

## Diagnosis of Periodontal Defects Utilizing Cone Beam Computed Tomography

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### Introduction

Current approaches to diagnosing periodontal defects, such as infrabony and furcation defects, utilize both a clinical and conventional radiographic examination. Clinical examination of infrabony and furcation defects is limited by the anatomy of the adjacent teeth, soft tissue and alveolar bone. Conventional radiographs project the alveolar process into a two-dimensional plane so that many anatomical structures overlie periodontal defects and obscure their view. Also, film positioning errors with conventional radiographs can change the relative position of anatomic landmarks resulting in over- or under-estimation of the amount of bone loss in these defects.<sup>1,2</sup>

Cone beam computed tomography (CBCT) is a recently developed imaging modality that is proving to be highly useful in the field of dentistry. Unlike a conventional radiograph, a CBCT allows for a volumetric three-dimensional image that can be used to isolate and reveal the anatomy of periodontal defects. Advances in CBCT imaging have improved vastly, allowing submillimeter resolution along with minimal image distortion.<sup>3</sup> Furthermore, other CBCT benefits include: improved image quality, three-dimensional reconstruction which can be digitally manipulated, a 1:1 aspect ratio allowing for accurate volumetric and direct-line measurements, integration with CAD/CAM technology and electronic portability.<sup>4</sup> In contrast to the inadequacy of conventional two-dimensional radiographs, CBCTs are proving to be highly useful in aiding in the identification of periodontal defects, streamlining diagnosis and advancing the quality of periodontal therapy.<sup>5,6</sup>

### CBCT Benefits in Diagnosing Infrabony Defects

Studies examining the use of CBCT images are showing success in aiding in the diagnosis of periodontal infrabony defects. In one study of 11 dried human hemimandibles, 163 sites consisting of 65 controls, 50 small (1-3mm) infrabony lesions, and 48 larger (3-6mm) infrabony lesions were examined by CBCT and periapical radiographs. The CBCT was more accurate in diagnosing all lesions when compared to conventional film.<sup>7</sup> Two studies involving cadaver skulls with multiple restorations and a soft tissue substitute also showed that CBCT provided better diagnostic results for infrabony defects than conventional film.<sup>2,8</sup>

*In vivo* studies mirror the results provided by *in vitro* studies.

One study examined 51 defects in 21 patients with a CBCT and a full mouth radiograph series. The CBCT more accurately predicted the true dimension of horizontal bone loss when examining the distance from the Cementoenamel Junction (CEJ) to the alveolar crest. Also, the CBCT identified lesions present buccally and lingually that were never visible on the conventional radiographs and accurately mapped the full anatomy of all infrabony defects.<sup>9</sup>

Utilizing the advantages of a CBCT, one patient was examined in a study that reconstructed all of the periodontal defects three-

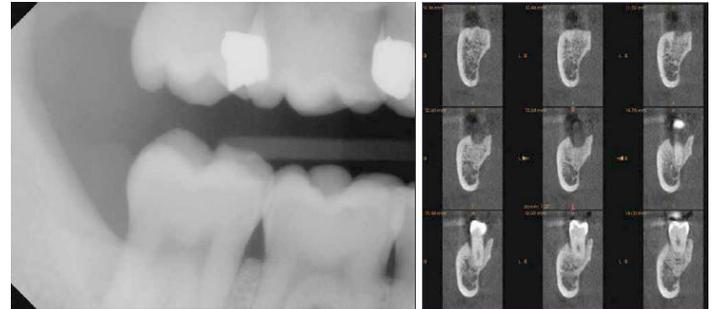


Figure 1: Conventional Film Obscuring an Infrabony Defect Distal to #31 Followed by CBCT Image Slices Revealing the Associated Defect.

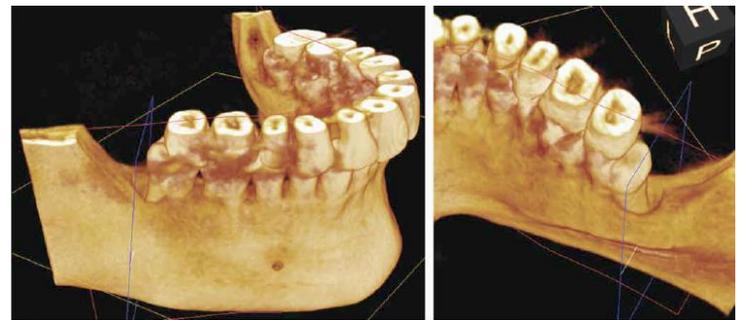


Figure 2: 3-D Image from the CBCT Clearly Displaying the Defect Distal to #31.



