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Optical Coherence Tomography: A novel 3-Dimensional biophotonic imaging technique for endodontic diagnosis and treatment outcome- A case report

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Abstract

3-D assessing intracanal anatomy in the clinical endodontic practice is always challenging. Although computed tomography could visualize intracanal anatomy, they all use harmful ionizing radiation and presented low sensitivity in the detection of fine canal anatomy images.

Optical coherence tomography (OCT) is a high-resolution imaging technique that allows micrometer-scale imaging of biologic tissues over small distances, uses infrared light waves that reflect off the internal microstructure within the biologic tissues and gives high-resolution images. In studies, OCT has previously been shown to be a valuable tool in assessing intracanal anatomy, cleanliness of the canal after preparation, and even perforations.

Case report: This paper described 3-D intracanal bioimaging using **Optical coherence tomography** (OCT) in managing micro-perforations and open root apex cases after traumatic injuries, by designing 3D guides to

customized gutta-percha. A 3D OCT pullback scan was made with an endoscopic rotating optical fiber probe inside the root canal and based on the intracanal lumen dimensions a 3D guided stent was fabricated, which serves as a guide for diagnosis and treatment. Based on the dimensions of the OCT scan a customized gutta-percha of the same dimension was fabricated to get apical closure.

Keywords: Optical coherence tomography, intracanal imaging, biophotonics, root canal, 3D guided stent.

Introduction

Modern imaging techniques are clinically applied throughout root-canal treatment, however necessary info on inner canal anatomy and dentin thickness remain restricted to in vitro observations. Optical Coherence Imaging (OCT) may be a comparatively recent development in diagnostic medical imaging technology that was initially introduced in 1991[1] then, it's become a regular tool in medicine and promising imaging methodology for intracoronary arterial sclerosis detection [2]. Most heart attacks are caused by fulminant ruptures of unstable blood vessel plaques that can't be detected exploitation standard imaging modalities. OCT has the potential to spot these arterial plaques and differentiate stable plaque from unstable, it is a technique for the first identification of channel malignancies, as well as the esophagus, stomach, associate degreed colon[3]. Recently optical in vivo biopsy, providing microscope-quality pictures during which cell operate may be distinguished, is one in every of the foremost difficult fields of Oct application[4].

Oct uses infrared radiation from a supply with a brief coherence length. The sunshine is scattered by the inner microstructure within the specimen. A reflectivity profile is recorded on the scanned direction exploitation of an interferometer: constructive interference happens if the lengths of sample and reference arms are adequate inside the coherence length of the source[5]. The coherence gate is scanned through the sample by dynamic the length of the reference arm. Oct achieves a depth resolution is of the order of ten µm, with an associate degree in-plane resolution reckoning on the imaging optics, presumably like the optical microscope, a picture is made from the envelope of the interferogram. By scanning the probe on the imaged specimen whereas deed image lines, a two- or three-dimensional image is made up. In examination Oct imaging, near-infrared light-weight is delivered to the imaged website (a vessel or a district of the gastrointestinal tract) through a single-mode fiber. The imaging tip contains a lens-prism assembly to focus the beam and direct it toward the lumen wall. The imaging beam is scanned on the wall by rotating the fiber. The fiber may be backward within a tube sheath to perform a questionable "pullback," permitting the user to form a stack of cross-sections, scanning he investigated vessel lengthwise. Progressive Oct systems reach a 6-mm imaging depth, with 8-µm resolution, at over eighty frames per second Oct potential in medical specialty wasn't overlooked. Oct pictures of arduous and soft tissues within the mouth were compared with microscopic anatomy images exploitation an associate model, showing a superb match[6].

Otis et al[7] mentioned the clear depiction of odontology tissue contour, sulcular depth, animal tissue attachment, and marginal adaptation of restorative materials to dentin, closing that Oct may be a powerful methodology for generating high-resolution, cross-sectional pictures of oral structures. Amaechi et al.[8] and Baumgartner et al.[9] delineate the popularity of decay with OCT. The technique may give dentists an unprecedented level of image resolution to help within the analysis of periodontal disease, dental restorations, and the detection of caries.

