







Periodontal furcation lesions: A survey of diagnosis and management by general dental practitioners

Luigi Nibali¹  | Melissa Shemie¹ | Guanhong Li¹ | Rachel Ting¹ |
Koula Asimakopoulou¹  | Giovanni Barbagallo²  | Ryan Lee³ | Peter Eickholz⁴  |
Thomas Kocher⁵ | Clemens Walter⁶  | Mario Aimetti⁷  | Stefan Rüdiger⁸

¹Periodontology Unit, Centre for Host Microbiome Interactions, Faculty of Dentistry, Oral and Craniofacial Sciences, King's College London, London, UK

²Department of General Surgery and Surgical-Medical Specialties, University of Catania, Catania, Italy

³School of Dentistry, University of Queensland, Brisbane, Australia

⁴Department of Periodontology, Center for Dentistry and Oral Medicine (Carolinum), Johann Wolfgang Goethe-University Frankfurt am Main, Frankfurt, Germany

⁵Department of Periodontology, University of Greifswald, Greifswald, Germany

⁶Department of Periodontology, Endodontology and Cariology, University of Basel, Basel, Switzerland

⁷Department of Periodontology, University of Torino, Turin, Italy

⁸Public Dental Service, Malmö University, Malmö, Sweden

Correspondence

Luigi Nibali, Centre for Host Microbiome Interactions, King's College London, London, UK.
Email: luigi.nibali@kcl.ac.uk

Funding information

This study was funded internally and by a small grant from the King's Undergraduate Research Fund (KURF)

Abstract

Aim: The aim of this study was to explore general dental practitioners' (GDPs) attitude to periodontal furcation involvement (FI).

Materials and methods: An online survey focused on diagnosis and management of periodontal FI was circulated to GDPs in seven different countries.

Results: A total of 400 responses were collected. Nearly a fifth of participants reported rarely or never taking 6-point pocket charts; 65.8% of participants had access to a Nabers probe in their practice. When shown clinical pictures and radiographs of FI-involved molars, the majority of participants correctly diagnosed it. Although 47.1% of participants were very/extremely confident in detecting FI, only 8.9% felt very/extremely confident at treating it. Differences in responses were detected according to country and year of qualification, with a trend towards less interest in periodontal diagnosis and treatment in younger generations. Lack of knowledge of management/referral pathways (reported by 22.8%) and lack of correct equipment were considered the biggest barriers to FI management. Most participants (80.9%) were interested in learning more about FI, ideally face to face followed by online tutorials.

Conclusions: Plans should be put in place to improve general dentists' knowledge and ability to manage FI, as this can have a significant impact on public health.

KEYWORDS

diagnosis, furcation, periodontitis, questionnaire, treatment

Clinical Relevance

Scientific rationale for study: FI affects the prognosis of a tooth, and therefore correct diagnosis and management are essential for effective treatment of a periodontal patient with FI.

Principal findings: The majority of participants have access to a Nabers probe in their practice and are confident in detecting furcation-involved teeth. However, confidence in maintaining FI teeth varied, with "younger" graduates being wearier of the prognosis of FI-involved teeth. There is great interest in learning more about FI among all participants through face-to-face and online tutorials.

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

© 2021 The Authors. *Journal of Clinical Periodontology* published by John Wiley & Sons Ltd.

Practical implications: More training in management of FI teeth is required in order to improve management in primary care.

1 | INTRODUCTION

A furcation involvement (FI) occurs when resorption of bone due to periodontal disease extends into the bifurcation or trifurcation areas of a multi-rooted tooth (American Academy of Periodontology, 2001). The current commonly used classification of FI includes measurement of the horizontal extent of FI (Hamp et al., 1975), as well as of its vertical component (Tarnow & Fletcher, 1984).

Presence of FI is associated with increased risk of tooth loss, both in populations under supportive periodontal therapy (Hirschfeld & Wasserman, 1978; McGuire & Nunn, 1996; Salvi et al., 2014; Graetz et al., 2015; Dannewitz et al., 2016; Nibali et al., 2016) and not (Nibali et al., 2017). As complexity factor, class II and III FI determine periodontitis stage according to the 2018 classification of periodontal diseases (Tonetti et al., 2018). Thus, proper diagnosis without comprehensive scores of FI is unlikely.

There is a vast literature exploring the best treatment options for FIs, but the best management involves early detection and prevention. This is because if a degree I furcation lesion is left untreated, it is associated with increased risk of tooth loss (Nibali et al., 2017). However, if it is diagnosed and managed with regular non-surgical periodontal therapy, no increased risk of tooth loss is detected (Huynh-Ba et al., 2009; Nibali et al., 2016). A degree II–III FI requires more complex treatment, often beyond non-surgical therapy, to minimize tooth loss risk (Dommisch et al., 2020; Jepsen et al., 2020; Sanz et al., 2020). Tooth loss in the posterior dentition is likely to reduce the quality of life through reduced masticatory function. However, if detected early at the degree I stage and treated appropriately, progression to tooth loss can be reduced or prevented.

