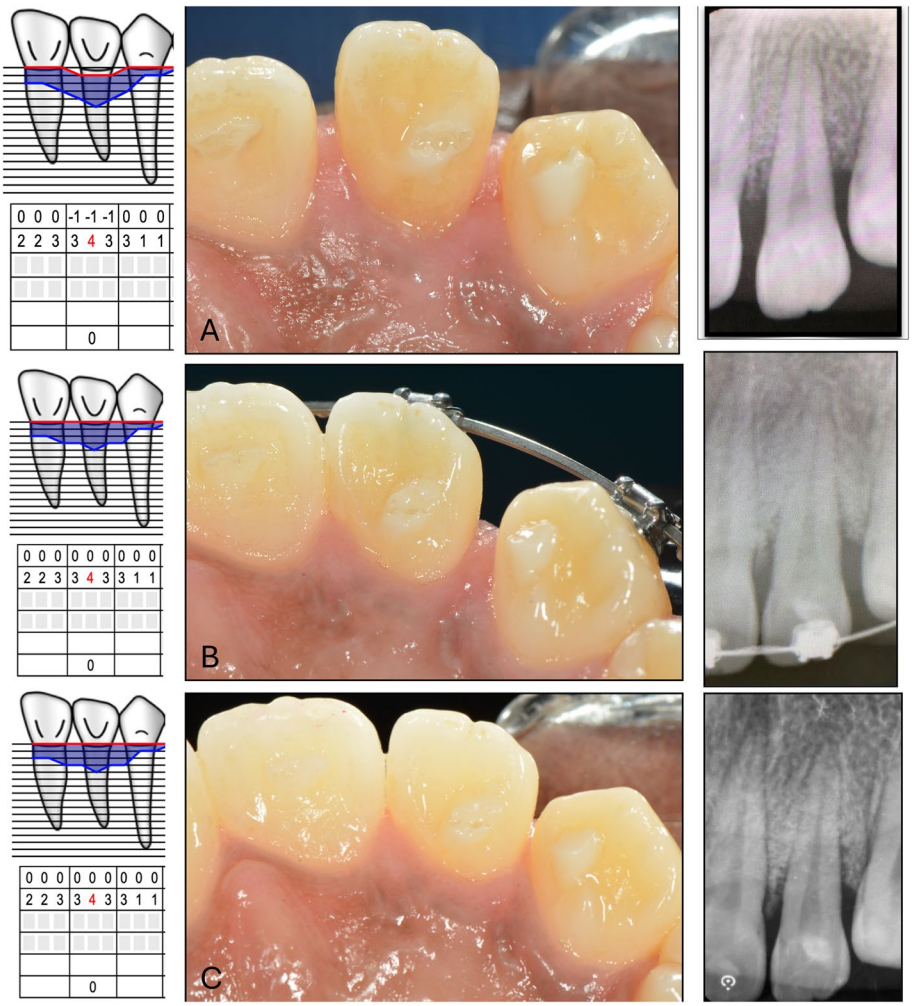

Fig. 5 Re-evaluation at 6 months (**a**); 18 months (**b**) and 30 months (**c**)

Groove location was disregarded in most cases, only one case [40] reported a distal location of the PG. It can be explained by the fact that this parameter will not affect the prognosis or the treatment sequence. In the latest study done on extracted teeth, PG appeared to originate in the distal area of the cingulum margin in most cases (65%), followed by the central fossa (25%), and the mesial area of the cingulum margin (10%) [61].

In terms of depth, only 7 cases reported a shallow PG (50%) and 7 cases reported a deep PG (50%) and no closed tube has been described. This finding is in accordance with Kogon's study [8] where 44% percent of the PG were described as shallow depressions, 42% as deep depressions, and 4% as closed tubes.

Considering the groove length, 4 cases reported an extension in the cervical third of the groove (17%), 6 in the middle third (25%) and 14 cases in the apical third (58%). According to Pinheiro's study [61], those grooves extended rarely only to the cervical third (5%), followed by the middle thirds (45%) and the apical thirds of the root in most cases (50%). It is of paramount importance for clinicians to understand the combination of both variations of groove depth along with their length to adapt an adequate treatment considering the fact that PG with deeper grooves and greater degree of extension are the determinants and predictors of poor prognosis periodontally and endodontically wise [5, 31, 42].

Considering the groove description in the selected studies, most of them failed to adequately report it. Only 7 of the 40 cases described the depth and length of the PG. This lack of analysis might result in an inadequate treatment highlighting the need for a classification.

