A Clinical Challenge & Solution: Detecting Cracks in Teeth Using PTR-LUM-The Canary System; A Case Report

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Abstract: Detecting cracks in teeth is a clinical challenge. Patients may complain of diffuse pain on chewing, pain, at times, on temperature change and pain that occurs episodically. Common diagnostic tools such as radiographs and visual examination may not detect cracks. This case study shows how PTR-LUM in The Canary System can detect cracks in teeth not seen with other devices. In this clinical situation, the crack involved a large part of the mesial and distal surfaces of a mandibular second molar. It led to a diagnosis of parafunction and placement of a mandibular flat plane bite splint.

Keywords: marginal ridge staining, enamel crack, detecting cracks in teeth, PTR-LUM

1. Introduction

Detecting cracks in teeth is one of the more challenging clinical situations. The "Cracked Tooth Syndrome" was described over 55 years ago [1} and clinicians still struggle to detect cracks early and to provide appropriate therapy [2]. Patients usually present with vague symptoms such as acute pain on mastication of grainy tough foods and sharp brief pain on cold. These findings relate to cusp fracture but there can also be other symptoms associated with a crack or fracture such as slight to severe pain consistent with irreversible pulpitis, or pulpal necrosis [3]. Periapical and bitewing radiographs usually cannot image the crack or fracture. So the dilemma is how does one detect and then manage cracks and fractures in teeth?

What are the predisposing factors to cracked teeth? A number of papers indicate that cracked teeth were associated with intra-coronal restorations and frequently found in mandibular molars [4-7]. The most commonly identified etiologic factor was the design of the cavity preparations. Large restorations, inappropriate use of pins, restorations encroaching upon the marginal ridges or undermining the marginal ridges are some of the factors. Selection of restorative materials may also be a factor. Bonded restorations may possibly reduce the incidence of cracks or fractures. Bruxism and other parafunctional habits, wear, malocclusion, steep cuspal inclines or deep occlusal grooves were also considered as pre-disposing factors [8-11]. Cracks can also occur in intact teeth with no restorations. One study found that 28% of the longitudinal fractures occurred in teeth with no restorations [12] while another study of 154 cases found that 60.4% had no restorations and a further 29% had only Class I restorations. [13]

The clinical challenge is how to detect cracks in teeth? Patients may present complaining of pain on chewing but not consistently. The pain would only occur when loading teeth in a certain position. There may be pain on temperature change or this may not be a feature. Clinically, the teeth look intact [2]. The marginal ridges may appear stained but there are not grooves or cracks. Radiographs may not show any interproximal defects or caries.

There are a number of new caries detection systems on market and they may provide some additional clinical information. In this case report we used The Canary System as one of the diagnostic tools for detecting cracks. The Canary System is a laser-based caries detection system that uses energy conversion technology called PTR-LUM, to image and examine teeth [14]. This case study found that The Canary System could detect cracks in a tooth which were not seen visually or with a radiograph.

2. Case Report

This 61 year old female has been a patient in our group practice for over 20 years. During this time there has been no evidence of bruxism or parafunction. Caries risk has been low and no restorations have been placed or replaced on the right side for over ten years. Four months prior to the examination, the patient began to complain of pain periodically on chewing on the mandibular right posterior area.

Radiographs taken three months prior to the pain occurring, did not indicate any caries or cracks on the mandibular first and second molar or on the distal surface of the mandibular right second bicuspid. The

maxillary first molar had a large amalgam restoration but there was no pain on hot, cold, percussion or occlusal loading. The amalgam restorations on the mandibular molar teeth appeared very shallow.

Figure 1 Bitewing Radiographs of the Right Posterior Teeth taken 3 months before pain occurred

On examination, the pain appeared to be focused on the mesial portion of the mandibular second molar and distal portion of the mandibular right first molar. The image below shows the clinical condition of the occlusal surface of the mandibular second molar. There were three shallow amalgams placed in the central area of the occlusal surface over 25 years ago. There were stained grooves on both the mesial and distal marginal ridges. There was a grey shadow on the distal aspect of the distal amalgam. The bite wing radiograph did not indicate that there was caries on the distal aspect of the tooth and visual examination did not show any open lesion or staining on the distal surface.