Patient and public involvement (PPI) groups are used to gather views on current dental services. A PPI group held at Guy's Hospital in October 2019 identified the need for improved education of general dental practitioners (GDPs) in the management and prevention of periodontally involved patients with furcation lesions. The group was presented the evidence relative to the high risk of tooth loss for molars affected by FI and were shown the available treatment options. Participants in the PPI group understood that FI worsens the prognosis of a tooth and suggested that greater emphasis ought to be placed on appropriate screening by GDPs. However, there is currently little research into the efficiency of GDPs in recognizing these issues and managing them appropriately (including diagnosis, treatment, and referral if necessary). It is possible that FI is under-diagnosed in primary care and it is important to better understand the attitude of GDPs towards FI and its management. This questionnaire-based study aimed to investigate the knowledge of GDPs in identifying and managing furcation lesions and to understand whether there is a need for improved education and continual professional development (CPD) in the detection and management of FI.

2 | MATERIALS AND METHODS

The specific objectives of this study were the following:

- To identify the level of GDPs' knowledge in detecting FI and the greatest barriers they face in managing them;
- To compare the attitude and knowledge base of FI in recent graduates and different groups of GDPs in various parts of the world.

The study was registered under King's College London Research Ethics Committee Research Ethics Minimal Risk Self-Registration Form (reference MRA-19/20-20077). This study stems from a collaboration among the authors as part of a research consortium to study furcations (FERG, Furcation European Research Group). Therefore, the questionnaire was limited to countries where authors are based. Separate ethics approval was obtained as required in Australia (UQ human ethics clearance number 2020001797/MRA-19/20-20077) and Sweden (Ethics Review Authority in Uppsala Dnr 2021/00292). An online questionnaire was created through a Qualtrics survey in English and translated into Italian, Swedish, German, and French. Questions were constructed by periodontists and undergraduate dental students. As no formal sample size calculation could be performed, due to the absence of previous similar studies, a convenience sample was included.

The questionnaire covered the following aspects:

- Participant demographics (e.g., country, year of qualification, professional group);
- Experience in periodontal treatment;
- Visual detection and diagnosis of FI;
- Perception of prognosis of teeth with FI;
- Confidence in detecting and managing FI;
- Barriers to dealing with FI;
- Perceived need for CPD.

A copy of the questionnaire in English can be found in Supplementary material 1. Although this was not a previously published validated scale, we tested it for reliability (Cronbach's alpha). The result ($\alpha = .669$) suggested good reliability of all items in the scale and the decision to retain them all for analysis was made on this basis.

3 | PARTICIPANT SELECTION AND RECRUITMENT

Participants in the study were all GDPs from the United Kingdom, Singapore, Italy (in the provinces of Torino and Catania), Sweden (county Skåne), Switzerland, Germany, and Australia, with the addition of King's College London dental alumni graduated between 2015 and

TABLE 1 Method of circulation of survey in different countries and the relevant response rates

Country	County/region/population	Method of circulation	Number of dentists	Responses	Response rate
United Kingdom	GDPs in United Kingdom	<i>British Dental Journal</i> online and print publication of August 2020	n/a	11	n/a
United Kingdom	King's College London alumni	KCL alumni email blast	1482	39	2.6%
Germany	GDPs in Germany	Zahnärztliche MitteilungenOnline (zm online), the official online publication of the Bundeszahnärztekammer (BZÄK: German Dental Association), and the Kassenzahnärztliche Bundesvereinigung(KZBV: Federal Association of Statutory Health Insurance Dentists), Web page/app of the Landeszahnärztekammer Hessen (Dentists' Chamber of Hassia), Quintessence News	n/a	55	n/a
Switzerland	GDPs in Switzerland	Email blast (Swiss Society of Dentistry)	5185	94	1.8%
Singapore	Singapore	Email blast through Singapore Dental Association (SDA) and College of General Dental Practitioners (CGDP) forum	2016	13	0.6%
Italy	Catania and Torino	Email blast	1758	73	4.1%
Sweden	County Skåne	Email blast	355	73	20.6%
Australia	Queensland	Link posted in closed social media group (ADAQ)	Approx. 1200	19	1.6%
Other	—	—	—	18	—

Note: "n/a" indicates not applicable, as the total number of dentists who saw the survey link is unknown. "Other" refers to dentists who have not indicated the country or how they received the link.