Considering the periodontal approach of the associated intra-bony defect, the selection of the regenerative biologic principle (or material) to use with the soft tissue surgical approach dependeds on the morphology of the intra- bony defect (width, depth, and number of residual bony walls) and on the

Table 3 Classifications of palatogingival groove and intra-bony defect associated

Classification	Feature
Location [8]	1) Distal 2) Mesial 3) Central (or midpalatal)
Length [14]	1) Mild: the grooves are gentle depressions of the coronal enamel that terminate at or immediately after crossing the CEJ 2) Moderate: the grooves extend some distance apically along the root surface in the form of a shallow or fissured defect 3) Complex: the grooves are deeply invaginated defects that involve the entire length of the root or that separate an accessory root from the main root trunk
Depth [8]	1) Shallow/flat (< 1 mm) 2) Deep (> 1 mm) 3) Closed tube
Periodontal intra-bony defect associated [48]	1) Patient factors (local factors: PI, BoP; behavorial factors: smoking, compliance; systemic factors: stress, diseases such as diabetes) 2) Presurgical conditions: endodontic conditions (vital, non-vital, endo treated), local contamination (BoP + or -), dental mobility (degree I, II or III) 3) Defect morphology: shallow/deep, narrow/large, 1/2/3 walls or circumferential 4) Surgical access: interdental space width (> 2mm or < / = 2 mm) or edentulous ridge next to defect 5) Flap design: defect involving 1/3 sides of the root or involving ¾ sides of the root and very severe 6) Regenerative therapy: contained defect or non-contained defect 7) Sutures: contained or non-contained defect

amount (and quality) of the soft tissues available to cover it [62]. As a general rule, deep and wide defects with only one residual bony wall require a mechanical stabilizer of the blood coagulum (membrane and/or bone filler), whereas in defects with lower defect angles and a greater number of bony walls, biologic mediators of the healing process (e.g. enamel matrix derivates) are indicated [62]. In the present study, only 2 cases [3, 40] succeeded in justifying the use of their regenerative procedure based on the description and analysis of the associated intra-bony lesion. As for PG anatomy, this lack of description of the associated periodontal lesion morphology could mislead the diagnosis and result in a non-optimal treatment. The PG issue had mostly been a concern for endodontist based on those case reports coming from endodontic journals, which might explain the few periodontal parameters reported and the lack of a clear description of the intra-bony defect associated to justify the different management of the periodontal defect. Moreover, the selected case reports do not cover all potentially applicable regenerative techniques, which continue to evolve [63–65] and should be further investigated in the particular context, from the microbiological and inflammatory perspectives, of PG-associate lesions.

Based on the presented literature review and in order to guide clinicians towards a comprehensive and complete evaluation of PG associated lesion, we suggested a decisional tree (Fig. 6) that introduces the periodontal parameter in the PG assessment, after evaluating the endodontic status. Indeed, the successful management of a tooth with a PG is firstly dependent on endodontic status, which should be systematically assessed. In cases of negative pulp response and periapical lesions, an endodontic treatment has to be undertaken in the first place [66]. But, the periodontal evaluation is also cardinal to obtain a successful and long-lasting management of PG.

The recognition and management of PG for tooth survival has been reported in details in a study done by Kim et al. [60] in 2017. In the rest of the considered literature, half of the treatments described were made without a clear initial diagnosis or proper description of the associated lesions to justify the type of regenerative strategy and flap design approached. Another interesting observation made in this review is that in the case of intentional replantation, among the 5 reported cases, 2 resulted in a failure necessitating the tooth removal [33]. This suggests that replantation strategy should be used as a the latest resort for complex cases involving a PG to the apex with a deep groove.

It must be acknowledged that the available literature and thus the present systematic review present several limitations. Firstly, as mentioned above, there is a lack of standardization in the diagnostic and treatment processes, with a high heterogeneity among the selected articles, most of the times case reports or case series. Secondly, the follow-up time was mostly set between 6 and 24 months, which may be too short to assess treatment outcomes or observed complications and relapse. Indeed, after a 36 months follow-up, failures have been reported [33] and after 10 years, a periodontal breakdown occurred on a treated tooth [35] and both resulted in the tooth removal. No re-entry surgery and/or histologic evaluations were described and no prospective longitudinal studies evaluating the stability of the clinical and radiographic parameters and the absence of the recurrence of disease were found. Thus, any conclusion about the success achieved with the treatments described in the present review should be drawn with caution as the long-term prognosis of the treatment of PG-associated lesions of teeth remains to be determined. Updates of case series and case reports that could describe results after 5, 10 and 15 years from the initial PG diagnosis are advocated.

