International Poster Journal IPJ of Dentistry and Oral Medicine

Int Poster J Dent Oral Med 2004, Vol 6 No 01, Poster 208

Digital radiography for assessment of bony defects

Language: English

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Date/Event/Venue:
June 18th - 21th, 2003
Europerio 4
Berlin/Germany

Objectives

Assessment of the accuracy of linear measurements of interproximal bone loss within infrabony defects after application of a digital filter designed particularly to image periodontal bone loss.

Material and Methods

Patients:

- 34 patients (20 female) 22 to 65 years of age.
- Untreated moderate to advanced periodontitis.
- At least one interproximal infrabony defect.

Radiographs:

- 50 standardized bitewing radiographs of teeth with infrabony defects using modified film holders (VIP 2 Film Positioning, UpRad Corp., Fort Lauderdale, FL, USA) (Fig. 1). Two orthodontic wires were placed on the mandibular side of the filmholder at a specified position. Shadows of these wires were cast onto the radiographs (Fig. 1).
- Intraoral dental films (Ultraspeed, Eastman Kodak Co., Rochester, NY, USA) size 2.
- X-ray source (Heliodent 70, 70 kV, 7 mA, Siemens, Bensheim, Germany).
- Development unit (Periomat, Dürr Dental GmbH, Bietigheim-Bissingen, Germany).

Clinical examinations:

At 6 sites per tooth:

- Gingival Index (GI) and Plaque Index (PII).
- Probing depth (PD) and vertical probing attachment level (PAL-V).

After reflection of a full thickness flap:

- Distance cemento-enamel junction (CEJ) to the apical extension of the bony defect (BD).
- Distance CEJ to the alveolar crest (AC).
- The depth of the infrabony defect (INFRA).
- All clinical measurements were performed by one examiner (PE) to the nearest 0.5 mm (PCPUNC 15, Hu Friedy, Chicago, USA).

Radiographic measurements:

- Digitization of all radiographs with a flatbed scanner (Linotype Saphir, Friadent, Mannheim) with a resolution of 600x1200 dpi.
- All further measurements were made using a computer programm (Friacom 2.4, Friadent, Mannheim, Germany) with 9.5 fold magnification.
- Marking of the ends of the maxillary wire on the radiographs and entering of its actual length. All further measurements were adjusted automatically for magnification.
- Measurement of distances between the projections of the orthodontic wires that had been fixed to the filmholders vertically (dv) and horizontally (dh) on every radiograph. From the distances between the images of these wires on a radiograph, the vertical and horizontal angulation difference between the central beam and the orthoradial projection was calculated.
- Of each radiograph 3 images were generated: one unfiltered, 2 using the perio filter (one with maximally and one with minimally extended region of interest (ROI) (Fig. 1b, c).
- Perio Filter (Algorithm): Assessment of local contrast, application of edge enhancement if the image is not sharp or noise reduction. In case of overexposure a gamma correction and of underexposure brightness adjustment is applied. Finally contrast adjustment.
- On a total of 150 images the following distances were measured: CEJ-AC, CEJ-BD, INFRA (Fig. 1).

- Definition of landmarks: If the CEJ was destroyed by a restoration its margin was taken as reference. BD was defined as most coronal point where the periodontal ligament space showed a continuous width. If no periodontal ligament space was identified the point where the projection of the AC crossed the root surface was taken as landmark. If both structures could be identified at one defect, the point defined by the periodontal ligament was used as BD. If several bony contours could be identified the most apical that crossed the root was defined as the BD. For measurement of INFRA an auxillary line was drawn parallel to the tooth axis (AUX1). A second auxillary line (AUX2) was drawn perpendicularly to AUX1 through the most coronal point of the lateral wall of the defect. INFRA was measured from BD to the point where AUX2 crossed the contour of the root.
- All radiographic measurements were perfor-med by one examiner blinded to the clinical and intrasurgical measurements: TH.

Statistical analysis:

- MANOVA : dependent variable (CEJ-AC, CEJ-DB, INFRA): Difference intrasurgical/radiographic measurement (accuracy). independent variables: patient, filter, vertical/horizontal angulation difference, intrasurgical measurement.

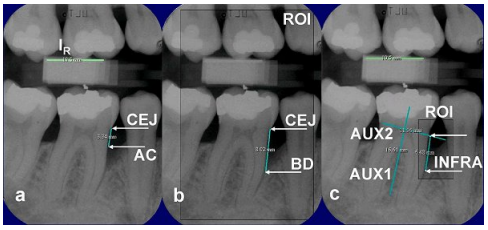

Fig. 1 a, b, c: Radiograph of an infrabony defect mesial of a rigth mandubular first molar (46): a) unfiltered image; b) perio-filter with maximally extended region of interest (ROI) encompassing the whole image; c) perio-filter with minimally extended ROI encompassing just the respective landmarks.

Results

For results see Tables 1 to 5.