TABLE 2 Demographics of survey participants

Demographics		Frequency	Percentage
Country	United Kingdom	41	10.3
	Italy	73	18.3
	Germany	57	14.3
	Switzerland	95	23.9
	Sweden	73	18.3
	Singapore	14	3.5
	Australia	19	4.8
	Other	26	6.5
Sector	Private	179	44.8
	Public/National Health Service	95	23.8
	Private and Public/National Health Service	126	31.5
Graduation year	1960–2000	106	26.5
	2001–2010	57	14.3
	2011–2020	143	35.8
	Missing data	94	23.5
KCL graduates	Yes	39	9.8
	No	361	90.2
Additional postgraduate qualifications	Yes	107	26.8
	No	291	72.8

Note: Missing answers account for the total 100% for each question.

TABLE 3 Access to the Nabers probe in relation to country and graduation year

Demographics		Access to Nabers probe (%)
Country	United Kingdom	25.6
	Italy	89.0
	Germany	83.3
	Switzerland	87.0
	Sweden	55.6
	Singapore	7.1
	Australia	29.4
Graduation year	Pre-2000	81.7
	2000–2010	71.4
	Post-2010	56.8

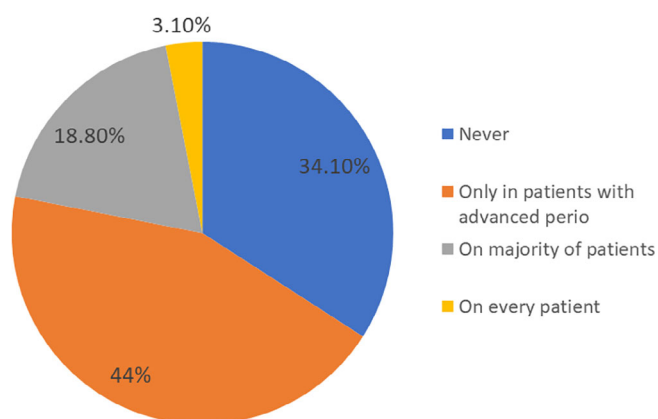


FIGURE 1 Frequency of Nabers probe use

2019 (some of whom now worked outside the United Kingdom). Participants were invited to take part as described in Table 1, either via cascading emails or posts on relevant websites, according to local regulations. No payment incentive was provided to participants.

An information sheet and consent form were provided prior to participation in the survey. Where email circulation was used, a reminder email was sent to access the questionnaire. The safety of participants' data was maintained by following the current information governance regulations (GDPR). All participants' data were anonymized, encrypted, and physically stored in a protected data point. The survey was open for 7 months, from 27 August 2020 to 10 April 2021.

3.1 | Data analysis

Data from the questionnaires were analysed descriptively. Further analysis was done by reporting responses separately by participants' group and by characteristics such as the year of graduation (divided into 1960–2000, 2001–2010, and 2011–2020) and country. Chi-square test was carried out to assess differences in responses across these different groups of participants for categorical variables.

4 | RESULTS

On survey closure, 480 participants had accessed the questionnaire. Of these, 400 (83.3%) consented to take part in the survey; 80 (16.7%) did not consent and were henceforth not included in the study.

