Photodiagnosis and Photodynamic Therapy 26 (2019) 43–44

Contents lists available at ScienceDirect

Photodiagnosis and Photodynamic Therapy

journal homepage: www.elsevier.com/locate/pdpdt

Case report

Can red fluorescence be useful in diagnostic decision making of residual dentin caries?

Jeong-Woo Lee[a], Eun-Song Lee[b], Baek-Il Kim[b,*]

[a] Department of Preventive Dentistry & Public Oral Health, Yonsei University College of Dentistry, 120-752, 50 Yonsei-ro, Seodaemun-Gu, Seoul, Republic of Korea
[b] Department of Preventive Dentistry & Public Oral Health, BK21 PLUS Project, Oral Science Research Institute, Yonsei University College of Dentistry, 120-752, 50 Yonsei-ro, Seodaemun-Gu, Seoul, Republic of Korea

ARTICLE INFO

Keywords:
Dentin caries
Quantitative light-induced fluorescence (QLF)
Removal end point

ABSTRACT

Introduction: A diagnosis based on traditional methods can differ under the same tooth condition. Additional diagnostic tools are required to overcome this limitation. QLF technology is a viable method for detecting residual caries and is increasingly being used to detect dentin-level residual caries. In this study we used the Qraypen (AIOBIO, Seoul, Korea) to investigate the usefulness of the QLF technology for diagnosing controversial cases.

Case 1: A 31-year-old man presented with pain in the left mandibular first molar. The old restoration and severe dental caries were removed as much as possible using traditional visual and tactile senses. The area of treatment was photographed using the Qraypen. We concluded that endodontic treatment was preferable based on the Qraypen findings combined with diagnostic information.

Case 2: A 67-year-old man presented with discomfort in the first molar on the right mandible. Most of the existing restoration and carious debris were removed. Black discoloration was observed around and within the crack line, but with no red fluorescence. Based on the results of these examinations we decided that a minimally invasive dentistry approach was appropriate.

Conclusion: Using QLF technology is more objective and accurate than other methods of determining the removal end point and detecting healthy marginal dentin for successful restoration.

1. Introduction

Detecting caries at the dentin level is complex due to the requirement of a real-time assessment of the viability of the pulp. A diagnosis based on traditional visual and tactile senses can differ under the same tooth condition according to the subjective criteria used by different dentists [1]. Additional diagnostic tools are therefore required to overcome this limitation.

QLF technology based on the autofluorescence of natural teeth is a viable method for detecting residual caries. This technology uses 405-nm visible light and special filters to detect the autofluorescence of tooth minerals, as well as the red fluorescence of porphyrin, which is a metabolite of oral microorganisms. These characteristics allow QLF technology to show caries lesions with mineral loss as a fluorescence reduction, and microbial activity in lesions as red fluorescence. QLF technology is increasingly being used to detect dentin-level residual caries [2].

In this study we used the Qraypen (AIOBIO, Seoul, Korea) to investigate the usefulness of the QLF technology for diagnosing controversial cases during the detection of deep dentin caries.

2. Case reports

2.1. Case #1

In June 2017, a 31-year-old man presented with the complaint of pain in the left mandibular first molar. The initial examination revealed fracture of an old restoration and severe caries with downward food impaction (Fig. 1A, B). The old restoration and caries were removed as much as possible considering the patient's pain complaint using traditional methods. The area of treatment was photographed using the Qraypen after removing the caries to assess the extent that the color and hardness of healthy dentin had been acquired.

The results showed that red fluorescence (indicating cariogenicity) appeared under the blue light of the Qraypen, even in the region that appeared to be healthy dentin under white light (Fig. 1C, D; red

* Corresponding author.
E-mail address: drkbi@yuhs.ac (B.-I. Kim).

https://doi.org/10.1016/j.pdpdt.2019.02.016
Received 11 January 2019; Received in revised form 15 February 2019; Accepted 19 February 2019
Available online 20 February 2019

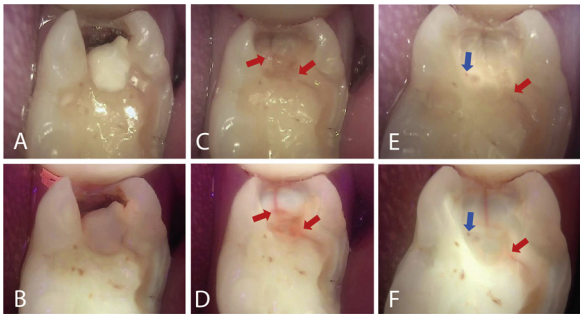

Fig. 1. Initial views (A, B), after primary removal of caries (C, D), and after removal to the extent of exposing the pulp (E, F). Under white light (A, C, E) and under blue light (B, D, F).

