



Case report

Diagnosis and management of cracked tooth by quantitative light-induced fluorescence technology

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ABSTRACT

Introduction: The aim of this case report was to describe the process of diagnosis and treatment of a cracked tooth using quantitative light-induced fluorescence (QLF).

Case report: A 43-year-old male presented at our dental clinic with a complaint of cold pain in #17 tooth. A routine oral examination with radiography was performed for evaluation of the oral condition and treatment planning. Additionally, QLF image capture was performed using Qraycam and Qraypen (AIOBIO, Seoul, Republic of Korea), to collect white-light and fluorescence images. The #17 tooth was observed to have a crack line, showing red fluorescence, from the distal to mesial aspect on the occlusal surface. Even though there was no visible root fracture in the radiographic image, bone loss was observed. Therefore, we performed periodontal treatment. One month later, a root canal treatment was performed because the patient still complained of pain in the #17 tooth. During this treatment, one fluorescent image and one white light image set was captured with the Qraypen. A crack line showing red fluorescence was observed, while the line was not visible to the naked eye. After treatment, the patient has had no complaint related to this tooth for 3 years until today.

Conclusions: Clinically, use of QLF confirmed the presence of a crack before and during a root canal treatment. Therefore, it is postulated that the QLF technology could objectively facilitate the diagnosis and treatment of a cracked tooth.

1. Introduction

A cracked tooth might progress to not only tooth loss, but also to periodontal disease, if not treated immediately [1]. The diagnosis of a cracked tooth is difficult because it is caused by diverse factors and the symptoms vary depending on the severity of the crack. Therefore, early detection and appropriate treatment are important for retaining the tooth.

Recently, systems based on the quantitative light-induced fluorescence (QLF) technology have been developed, which facilitates enamel crack detection and depth estimation [2]. This is an optical technology using a visible light wavelength with a special filter and is less harmful to the human body than X-ray for example. It can quantify enamel crack depth by calculating loss of green autofluorescence of the tooth due to back scattering caused by decreased mineral levels. In addition, red autofluorescence derived from bacterial metabolites, such as porphyrin, is used to diagnose bacterial deposits and bacteria-related lesions [3].

These two kinds of fluorescence observed using the QLF technology could be one of the evidences for diagnosis of a cracked tooth. The aim of this case report was to describe the process of diagnosis and treatment of a cracked tooth using QLF.

2. Case report

A 43-year-old male patient visited the hospital with a complaint of cold pain on his #17 tooth. The patient had no systemic disease and a parafunctional habit of clenching. After obtaining the consent of the patient, a diagnosis and treatment plan were established. A dentist performed a conventional oral examination (visual inspection with radiography) and the QLF examination for evaluating the oral cavity by using the Qraycam (AIOBIO, Seoul, Republic of Korea), which is a third generation QLF device. Cracks and worn areas in the upper and lower occlusal surfaces were observed in white-light images (Fig. 1A and B). These were also clearly observed in the fluorescence images, due to

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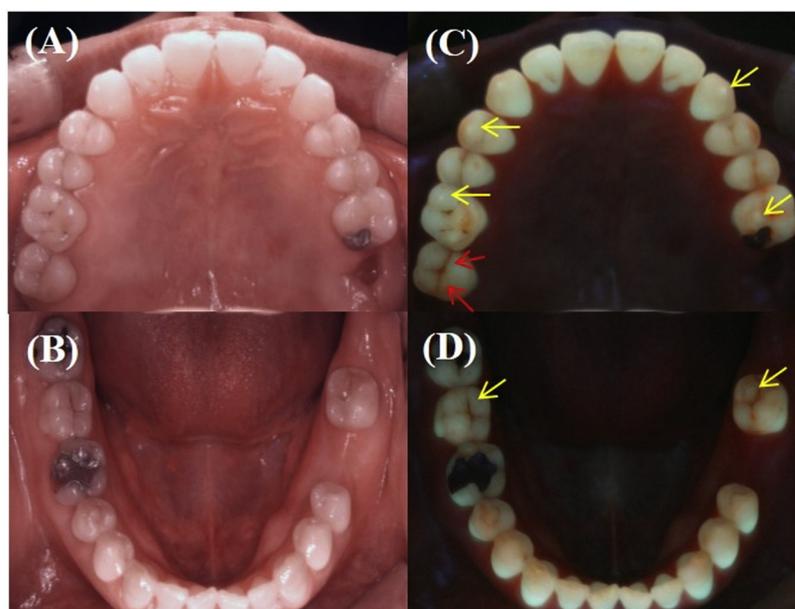


Fig. 1. White-light images (A,B) and blue-light images (C,D) taken with the Qraycam. Multiple tooth wear (#14, #16, #23, #37, #47), loss of two teeth (#27, #36), one cracked tooth (#17), and two teeth with secondary caries (#26, #46) were diagnosed with visual inspection and Qraycam images.