Case Report

Case: A 22-year-old male patient reported to the Department of Conservative Dentistry and Endodontics with the chief complaint of pain and discoloration in the upper right front tooth region. The patient's history revealed that he had suffered a trauma 10 years back, for which he undergo root canal treatment irt 11. The medical history was not significant. On clinical examination, the right maxillary central incisor was discolored and tender on percussion FIG 1. On doing the pulp-vitality test, there was a negative response to heat and electric pulp testing. The periapical radiograph showed previously endodontic treated tooth irt 11 with Widening of periodontal ligament and Periapical radiolucency 11 FIG 2.

With the evident clinical and radiographic findings, final diagnosis of Diagnosis Previously endodontic treated tooth with infected root canal system irt 11 and Ellis class II fracture irt 21 was made.

Figure 1: Clinical profile

Figure 2: IOPAR 11

On the first appointment, access opening was done using round bur No. 2 and endo-access bur, and old gutta-percha was removed followed by working length determination.

An intracanal OCT scan was made by introducing OCT catheter up to a working length of 24 mm with a “pullback” technique starting at the apex. The pullback speed was 1 mm/second, and video files were generated at a rate of 10 frames per second FIG 3.

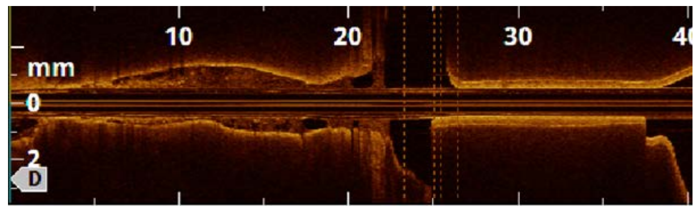

Figure 3: OCT scan of 11

Based on the apical diameter of OCT scan a 3 D guided template was made whose apical diameter is the same as measured by OCT scan apically shown in FIG 4.

Figure 4: Apical diameter of guided template

Based on the diameter of guided stent a customized gutta-percha was made using flowable gutta-percha gun FIG 5.

Figure 5: Customized GP

Customized gutta percha was introduced in prepared canal and master cone IOPA was taken FIG 6 and FIG 7 followed by back filled thermoplasticize obturation technique for final obturation FIG 8.

Figure 6: Customized GP

Figure7: IOPAR customized GP

Figure 8: Final Obturation 11

Figure 9: Pre op and post op obturation IOPAR

Discussion

The use of novel imaging techniques is gaining a lot of attention in the field of endodontics. New computed tomography (CT) methods prove to be more accurate in the evaluation of bone lesions than conventional radiography[10]. These methods use ionizing radiation which could be harmful at higher doses when used in-vivo, two major disadvantages are limiting the successful application of these methods for intracanal imaging: First, the resolution is usually not suitable for microscopic level imaging. Digital dental radiography systems have a pixel size approaching 100 µm. Second, the probe size is usually much bigger than a root canal. These methods are also time consuming and often require the interpretation of thousands of images.

In contrast, OCT combines a very thin optical catheter measuring 0.5 mm in diameter, with high resolution capacities, enabling imaging of objects measuring a few micrometers and does not involve ionizing radiation. The imaging wire can be deployed independently or integrated straightforwardly into existing therapeutic or imaging catheters. Furthermore it can easily fit into a prepared root canal, and is flexible, allowing penetration through curvatures. Fiberoptic endoscopy was previously described as a method for intracanal visualization[11].

In this system, a 0.7 mm probe is inserted into a dry canal, to image the inner anatomy, this system is based on a camera which produces a digital image and not on microscopic level characterization or light propagation as observed by the OCT.

Conclusion

Optical coherence tomography is a non-invasive and non-destructive technique for endodontic imaging. It proved to be suitable for analyzing the anatomy and cleanliness of root canal walls, and has a high sensitivity and specificity for detection of internal anatomy of canals. OCT generates high-resolution, real time, intra-canal microscopic images, and holds great potential for in-vivo application.

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