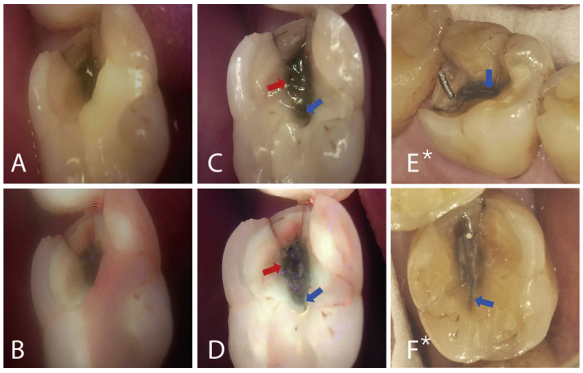

Fig. 2. Initial view (A, B) and after primary removal of caries (C, D). Under white light (A, C) and blue light (B, D). Final removal and before restoration (E, F). Note that the black color and crack line are also visible with white light. The photos E and F with * marked were captured with a Nikon® D100 camera with manual settings F45, S160, and ISO200.

arrows). Considering the patient's current pain, we informed him that he might require an invasive endodontic treatment and that dentin at the site where red fluorescence remained should be more clearly removed. However, red fluorescence (red arrow) remained despite removing sufficient dentin to expose the pulp tissue (blue arrow) (Fig. 1E, F).

In this patient it was difficult to confirm the efficacy of endodontic treatment despite the progression of subjective symptoms and performing visual, tactile, and radiographic examinations. However, we concluded that endodontic treatment was preferable based on the Qraypen findings combined with the above-mentioned diagnostic information. We showed photographs to the patient while explaining the need for endodontic treatment and asking for his consent. The patient easily understood his condition and agreed to the proposed treatment methods. The patient underwent crown restoration after the endodontic treatment, and at a 14-month follow-up he did not report any major inconveniences.

2.2. Case #2

In August 2017, a 67-year-old man presented with discomfort in the first molar on the right mandible. A traditional diagnosis revealed fracture of a restoration and caries with food impaction (Fig. 2A, B). Most of the existing restoration and carious lesions were removed first using traditional methods, which revealed a dark discolored dentin caries lesion.

There was no red fluorescence in the section suspected of severe caries on the basis of the black color change (Fig. 2C, D; red arrow). In addition, black discoloration was observed around and within the crack line, but with no red fluorescence (Fig. 2D, blue arrow). Based on the results of these examinations we decided that a minimally invasive dentistry approach was appropriate, and removed only the least-visible portion responsible for the red fluorescence. Finally, the crack line was judged to be in an arrested state, and was reinforced with a custom pin and core. This patient received a crown restoration without endodontic treatment (Fig. 2E, F), and was using this appropriately at the 12-month follow-up.

3. Discussion

In the first case, the red fluorescence detected by the Qraypen confirmed the ability of the QLF technology to provide the clinician with objective evidence for an accurate diagnosis in the decision-making process about treatment. In the second case, when the caries became severe and discoloration progressed, the clinicians were uncertain of the removal end point. According to previous studies, dentinal tubules are closed in an arrested state, and so red fluorescence—representing the metabolic products of bacteria—is not expected [3]. QLF technology was used to evaluate the absence of cariogenic discoloration in red fluorescence, which made it was possible to diagnose the removal end point and avoid complete excavation [4].

Using QLF technology is more objective and accurate than other methods of determining the end point, such as those based on hardness, color, or dyeing [5]. In particular, the red fluorescence detected by a Qraypen meaningfully reflects the metabolic activity of anaerobic Gram-negative bacteria, which can survive mainly in dentin lesions with a lower pH and nutrient limitations compared to healthy dentin [6]. The importance of clearly diagnosing healthy marginal dentin for successful restoration makes objective diagnosis based on QLF technology very helpful for obtaining successful clinical results.

Conflict of interest

The authors declare that they have no conflict of interest.

References

[1] M.M. Koopaeei, M.R. Inglehart, N. McDonald, M. Fontana, General dentists', pediatric dentists', and endodontists' diagnostic assessment and treatment strategies for deep carious lesions: a comparative analysis, J. Am. Dent. Assoc. 148 (2017) 64–74.
[2] J.W. Lee, E.S. Lee, B.I. Kim, Optical diagnosis of dentin caries lesions using quantitative light-induced fluorescence technology, Photodiagnosis Photodyn. Ther. 23 (2018) 68–70.
[3] E. Kidd, O. Fejerskov, B. Nyvad, Infected dentine revisited, Dent. Update 42 (2015) 802–806.
[4] H.S. Lee, S.K. Kim, S.W. Park, de Josselin de Jong, H.K. Kwon, S.H. Jeong, et al., Caries detection and quantification around stained pits and fissures in occlusal tooth surfaces with fluorescence, J. Biomed. Opt. 23 (2018) 1–7.
[5] E.S. Lee, de Josselin de Jong, H.I. Jung, B.I. Kim, Red fluorescence of dental biofilm as an indicator for assessing the efficacy of antimicrobials, J. Biomed. Opt. 23 (2018) 1–6.
[6] A.M. Lennon, W. Buchalla, L. Brune, O. Zimmermann, U. Gross, T. Attin, The ability of selected oral microorganisms to emit red fluorescence, Caries Res. 40 (2006) 2–5.