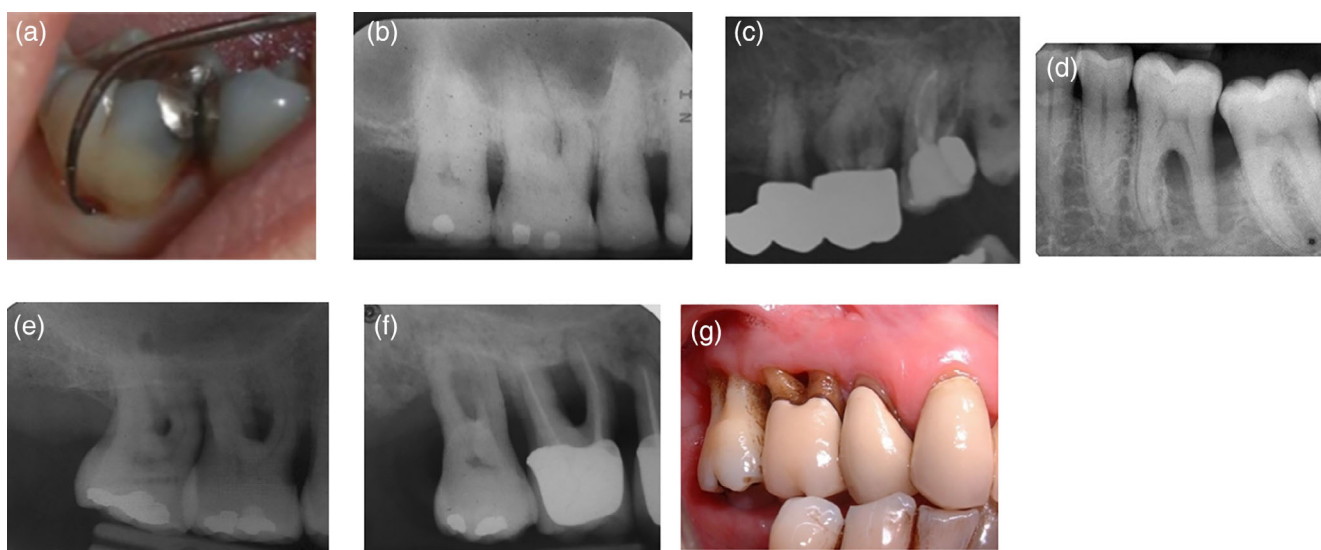


FIGURE 2 Clinical images and radiographs to assess competence in detecting and diagnosis furcation involvement (FI). (a) Nabers probe in furcation. (b) A long cone peri-apical (LCPA) showing FI in UR6. (c) A section of a dental panoramic tomograph with FI in UL6. (d) An LCPA showing FI in LL6. (e, f) LCPA and clinical photo of patients with FI III C on UR6 and UR7

4.1 | Demographics

Table 2 shows the demographics of the survey participants. The largest number of participants who took part in the survey was from Switzerland ($n = 97$), followed by Italy and Sweden, Germany, United Kingdom, Australia, and Singapore, with 6.5% from other countries. Most participants worked in the private sector, followed by mixed public and private, with the least number from the public/National Health Service sector exclusively. More than a quarter ($n = 106$) of the participants had graduated between 1960 and 2000, while 57 reported a graduation year between 2001 and 2010 and 143 participants had graduated in the last decade (2010 onwards). The graduation year response was missed by nearly 100 participants. King's College London graduates made up just under 10% of the population.

4.2 | Experience in periodontal treatment

Just prior to the COVID-19 pandemic, most of the participants (44.6%) estimated treating less than 5 periodontal cases per week, 34% treated 5–10 cases, while 12% treated about 11–20 cases. Only 7.8% of participants treated more than 20 cases per week. A similar trend was seen in the number of periodontal referrals in the past 6 months. Eighty-five per cent of respondents referred less than five periodontal cases over a 6-month period, while only 15% referred a larger number. Just over half of participants had treated FI with surgery in their careers, while 12.5% of participants reported treating more than 50 patients with FI, and very few felt they had “a great deal” of experience in periodontal surgery (3.8% for regeneration and none for resective or implant surgery). The majority of the more experienced participants in periodontal surgery were from Switzerland, Germany, and Italy.

Less than half of participants (41.8%) reported taking a 6-point pocket chart (6PPC) after the patient records a CPITN/BPE score of 3, while 18.5% of participants routinely take a 6PPC when patients recorded BPE scores of 3 twice, and 17.0% participants when BPE scores of 4 were recorded, while 17.0% of participants reported rarely or never taking a 6PPC of their patients.

4.3 | Diagnosis

Table 3 reports the results relative to access to Nabers probes. Most participants stated that they had access to a Nabers probe in their

practice (257 participants, 64.3%), while 109 participants (27.3%) did not and 22 participants (5.5%) were not sure. Access to a Nabers probe was more frequent in the older group (pre-2000 graduates, 81.6%), compared with 2000–2010 graduates (71%) and post-2010 graduates (56%). These differences were statistically significant ($p < .001$ at Chi-square). Access to the Nabers probe varied considerably across countries (e.g., 89% and of 23% for respondents from Italy and United Kingdom, respectively). Figure 1 shows frequency of use of the Nabers probe. Most participants (44%) reported using the Nabers probe only in patients with advanced periodontitis, 19% reported using it on the majority of their patients, and 3% reported using it on every patient. A third of the responders never used the Nabers probe. Despite the not-so-frequent use of the Nabers probe, the majority of participants were confident in detecting FI but not managing it.

A series of clinical images and radiographs (Figure 2) were used to assess participants' competence in detecting and diagnosing furcation-involved teeth. All of these molars had FI measured clinically. Looking at the first molar in the clinical image (Figure 2a), most of the participants (76.0%) were able to identify the presence of FI, while 14.6% denied the presence of FI, and 9.4% were unsure. Looking at the various radiographs, most participants were also able to identify the presence of furcation bone loss, and therefore FI, in the first permanent molars (75.7%, 85.3%, 79.6%, and 98.9%, respectively, for Figure 2b–e).