Figure 2 Occlusal view of the Mandibular Right Second Molar

The Canary System was used to scan and examine the occlusal surfaces of the mandibular right second molar. The intra-oral camera image was used to record the location of the various readings. Canary Numbers above 20 indicated that the crystal structure of the tooth was not intact. The Canary examination of this tooth indicated that the marginal ridges and central pit all have caries and or cracks.

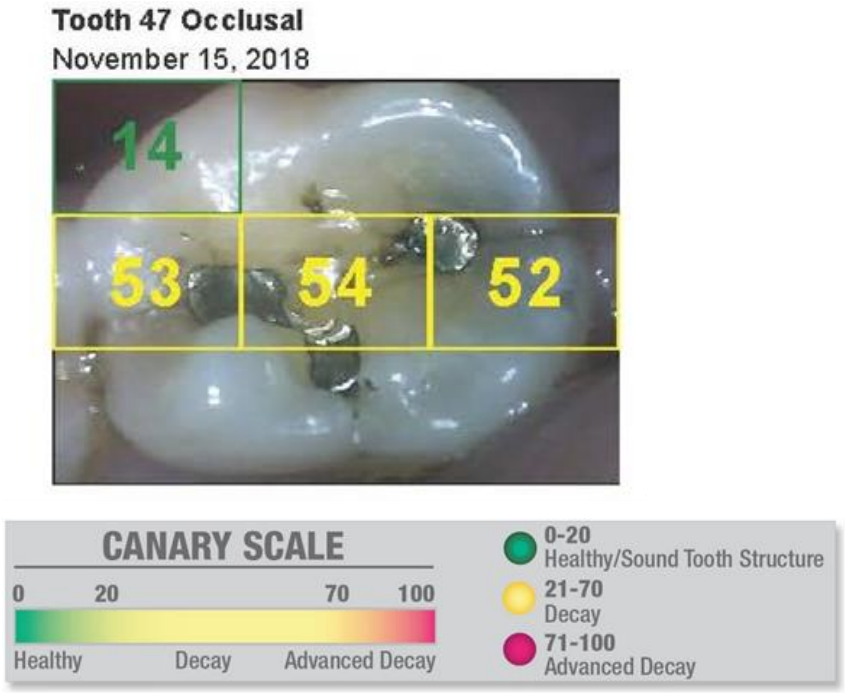

Figure 3: Canary Scan of the Occlusal Surface of the Mandibular Right Second Molar. The Canary Scale indicates that there are defects in the crystal structure of the tooth in three locations requiring treatment.

Figure 4 Initial Removal of the Amalgam showed cracks on both marginal ridges and some cracks or caries in the central pit.

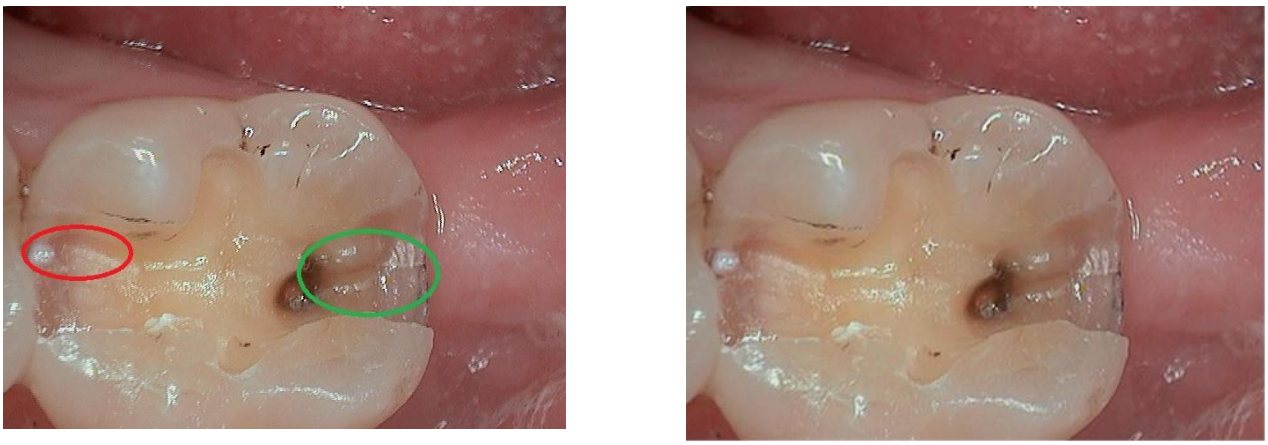

Figure 5 Image taken after removal of the amalgam and preparation of the proximal boxes. There are still cracks present on the mesial and distal proximal boxes. The circles indicate areas of concern / pathology

