Self-repaired Process of a Traumatized Maxillary Central Incisor with Pulp Infarct after Horizontal Root Fracture Monitored by Laser Doppler Flowmetry Combined with Tissue Oxygen Monitor

Qian Liao, DDS, Wenjun Ye, DDS, Junli Yue, DDS, Xiaoxi Zhao, Ling Zhang, Lan Zhang, DDS, PhD, Dingming Huang, DDS, PhD, and Qinghua Zheng, DDS, PhD

Abstract

Achieving a precise diagnosis of the pulp status of traumatized teeth is difficult. The time to interfere through endodontic treatment for these teeth is greatly dependent on the doctor's experience. A 24-year-old male patient suffered a traumatic injury to tooth #9 that resulted in an apical root horizontal fracture 3 days before he came to the hospital. The injured tooth showed no response to pulp sensitivity testing at the first visit and was discolored 1 week later. Tooth #9 was immobilized to its adjacent teeth for 4 weeks by a composite splint. The patient was asked to make regular follow-up appointments for 72 weeks. The changes in the pulp microcirculation of tooth #9 after the injury were recorded using laser Doppler flowmetry (LDF) and a tissue oxygen monitor (OXY). The LDF was used to directly measure the pulpal blood flow, and the OXY was used to detect the tissue oxygen saturation and total hemoglobin at each appointment. Tooth #9 survived a period of pulp infarct that started at week 4 and showed complete revascularization within 10 weeks. The color of the tooth returned to normal after revascularization. The tooth responded to sensitivity testing at week 58, and radiographic examinations confirmed its hard tissue was healing. Without other clinical signs besides tooth discoloration and an absence of response to pulp sensitivity testing, the complete self-repair of pulp can be expected in teeth with pulp infarct after a horizontal root fracture, and more than 1 year of follow-up is recommended. The use of LDF combined with OXY monitoring has great value in the timely and precise reflection of changes in pulp status after dental trauma. *(J Endod 2017;■:1–5)*

Key Words

Discoloration, horizontal root fracture, laser Doppler flowmetry, pulp revascularization, tissue oxygen monitor

Significance

We firstly presented the pulp response after root fracture intuitively. The pulp experienced inflammation, infarct, and finally revascularization. The process can provide a basis for precise diagnosis of pulp status on root-fractured teeth and help to determine the best treatment plan.

The vitality of pulp has important significance in the lifetime of teeth. Dental trauma can damage the pulp, resulting in pulp infarct or coagulation necrosis and, even worse, permanent necrosis (1). If there is a more rapid cellular ingrowth than bacterial invasion, revascularization may occur, and the damaged pulp could regain vitality (1).

It is difficult to differentiate permanent pulp necrosis from transient pulp infarct or coagulation necrosis at its early stage. The most commonly used methods for pulp status diagnosis are thermal testing and electric pulp testing. A positive response to them actually indicates that the nerve fibers are functioning and does not give any clue of pulp circulation, which is considered as the earliest indicator and may be the only available true indicator of pulpal health (2). It should be noted that the nerve fibers are not functioning after dental trauma (3). Some researchers suggest that clinical signs such as dramatic color change of the crown, vestibule swelling, periapical lesions, and external/internal root resorption are indicators of pulp necrosis, and a lack of pulp sensitivity combined with at least 1 of the other signs mentioned earlier suggest permanent necrosis (4, 5). However, by the time the clinical signs of pulp necrosis actually occur, they may indicate a delayed treatment and serious complications (6). Therefore, it is crucial to explore a reliable method to provide accurate information for a timely diagnosis and treatment plan.

There are several methods to directly evaluate pulp vitality by detecting pulp circulation, such as laser Doppler flowmetry (LDF) and pulse oximetry (PO). LDF is a noninvasive method for assessing pulpal blood flow (PBF). It can provide

From the State Key Laboratory of Oral Diseases, Department of Conservative Dentistry and Endodontics, West China Hospital of Stomatology, Sichuan University, Chengdu, China.

Address requests for reprints to Dr Qinghua Zheng and Dr Dingming Huang, State Key Laboratory of Oral Diseases, Department Of Conservative Dentistry and Endodontics, West China Hospital of Stomatology, Sichuan University, 14# 3rd Section, Renmin South Road, Chengdu, Sichuan Province 610041, China. E-mail address: qhzheng1001@126.com or dingminghuang@163.com

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results of the intuitive changes of microcirculation in dental pulp and has a proven ability to differentiate between healthy and nonvital teeth (7). Pulp revascularization can be detected by LDF much earlier than is expected from sensitivity testing (8). However, its measurement relies on the moving objects in the detected area. Therefore, not only red blood cells (RBCs), the index of PBF (9), but also any other moving objects can be detected by LDF, which may result in inaccurate readings of the pulp status. PO is an oxygen saturation monitoring device for recording blood oxygen saturation (SO_2) levels. Its measurement relies on spectrophotometric principles that relate light absorption to chromophore concentrations and only detects the hemoglobin in RBCs. Some researchers suggest that detecting SO_2 in the pulp chamber can be used to differentiate healthy pulps from inflamed pulps and pulp necrosis (10, 11). Despite this, there are still limitations for PO. For example, if the PBF is at a low level, PO measurement is actually unobtainable (3), and these results are misleading and may cause the wrong diagnosis of necrosis. Besides this, the SO_2 reading is displayed as a percentage of the oxygenated hemoglobin divided by the total hemoglobin in RBCs, not the amount of RBCs. Therefore, some researchers suggest that the evaluation of pulp status might be more accurate if the measurement of total hemoglobin (Hb) is added (12) because it can directly reflect the amount of RBCs. The tissue oxygen monitor (OXY) is a newly developed device that has a similar working theory to PO. When compared with traditional PO, the OXY can provide a measurement of SO_2 and total Hb simultaneously, which may be more reliable for the detection of pulp status on traumatized teeth. However, no further study considering these parameters has been reported in the field of dental trauma.