4.4 | Perception of prognosis of teeth with FI

Almost all (95.1%) participants agreed that FI affects tooth prognosis. When presented with a radiograph showing the upper right first and second permanent molar with furcation bone loss (Figure 2f,g), the management suggested by 40.8% of participants was to treat the teeth, while 30.4% would refer the patient to a specialist and 14.9% would extract the tooth. In the free-text option, several participants highlighted the difficulty of making treatment decisions based on just a radiograph and a photograph. Some highlighted the importance of patient preferences in making a decision, the prosthetic considerations for the dentition as a whole, as well as the importance of focusing on oral hygiene first. Some suggested extraction only once the tooth became grade II–III mobile, or painful. Others suggested root resection as a possible treatment alternative. Patient compliance and medical history were highlighted as factors

TABLE 4 Confidence in detecting and managing furcation involvement

	Confidence in detecting FI		Confidence in managing FI		Confidence in maintaining grade IIIC FI tooth	
	Frequency (n)	Percentage	Frequency (n)	Percentage	Frequency (n)	Percentage
Not at all	2	0.54	30	8.22	101	27.82
A little	25	6.72	105	28.77	124	34.16
Somewhat	99	26.61	165	45.21	118	32.51
Very	176	47.31	57	15.62	17	4.68
Extremely	70	18.82	8	2.19	3	0.83

that would contribute to treatment planning. One participant outlined how the patient's age may contribute in the decision-making process—extraction being preferred if the patient is young, while considering regular professional cleaning alone for an older patient as long as the tooth was asymptomatic. When asked about whether an implant would have a higher survival than a tooth with FI in a periodontally stable patient, a majority (59.3%) did not believe an implant would have a higher survival, 24.0% believed it would, while 16.7% were unsure.

4.5 | Confidence in detecting and managing FI

Table 4 shows the responses related to confidence in managing furcation-involved teeth. Most participants (47.1%) were very confident in detecting furcation-involved teeth, while only 0.5% were not. However, participants showed less confidence in their knowledge on managing furcation-involved teeth, with only 17.9% very/extremely confident, compared with 36.7% little or not confident at all. When asked about their confidence in maintaining the upper molars in Figure 2f,g over the next 10 years, 56% were not at all/little confident versus 7.9% very/extremely confident. Confidence in detecting FI, managing FI, and maintaining the example case for 10 years was higher for dentists qualified before 2000 than for the more recently qualified groups (respectively, $p = .013$, $p < .001$, $p < .001$ at Chi-square).

4.6 | Barriers to dealing with FI and ways to improve it

The participants' perceived barriers to dealing with FI included lack of knowledge of management/referral pathways, lack of correct equipment, lack of time, and lack of experience in detection and classification. In the free-text option, many participants identified patient compliance and motivation as a very important barrier to overcome (see Supplementary material 2 for a summary of free-text answers). The majority (80.9%) of participants were interested in learning more about furcation detection, classification, and management. The most favoured CPD format was face-to-face teaching (42.1%), followed by online tutorials (30.3%) and shadowing a specialist (23.2%).

5 | DISCUSSION

To the authors' knowledge, this is the first study aiming to investigate dentists' attitude to periodontal furcation diagnosis and treatment in a group of GDPs from different countries. The main finding is that, despite recognizing that FI is important for tooth prognosis, less than half of participants use a Nabers probe to diagnose and a third of them had never used a Nabers probe. Furthermore, a 6PPC is not commonly taken by a large proportion of participating GDPs, even in the presence of a CPITN/BPE score of 3.

The group of participants, mainly from seven different countries, had some experience of periodontal treatment in practice, including carrying out periodontal surgery, for just over half the participants. This suggests that the surveyed dentists were GDPs particularly interested in periodontology. Despite this, it is worrying that the majority of them did not use the Nabers probe, which is specifically designed for furcation diagnosis and has been shown to be a reliable method in detecting FI (Eickholz, 1995; Eickholz & Kim, 1998; Eickholz & Walter, 2018). Most participants were able to identify teeth with FI through the radiographs and clinical pictures provided, which may suggest that the participating GDPs were mainly relying on radiographs for furcation diagnosis. Based on the British Society of Periodontology, a Basic Periodontal Examination score of 3 should instigate basic self-care advice, followed by supragingival debridement and a 6PPC of the sextant post initial therapy. If a score of 4 is present, a 6PPC of the entire mouth should be carried out (The British Society of Periodontology, 2019). Access to Nabers probe seems to differ significantly by the year of graduation (younger dentists having less access), which represents a worrying trend for future generations of dentists and patients. This stresses the importance of education at the university level and beyond. The great majority of King's College graduates, most of whom did not routinely use Nabers probes, were young and had little experience of periodontal surgery. Access to the Nabers probe was also different by country. Although the sample of participants was not selected to be representative of dentists in these countries, and these comparisons between countries have to be interpreted with caution, this may reflect differences in training and overall attitude to periodontal treatment across different realities and different health systems.