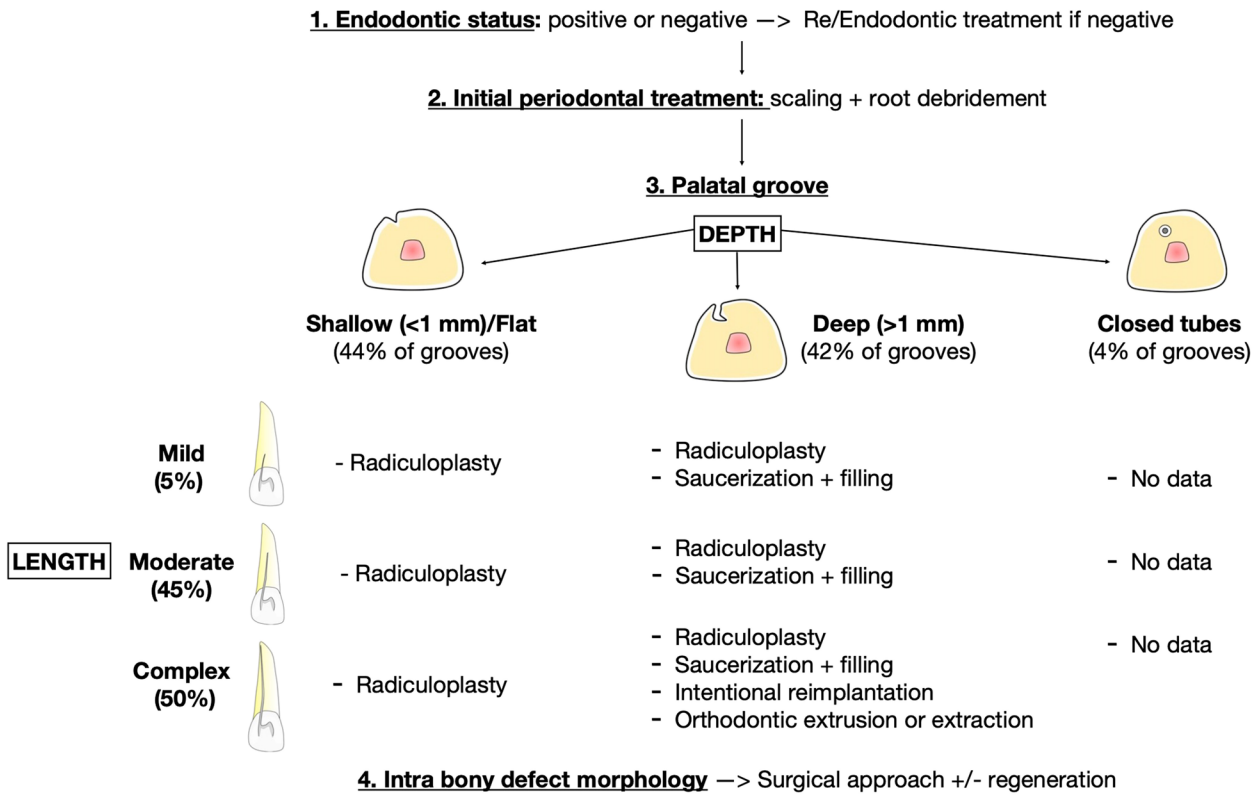

Fig. 6 Decisional tree. This graph proposes a decision-making process for the management of PG-associated lesions that takes into account the endodontic status, the characteristics of the palatal groove, and the presence of intra-bony defect

Finally, the level of the body of evidence on PG is considered as low. Although the nature of PG as rare condition may explain why mainly case reports or case series are published, future clinical and comparative studies should be designed to investigate PG management and treatment success at long term. Nonetheless, based on the currently available literature, a decisional tree (Fig. 6) has been proposed to guide clinicians and create a reference for PG management to respond to a patient's health condition. This should be periodontally updated as new evidence emerges but in the meantime, it can be useful to provide a clinical guidance as well as a model for the standardization of the diagnostic and treatment processes in clinical cases dealing with PG management.

Conclusion

Teeth with PG represent a challenge for clinicians. Despite their rarity (2% of maxillary lateral incisors), the complexities associated with PG, such as diverse anatomical features and clinical scenarios, underscore the necessity for accurate diagnosis and tailored treatment approaches. This study provides a systematic review of pertinent literature, consisting mainly in case reports, and culminates in the proposal of a decision tree, which aims to assist clinicians in the decision-making process through a structured evaluation of the PG characteristics guiding the treatment approach. The ultimate goal is to mitigate potential periodontal and endodontic complications of PG while providing a successful management. In parallel, the present study highlights the need of future research on this topic, particularly with clinical studies with a sufficiently long follow-up to monitor the treatment outcomes and their stability over time. Indeed, further evidence is needed to develop standardized diagnostic and treatment protocols for PG.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12903-024-04771-z.

Supplementary Material 1.

Supplementary Material 2.

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Authors' contributions
Y.G. and V.G. drafted the manuscript text, and were involved in the literature review, data acquisition, analysis, and interpretation. Y.G. and V.G. prepared Tables 1 and 2. Y.G., P.B. and I.F. Contributed the case report and Figs. 2, 3, 4

and 5 M.C.C and S.K. prepared Table 3 and Fig. 6. M.C.C., P.B. and S.K revised the draft of the manuscript and contributed to the general criticism. All authors reviewed and approved the manuscript.

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Declarations

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Competing interests
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