The purpose of our case study was to analyze the posttraumatic pulp response through the measurement of all the parameters mentioned previously using LDF combined with OXY and to provide accurate information for the diagnosis and treatment plan of traumatized teeth. This case is the first to intuitively present the complete process of transient pulp inflammation, infarct, and subsequent revascularization.

Case Report

A 24-year-old man arrived for treatment at the Hospital of Stomatology, Sichuan University, Chengdu, China, for his maxillary anterior tooth (tooth #9) that had been injured 3 days before. The patient complained that the traumatized tooth was tender to biting. No spontaneous pain occurred. Clinical examination showed that tooth #9 had grade I mobility with normal color, and the gingival and papilla showed slight congestion and edema. The tooth had no crown fracture or deep periodontal pocket. There was severe pain when percussion was performed in the horizontal and vertical direction and moderate pain when palpation was performed in the apical area. Cold testing and electric pulp testing were negative. The normal control tooth #8 responded normally to the examinations. Radiographic examination showed that tooth #9 was fully developed and had a horizontal fracture in the apical third (Fig. 1*A*). Tooth #9 and its adjacent teeth were immobilized by a composite splint.

To evaluate the pulp vitality of tooth #9, LDF (moorVMS-LDF, Moor Instruments Ltd, Devon, UK) and OXY (moorVMS-OXY, Moor Instruments Ltd) monitors were used. A 2-in-1 probe was provided for the designed combination use of LDF and OXY (Fig. 2*A* and *B*). A bandwidth of 15 kHz and a time constant of 0.1 second were set. The wavelength of

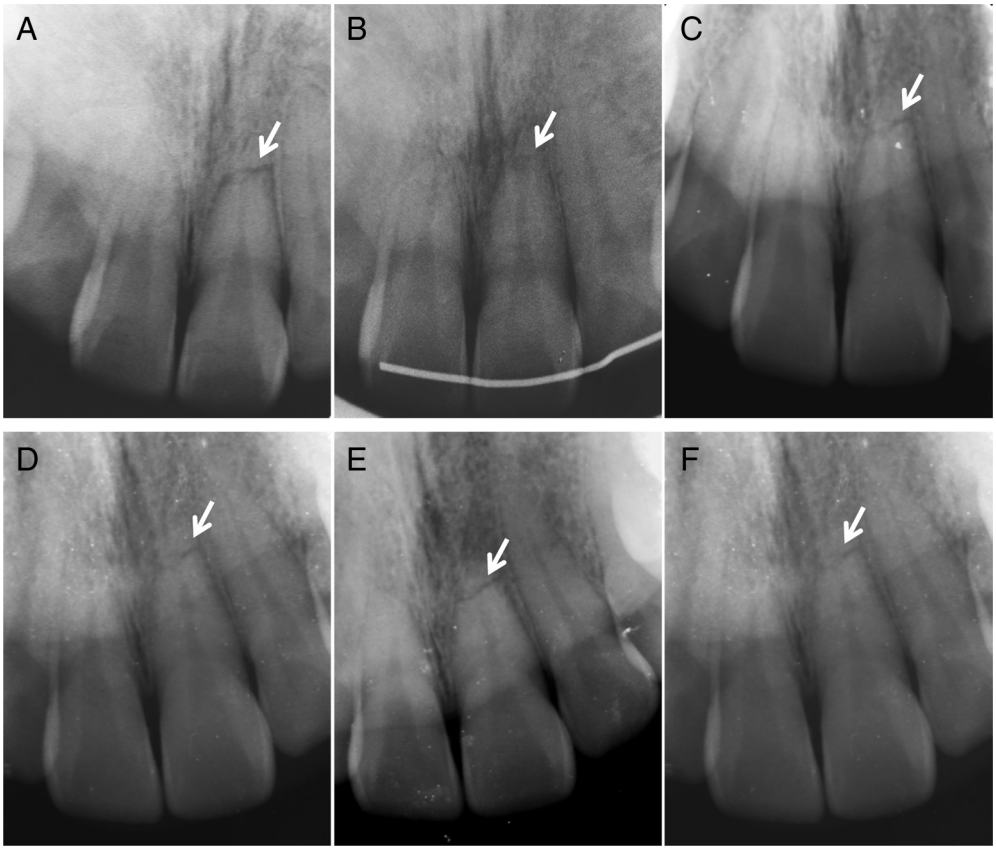

Figure 1. Radiographic examinations of the traumatized tooth at (*A*) day 3, (*B*) week 4, (*C*) week 10, (*D*) week 34, (*E*) week 58, and (*F*) week 72. The fracture lines had no obvious change (*arrows*). The radiographic examinations revealed hard tissue healing modality, and no root resorption or periapical lesion occurred.