The importance of furcation diagnosis needs to be considered in the context of the prognostic value of FI, which is shown to be associated with tooth loss both in populations under strict periodontal supportive care (Hirschfeld & Wasserman, 1978; McGuire & Nunn, 1996; Salvi et al., 2014; Graetz et al., 2015; Dannewitz et al., 2016; Nibali et al., 2016) and in untreated populations (Nibali et al., 2017). Almost all participants agreed that FI affects tooth prognosis, and it is encouraging to see that the majority would attempt to treat the tooth before referring to a specialist or extracting the tooth. However, the results are likely to have been skewed towards a more optimistic prognostic outlook due to the number of participants with above-average periodontal experience.

The attitudes to management of FI molars were explored with a question about the potential management of a periapical radiograph of a case affected by severe FI (degree III C) (Hamp et al., 1975; Tarnow & Fletcher, 1984) on two maxillary molars. Approximately 41% of the participants felt they could treat the affected teeth, while 15% would extract them. About a third of the GDPs would refer the patient to a specialist. Interestingly, the majority of the participants felt that an implant would not have a higher survival chance than a tooth with FI in a periodontally stable patient, while 24% favoured an implant and 16.7% were unsure. Several participants added the importance of the oral hygiene of the patients and their preferences in treatment decisions. Although the different strategies of extraction

and implant placement or maintenance of molars with advanced FI have never been tested in a randomized controlled trial, indirect comparison suggests that similar survival rates could be expected (Fugazzotto, 2001). It has recently been highlighted how the presence of FI should not be a reason to extract and replace a tooth (Sanz et al., 2020). Furthermore, retaining furcation-involved teeth may also be more cost effective than replacing them with implants (Schwendicke et al., 2014; Ntoulou et al., 2016).

Having identified the attitude to periodontal FI in participating dentists, we aimed to identify potential barriers and ways to improve furcation management in primary care settings. Participants agreed that lack of knowledge of management/referral pathways, lack of correct equipment, lack of time, and lack of experience in detection and classification were the main barriers to the management of FI. Ensuring patient compliance and motivation was seen as another major challenge added by many respondents as free text. The majority (80.9%) of participants were interested in learning more about furcation detection, classification, and management, favouring face-to-face teaching and online tutorials, followed by the option of shadowing a specialist (23.2%). This shows that there is the potential to increase the ability and confidence of GDPs to diagnose and manage properly periodontal FI.

It was somewhat surprising that, despite the fact that nearly half of the participants were very/extremely confident in detecting FI and only 8.9% felt very/extremely confident at treating it, very few respondents (15%) were regularly referring patients for periodontal treatment. This, coupled with a high response rate relative to "lack of knowledge of management/referral pathways," suggests a lack of access to secondary care (Linden, 1998; Bhandal, 2020). These findings differ from those of surveys by Scottish and Australian GDPs, which found that while most GDPs were confident in treating early stages of periodontitis, they would refer more complex treatment (Chestnutt & Kinane, 1997; Darby et al., 2005). Patient motivation was also noted as major barrier to dealing with FI, similar to previous studies (Chestnutt & Kinane, 1997; Darby et al., 2005). This study also confirmed that most GDPs are interested in more CPD courses and would benefit from more training.

The main strengths of this study are its originality and the collection of the views of 400 GDPs from different countries. A range of questions about attitude to diagnosis and management were asked and most participants answered all questions. The main limitation lies in the relatively low response rate (ranging from 0.7% to 20.6% in different countries), based on the number of GDPs who received the online invitation to take part. This means that the participants cannot be considered representative of GDPs in the respective countries. However, a high percentage (83%) of dentists who accessed the survey consented to take part. It appears that in countries where the survey was emailed directly to participants, such as in Switzerland, Italy, Sweden, and Germany, response rates were higher. Furthermore, the conclusions derived from this study, where we used a non-representative convenience sample, are limited, and not representative, to the seven countries where the survey was conducted and cannot be generalized worldwide.

In an effort to improve tooth survival and oral-health-related quality of life, emphasis needs to be placed on further training of GDPs, particularly recent graduates working in primary care. This could have a

much higher impact on the general population than efforts aimed at improving the efficacy of specific surgical approaches. More emphasis on furcation diagnosis in the undergraduate dental curriculum, as well as online tutorials and face-to-face teaching aimed at improving diagnostic and prognostic knowledge and at clarifying and facilitating access to referral pathways, could be key in this effort. From a research standpoint, a replication of this work with a representative sample of dental practitioners would be necessary to increase the level of evidence.

ACKNOWLEDGEMENTS

The help in translation and distribution of the questionnaire on furcations by Prof. P. Schmidlin, PD Dr. J. Difloe Geisert, Dr. C. Theissen, Dr. T. Jambrec, and the Swiss Society of Dentistry is gratefully acknowledged. The support of Dr. Doris Seiz (Dentists' Chamber of Hassia), Dr. Marion Marschall (Quintessence News), and Benn Roolf (zm online) in distributing the questionnaire in Germany is gratefully acknowledged.