Upon removal of the amalgams, cracks were found on the mesial (red circle) and distal proximal boxes (Figure 5). The crack on the distal appeared to be much more extensive (Figure 5 green circle). There was also some demineralized dentin beneath the amalgam on the distal and some stain from the amalgam (indicated with the green circle). On removal of the amalgam in the central pit, we noted a small crack and leakage around the amalgam margin.

The MOD preparation was completed and a bonded composite restoration was placed. This restoration has been placed 6 months and the patient has had no pain on temperature change or on chewing. We are now currently assessing her to see if there is any evidence of parafunction and may consider placement of a bite splint in the future.

4. Discussion

Detecting cracks is a clinical challenge. At times, the symptoms may not be indicative of the presence of a crack. [2] As we have seen in this case report, bitewing radiograph may not be able to image small micro-fractures. Clinicians then need to find caries detection devices that image defects, cracks and caries.

Visual examination may detect surface staining. Probing with an explorer may find pits and fissures but these might not be indicative of a crack or caries. Studies indicate that classical use of sharp explorers may produce irreversible traumatic defects in demineralized areas in occlusal fissures favouring conditions for isolated lesion progression.[14].

Fluorescence is one method that is being used for caries detection. Fluorescence is simply the emission of light from an object that has absorbed light at a specific wavelength. This is the core technology in SOPROLIFE (Acteon), Spectra (Air Techniques) and DIAGNODent (KaVo).[16] These devices produce

glow from the tooth surface when an LED or laser light is shone on the tooth. The research literature indicates that the glow is from one or more of the following whether or not caries is present. [17-22]

- bacterial porphyrins (bacterial breakdown product) [19],
- stain,
- tartar,
- food debris.

Another problem with fluorescence is that it does not penetrate beneath the tooth surface due to scattering of light from stain, plaque, organic deposits and surface features such as pits and fissures. [23, 23] Studies have also demonstrated poor correlation between DIAGNOdent and other fluorescence devices readings with caries lesion depth. [14, 21, 25-27] This indicates that fluorescence based devices may not be able to detect cracks in teeth. When a crack occurs near a restoration then the fluorescence or glow from the restoration may impede the ability of the device to detect any information from the enamel surface.

The Canary System uses pulses of laser light to detect caries and defects in tooth structure and can measure defects and caries around and beneath restorations and through sealants. Pulses of laser light are shone on the tooth and the laser light is converted to heat (Photothermal Radiometry or PTR) and light (luminescence or LUM) which are emitted from the tooth surface when the laser is modulated. These harmless pulses of laser light allow a clinician to examine sub-surface caries and crystal structure defects, up to 5 mm. below the surface [28, 29]. Carious lesions modify the thermal properties (PTR) and glow (LUM) from the healthy teeth. As a lesion grows, there is a corresponding change in the signal as the heat is confined to the region with crystalline disintegration (dental caries); PTR increases and LUM decreases. As remineralization progresses and enamel prisms begin to reform their structure, the thermal and luminescence properties begin to revert back in the direction of healthy teeth [30-33]

The Canary Number (ranging from 0 – 100) is created from an algorithm combining the PTR and LUM readings and is directly linked to the status of the enamel or root surface crystal structure [33, 34]. A Canary Number of less than 20 indicates a healthy tooth surface. Any Canary Number above 20 indicates a defect in the tooth structure [35]. In this clinical situation, the Canary Numbers were above 50, indicating large cracks or extensive cracks along the marginal ridges and caries in the central pit. These cracks were found upon preparation of the tooth for the restoration.

5. Conclusions

Detecting cracks in teeth is a clinical challenge. A good clinical history and an accurate caries detection system such as The Canary System can provide the clinician with the tools needed to detect cracks and caries. Once found, the cracks can be treated with the placement of direct restorations or full coverage restorations. One also needs to assess the cause of the cracks and how best to prevent them from occurring in the future.

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