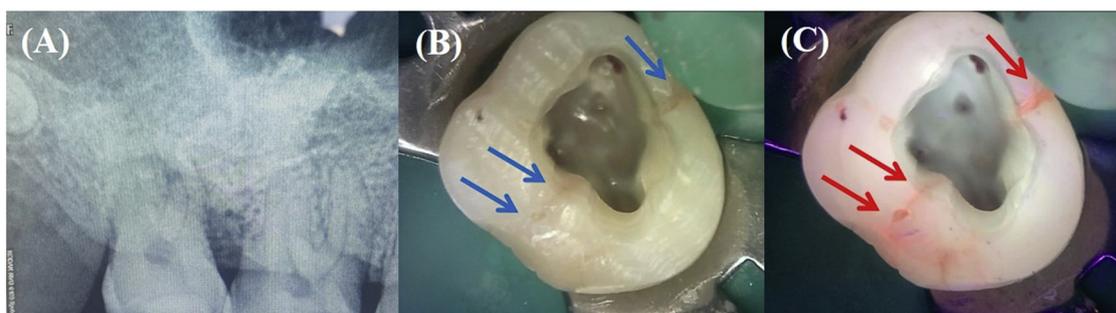


Fig. 2. Radiographic image (A), white-light images (B), and blue-light images (C) taken with the Qraypen. Images taken after opening of the pulp chamber (B, C).

differences in the fluorescence of the lesion (Fig. 1C and D). With tooth wear, decreased enamel thickness caused by repetitive occlusion results in strong fluorescence intensity in the form of a bright spot, as compared to that of the sound enamel (Fig. 1C and D, yellow arrow). In the fluorescence image, we observed a line showing loss of fluorescence and red fluorescence in the #17 tooth, across the occlusal plane (Fig. 1C, red arrow). There was no root fracture in the radiographic image, but a periapical lesion and bone loss were observed. we performed periodontal treatment (Fig. 2A).

One month later, the patient still complained of cold, sharp pain in the #17 tooth. Based on the presence of the red fluorescent line on the cracked tooth, the possibility of recurrent pain and extraction was explained to the patient. Root canal treatment (RCT) was performed thereafter. When we opened the pulp chamber, a Qraypen (AIOBIO, Seoul, Republic of Korea), an intraoral camera type QLF device, was used to capture an image of the crack line. After opening the pulp chamber, there was no crack line visible to the naked eye (Fig. 2B, blue arrow). On the other hand, the fluorescence image obtained with the Qraypen showed that the fluorescence loss line, seen as red fluorescence, progressed to the marginal ridge, but not to the pulp floor (Fig. 2C, red arrow). After the RCT, a permanent gold crown was applied. At the end of overall treatment, a splint was placed on the maxilla. The patient has had no complaint related to this tooth for 3 years until today.

3. Discussion

A cracked tooth showing a dark fluorescence line could be used as an index to estimate the depth of the crack line. A previous study has also reported that fluorescence loss could indicate the presence or absence of the crack line, as well as the severity of the crack [2]. Analysis of the #17 tooth (Fig. 1C, red arrow) showed that the $|\Delta F_{max}|$ value of fluorescence loss was 33, which can be divided into cracks extending to the dentin according to previous studies [2]. Meanwhile, red fluorescence emitted from the crack line was clearly observed. It can be postulated that porphyrin, a byproduct of anaerobic bacterial metabolism, had penetrated the crack line providing evidence that bacterial activity has accumulated over a long period of time [3]. It is likely that a crack line showing red fluorescence is older and more likely to have bacterial activity than a crack line without red fluorescence. It has been reported in a previous clinical study that the red fluorescence could be detected by the QLF device from a crack line after removal of the restoration near a secondary caries lesion [4]. However, further studies are needed to investigate the correlations of red fluorescence intensity with crack depths and bacterial infection within the crack.

In addition, tooth wear due to clenching was observed in the present case. In the fluorescence image, brighter fluorescence was observed in the occlusal worn area than in the sound enamel. This demonstrated that increased fluorescence was emitted from exposed dentin in areas with loss of sound enamel [5]. These results allowed us to detect cuspal interference or oral parafunctional habits such as bruxism by using the

QLF device.

In this clinical case, the QLF technology, which is a supportive diagnostic method was used for objective real-time detection of tooth cracks and tooth wear. The # 17 tooth was diagnosed as a cracked tooth by visual inspection and cold pain with the existence of a crack. However, it was difficult to assess depth of crack and obtain the patient's consent for treatment. The use of QLF technology could provide the patient with an understanding of the depth of the crack during the treatment process. The Qraycam, which is capable of imaging the entire mouth, could be used for comprehensive diagnostic investigation of the total oral cavity [6]. During treatment, the Qraypen was able to demonstrate the existence and the direction of the crack line and bacterial infection in the opening of the pulp chamber.

In conclusion, QLF could objectively facilitate diagnosis and treatment of a cracked tooth.

Conflict of interest

The authors declare that they have no conflict of interest.

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