CONFLICT OF INTEREST

The authors declare no conflict of interests.

ETHICS STATEMENT

The study was registered under King's College London Research Ethics Committee Research Ethics Minimal Risk Self-Registration Form (reference MRA-19/20-20077). Separate ethics approval was obtained as required in Australia (UQ human ethics clearance number 2020001797/MRA-19/20-20077) and Sweden (Ethics Review Authority in Uppsala Dnr 2021/00292).

AUTHOR CONTRIBUTIONS

Luigi Nibali was responsible for study conception. All authors took part in protocol writing and data collection. Luigi Nibali, Melissa Shemie, Guanhong Li, Rachel Ting, and Koula Asimakopoulou took part in data analysis. All authors contributed to data interpretation and paper writing, approved the final version of the paper, and agreed to be accountable for all aspects of the work.

DATA AVAILABILITY STATEMENT

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

ORCID

Luigi Nibali  <https://orcid.org/0000-0002-7750-5010>
 Koula Asimakopoulou  <https://orcid.org/0000-0003-3420-8523>
 Giovanni Barbagallo  <https://orcid.org/0000-0002-9006-7262>
 Peter Eickholz  <https://orcid.org/0000-0002-1655-8055>
 Clemens Walter  <https://orcid.org/0000-0002-9967-1570>
 Mario Aimetti  <https://orcid.org/0000-0003-0657-0787>

REFERENCES

American Academy of Periodontology. (2001). *Glossary of periodontal terms*. Retrieved from <https://www.perio.org/sites/default/files/files/PDFs/Clinical%20Resources/GlossaryOfPeriodontalTerms2001Edition.pdf>