Figure 3: Defect Distal to #31 with Identical Anatomy to that of the 3-Dimensional CBCT Reconstruction

dimensionally. The quantitative information discovered using the CBCT allowed for a complete depiction of the infrabony defects in their entirety around the tooth.<sup>5</sup> Also, a review noted that when compared to surgical measurements, conventional intraoral radiographs failed to detect infrabony defects, especially defects of small depth or buccolingual width, and that they were better detected by a CBCT.<sup>10</sup> Figures 1 through 3 demonstrate how an infrabony defect not visible on conventional film was clearly detected on the CBCT.

### CBCT Benefits in Diagnosing Furcation Defects

Similar to its utility with infrabony defects, CBCT imaging is also proving to be far superior to conventional radiographs in aiding in the diagnosis of furcation defects. In one study, 19 teeth and 30 sites were examined in two skulls using a CBCT compared to conventional radiographs. A rating from 0 (poor) to 3 (good) was given for each furcation site as visualized using the different radiographic modalities. The conventional film averaged 1 while the CBCT averaged 3.<sup>8</sup> Also, when two skulls were examined using a CBCT and conventional periapical films, only 56% of furcation defects were detected with the periapical images while 100% of furcation defects were detected by the CBCT imaging.<sup>2</sup> Examination of a human skull free of restorations clinically and by CBCT revealed that all furcations could be detected by the CBCT regardless of extent or location.<sup>6</sup> In a prospective clinical study of 75 furcation defects in 14 patients comparing CBCT measurements to intra-surgical measurements, 84% of measurements by CBCT correlated directly with the intra-surgical measurements while only 14% were underestimated and 1.3% were overestimated.<sup>11</sup>

### CBCT Radiation

CBCTs do result an increase in radiation exposure to the patient. Current effective dose for the Carestream 9300 CBCT scanner at the Naval Postgraduate Dental School is 48  $\mu$ Sv - 66  $\mu$ Sv for small field, 56-75  $\mu$ Sv for medium field, and 76- 184  $\mu$ Sv for large field. When compared to conventional film, a digital periapical radiograph is approximately 6  $\mu$ Sv and a panoramic radiograph ranges from 9 to 24  $\mu$ Sv showing a reduction in the effective radiation dose over a CBCT; however much more diagnostic information is acquired from the CBCT so the benefit of this modality can outweigh the risk of the additional radiation to the patient (Fig. 4).<sup>12,13,14</sup>

### Conclusion

When viewing infrabony and furcation defects, CBCTs are proving to be highly effective diagnostic tools for periodontal defects with up to 100% accuracy with their three-dimensional imaging of the defect site. These benefits, along with the ability to visualize buccal/lingual defects not visible in conventional radiographs, can lead to a more accurate periodontal diagnosis and potentially better treatment for the patient. These findings offer strong rationale for the utilization of CBCT imaging as a diagnostic modality option for the treatment of periodontitis.

| Modality                                    | Effective Dose ( $\mu$ Sv) | Days of Equivalent Background Radiation |
|---|----------------------------|---|
| 1 day background radiation at sea level     | 7- 8                       | 1                                       |
| Digital PA                                  | ~ 6                        | 0.75                                    |
| Digital Pano                                | 9 - 24                     | 1 - 3                                   |
| FMX (CCD, Round Collimation)                | 85                         | 10                                      |
| Carestream 9300 CBCT (5 x 5 cm) (maxilla)   | 35-48                      | 4.38 - 6                                |
| Carestream 9300 CBCT (5 x 5 cm) (mandible)  | 48-66                      | 6 - 8.25                                |
| Carestream 9300 CBCT (10 x 5 cm) (maxilla)  | 56                         | 7                                       |
| Carestream 9300 CBCT (10 x 5 cm) (mandible) | 75                         | 9.38                                    |
| Carestream 9300 CBCT (8 x 8 cm)             | 75                         | 9.38                                    |
| Carestream 9300 CBCT (10 x 10 cm)           | 76                         | 9.5                                     |

Figure 4: Comparison of Effective Radiation Dosages<sup>12, 13, 14</sup>

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