50 radiographs of 50 infrabony defects

Tab. 1:	clinical parameters				angulation/°	
	GI	PII	PD/mm	PAL-V/mm	vertical	horizont.
mean±SD	1.9±0.4	0.4±0.8	7.8±1.8	8.8±1.8	1.6±1.0	0.9±0.7
range	0.0-2.0	0.0-3.0	4.0-12.5	5.0-14.0	0.0-3.3	0.0-3.4

Tab. 2: intrasurgical and radiographic parameters

	CEJ-AC	CEJ-BD	INFRA
intrasurgical radiographic	3.78±1.59	9.34±2.21	5.31±2.11
without filter	4.30±2.74	8.31±2.97	4.66±2.82
intra-without filter	-0.52±2.38	1.03±2.87	0.66±3.52
perio filter large (ROI)	4.13±2.78	8.22±2.97	4.56±2.76
intra-perio/large	-0.35±2.53	1.12±2.92	0.76±3.49
perio filter small ROI	4.46±3.10	8.50±2.68	4.55±2.55
intra perio/small	-0.68±2.86	0.84±2.72	0.76±3.24

Tab. 3: Repeated measures analysis of variance (CEJ-AC)

source	F-ratio	*P*	G-G	H-F
between subjects				
patient	2.03	0.064		
vertical angulation	4.61	0.047		
horizontal angulation	0.34	0.570		
intrasurgical CEJ-AC	11.71	0.003		
within subjects				
filter	2.97	0.065	0.081	0.065
filter x patient	0.71	0.874	0.844	0.974
filter x vertical ang.	0.09	0.912	0.864	0.912
filter x horizontal ang.	1.34	0.274	0.272	0.274
filter x intrasurg. CEJ-AC	1.96	0.156	0.168	0.156

Tab. 4: Repeated measures analysis of variance (CEJ-BD)

source	F-ratio	*P*	G-G	H-F

between subjects				
patient	2.13	0.052		
vertical angulation	2.30	0.148		
horizontal angulation	0.18	0.674		
intrasurgical CEJ-BD	7.88	0.012		
within subjects				
filter	0.25	0.782	0.666	0.782
filter x patient	0.50	0.991	0.679	0.991
filter x vertical ang.	0.85	0.436	0.386	0.436
filter x horizontal ang.	1.60	0.216	0.223	0.216
filter x intrasurg. CEJ-BD	0.77	0.471	0.413	0.471

Tab. 5: Repeated measures analysis of variance (INFRA)

source	F-ratio	*P*	G-G	H-F
between subjects				
patient	3.55	0.004		
vertical angulation	0.10	0.759		
horizontal angulation	2.91	0.106		
intrasurgical INFRA	23.72	0.000		
within subjects				
filter	4.55	0.018	0.032	0.018
filter x patient	1.50	0.101	0.146	0.101
filter x vertical ang.	1.49	0.241	0.243	0.241
filter x horizontal ang.	1.36	0.272	0.269	0.272
filter x intrasurg. INFRA	7.23	0.002	0.007	0.002

Discussion and Conclusions

- Digital filtering failed to increase the accuracy of radiographic measurements as referred to intrasurgical measurements of interproximal bone loss.
- Overall measurements on digitized unfiltered and filtered images of radiographs came quite close to the gold standard of intrasurgical measurements.

This Poster was submitted by Torsten Hörr.

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Poster Faksimile:

98 Digital radiography for assessment of bony defects

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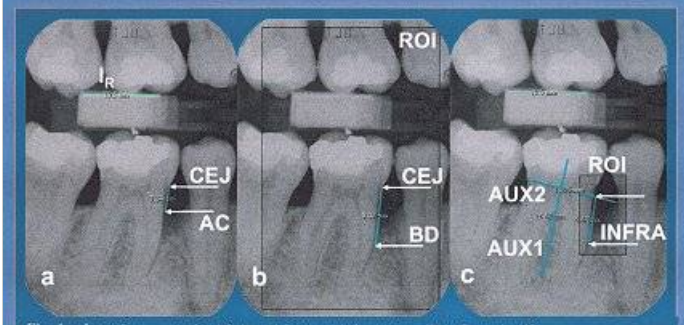

Fig. 1 a, b, c: Radiograph of an infrabony defect mesial of a right mandibular first molar (46):
a) unfiltered image;
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If the CEJ was destroyed by a restoration its margin was taken as reference. BD was defined as most coronal point where the periodontal ligament space showed a continuous width. If no periodontal ligament space was identified the point where the projection of the AC crossed the root surface was taken as landmark. If both structures could be identified at one defect, the point defined by the periodontal ligament was used as BD. If several bony contours could be identified the most apical that crossed the root was defined as the BD. For measurement of INFRA an auxiliary line was drawn parallel to the tooth axis (AUX1). A second auxiliary line (AUX2) was drawn perpendicularly to AUX1 through the most coronal point of the lateral wall of the defect. INFRA was measured from BD to the point where AUX2 crossed the contour of the root.

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