- Bhandal, S. (2020). An explorative study of the current practice and attitude towards the management of chronic periodontitis by general dental practitioners in the West Midlands. *British Dental Journal*, 228(7), 537–545. <https://doi.org/10.1038/s41415-020-1426-9>
- Chestnutt, I. G., & Kinane, D. F. (1997). Factors influencing the diagnosis and management of periodontal disease by general dental practitioners. *British Dental Journal*, 183(9), 319–324. <https://doi.org/10.1038/sj.bdj.4809486>
- Dannewitz, B., Zeidler, A., Husing, J., Saure, D., Pfeifferle, T., Eickholz, P., & Pretzl, B. (2016). Loss of molars in periodontally treated patients: Results 10 years and more after active periodontal therapy. *Journal of Clinical Periodontology*, 43, 53–62. <https://doi.org/10.1111/jcpe.12488>
- Darby, I. B., Angkasa, F., Duong, C., Ho, D., Legudi, S., Pham, K., & Welsh, A. (2005). Factors influencing the diagnosis and treatment of periodontal disease by dental practitioners in Victoria. *Australian Dental Journal*, 50(1), 37–41. <https://doi.org/10.1111/j.1834-7819.2005.tb00083.x>
- Domisch, H., Walter, C., Dannewitz, B., & Eickholz, P. (2020). Resective surgery for the treatment of furcation involvement: A systematic review. *Journal of Clinical Periodontology*, 47(Suppl 22), 375–391. <https://doi.org/10.1111/jcpe.13241>
- Eickholz, P. (1995). Reproducibility and validity of furcation measurements as related to class of furcation invasion. *Journal of Periodontology*, 66, 984–989. <https://doi.org/10.1902/jop.1995.66.11.984>
- Eickholz, P., & Kim, T. S. (1998). Reproducibility and validity of the assessment of clinical furcation parameters as related to different probes. *Journal of Periodontology*, 69, 328–336. <https://doi.org/10.1902/jop.1998.69.3.328>
- Eickholz, P., & Walter, C. (2018). Clinical and radiographic diagnosis and epidemiology of furcation involvement. In L. Nibali (Ed.), *Diagnosis and treatment of furcation-involved teeth* (pp. 15–31). John Wiley & Sons Ltd.
- Fugazzotto, P. A. (2001). A comparison of the success of root resected molars and molar position implants in function in a private practice: Results of up to 15-plus years. *Journal of Periodontology*, 72, 1113–1123. <https://doi.org/10.1902/jop.2001.72.8.1113>
- Graetz, C., Schutzhold, S., Plaumann, A., Kahl, M., Springer, C., Salzer, S., Holtfreter, B., Kocher, T., Dorfer, C. E., & Schwendicke, F. (2015). Prognostic factors for the loss of molars – An 18-years retrospective cohort study. *Journal of Clinical Periodontology*, 42, 943–950. <https://doi.org/10.1111/jcpe.12460>
- Hamp, S. E., Nyman, S., & Lindhe, J. (1975). Periodontal treatment of multirooted teeth. Results after 5 years. *Journal of Clinical Periodontology*, 2, 126–135.
- Hirschfeld, L., & Wasserman, B. (1978). A long-term survey of tooth loss in 600 treated periodontal patients. *Journal of Periodontology*, 49, 225–237. <https://doi.org/10.1902/jop.1978.49.5.225>
- Huynh-Ba, G., Kuonen, P., Hofer, D., Schmid, J., Lang, N. P., & Salvi, G. E. (2009). The effect of periodontal therapy on the survival rate and incidence of complications of multirooted teeth with furcation involvement after an observation period of at least 5 years: A systematic review. *Journal of Clinical Periodontology*, 36(2), 164–176. <https://doi.org/10.1111/j.1600-051X.2008.01358.x>
- Jepsen, S., Gennai, S., Hirschfeld, J., Kalemaj, Z., Buti, J., & Graziani, F. (2020). Regenerative surgical treatment of furcation defects: A systematic review and Bayesian network meta-analysis of randomized clinical trials. *J Clin Periodontol*, 47(22), 352–374. <https://doi.org/10.1111/jcpe.13238>
- Linden, G. J. (1998). Variation in periodontal referral by general dental practitioners. *Journal of Clinical Periodontology*, 25(8), 655–661. <https://doi.org/10.1111/j.1600-051X.1998.tb02502.x>
- McGuire, M. K., & Nunn, M. E. (1996). Prognosis versus actual outcome. III. The effectiveness of clinical parameters in accurately predicting tooth survival. *Journal of Periodontology*, 67, 666–674. <https://doi.org/10.1902/jop.1996.67.7.666>
- Nibali, L., Krajewski, A., Donos, N., Volzke, H., Pink, C., Kocher, T., & Holtfreter, B. (2017). The effect of furcation involvement on tooth loss in a population without regular periodontal therapy. *Journal of Clinical Periodontology*, 44, 813–821. <https://doi.org/10.1111/jcpe.12756>
- Nibali, L., Zavattini, A., Nagata, K., Di Iorio, A., Lin, G. H., Needleman, I., & Donos, N. (2016). Tooth loss in molars with and without furcation involvement – A systematic review and meta-analysis. *Journal of Clinical Periodontology*, 43, 156–166. <https://doi.org/10.1111/jcpe.12497>
- Ntolou, P., Prevezanos, I., & Karoussis, I. K. (2016). Prognosis of furcation involved teeth: Cost-effectiveness over implant placement. *Dental Health: Current Research*, 2, 3. <https://doi.org/10.4172/2470-0886.1000121>
- Salvi, G. E., Mischler, D. C., Schmidlin, K., Matuliene, G., Pjetursson, B. E., Bragger, U., & Lang, N. P. (2014). Risk factors associated with the longevity of multi-rooted teeth. Long-term outcomes after active and supportive periodontal therapy. *Journal of Clinical Periodontology*, 41, 701–707. <https://doi.org/10.1111/jcpe.12266>
- Sanz, M., Herrera, D., Kerschull, M., Chapple, I., Jepsen, S., Beglundh, T., Sculean, A., Tonetti, M. S., & EFP Workshop Participants and Methodological Consultants. (2020). Treatment of stage I–III periodontitis – The EFP S3 level clinical practice guideline. *Journal of Clinical Periodontology*, 47(Suppl 22), 4–60. <https://doi.org/10.1111/jcpe.13290>
- Schwendicke, F., Graetz, C., Stolpe, M., & Dörfer, C. E. (2014). Retaining or replacing molars with furcation involvement: A cost-effectiveness comparison of different strategies. *J Clin Periodontol*, 41(11), 1090–1097. <https://doi.org/10.1111/jcpe.12315>
- Tarnow, D., & Fletcher, P. (1984). Classification of the vertical component of furcation involvement. *Journal of Periodontology*, 55, 283–284. <https://doi.org/10.1902/jop.1984.55.5.283>
- The British Society of Periodontology. (2019). *BPE guidelines 2019*. Retrieved from https://www.bsperio.org.uk/assets/downloads/BSP_BPE_Guidelines_2019.pdf
- Tonetti, M. S., Greenwell, H., & Kornman, K. S. (2018). Staging and grading of periodontitis: Framework and proposal of a new classification and case definition. *J Clin Periodontol*, 45(20), S149–S161. <https://doi.org/10.1111/jcpe.12945>

SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

How to cite this article: Nibali, L., Shemie, M., Li, G., Ting, R., Asimakopoulou, K., Barbagallo, G., Lee, R., Eickholz, P., Kocher, T., Walter, C., Aimetti, M., & Rüdiger, S. (2021). Periodontal furcation lesions: A survey of diagnosis and management by general dental practitioners. *Journal of Clinical Periodontology*, 48(11), 1441–1448. <https://doi.org/10.1111/jcpe.13543>