

# The Subjective Image Quality of Conventional and Digital Panoramic Radiography Among 6 to 10 year old Children

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*Objectives:* To compare the diagnostic quality of orthopantomographs made with the conventional unit Orthophos Siemens and the direct digital unit Planmeca 2000 cc Proline among children 6-10 years old and to investigate possible differences on image interpretation between oral radiologists and pediatric dentists.

*Methods:* Study material included two independent groups of panoramic images (50 in each group) made with different panoramic modalities (digital, conventional). Eight observers (four pediatric dentists and four oral radiologists) evaluated all images for diagnostic quality in 12 pre-determined areas using a 4-point rating scale.

*Results:* Digital and conventional panoramic radiography performed almost similarly as far as it concerns the specific diagnostic tasks rated with the exception of the interproximal contacts of mandibular molars where digital panoramic radiography was scored significantly higher and the periapical region of anterior mandible and anterior mandibular tooth germs where conventional panoramic radiography was found to be significantly better. Both oral radiologists and pediatric dentists graded similarly digital and conventional radiographs for a variety of diagnostic tasks.

*Conclusions:* It can be concluded that diagnostic image quality obtained with the digital orthopantomograph unit Planmeca 2000 cc Proline was generally equal to image quality obtained with the conventional orthopantomograph unit Orthophos Plus CD. Image interpretation between oral radiologists and pediatric dentists was not substantially different

**Key words:** Dental radiography; Panoramic radiography; Digital dental radiography; Radiographic image enhancement; Children

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## INTRODUCTION

Digital technology and use of personal computers are undeniably interlaced with the progress of modern sciences. This technological revolution has already influenced almost all aspects of medical science. Over the last two decades efforts are focused on exploring the potentials of the use of digital imaging in dental radiography. The results are very promising and is expected to become the standard of the 21st century as the technical developments are already numerous.

The evolution from analog film to digital systems using either storage phosphor (PSP) or charged-coupled device (CCD) technolo-

gies is offering many perspectives. The up-to-date advantages are the direct depiction and electronic processing of the digital image and the avoidance of chemical processing, which is time-consuming and sometimes, due to mistakes in the procedure, a reason for the retake of the radiograph. Another reason for the retake of the radiograph when using the analog film is the wrong choice of the exposure parameters causing poor image quality, where in digital techniques can be treated using different filters to produce an acceptable image.<sup>1</sup> Also, digitalization of the radiographic images, offers the ability of storing and administrating the images in an electronic patient file,<sup>2</sup> as well as the possibility of a quick restoration and the print of images on various hardcopy media and film.<sup>3</sup>

Nowadays, discussion is in process about the radiation doses absorbed by the patients during radiographic procedures<sup>4-7</sup>, especially in vulnerable groups of patients such as children. The relating bibliography<sup>8,9</sup> reports that although dose reduction in extraoral digital radiography is not expected to be as effective as with intraoral systems, some papers report that it may be achieved by means of intentional radiographic underexposure and later adjusted with the software features.<sup>10-12</sup>

Although dental literature is rich in studies addressing digital image quality for intraoral systems<sup>13-23</sup> our literature search yielded only a few studies testing image quality of digital panoramic systems.<sup>24-27</sup>

The aim of the present study was to compare the diagnostic quality of orthopantomographs made with the conventional unit

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Orthophos Siemens and the direct digital unit Planmeca 2000 cc Proline among 6-10 year old children. This was based on the observer's ability to form a diagnosis upon investigating regions of interest. Possible differences on image interpretation between oral radiologists and pediatric dentists were also investigated.

**MATERIAL AND METHODS**

Two independent groups of panoramic images (50 in each group) made with different panoramic modalities (digital, conventional) were compared for diagnostic image quality. All images were made by the same operator on pediatric patients for orthodontic assessment. Images that demonstrated any dental anomalies, clefts, syndromes and neoplastic diseases were excluded from the study.

Direct digital panoramic images were made with a Planmeca 2000 cc Proline (Planmeca Oy, Helsinki). Exposure parameters were set at 60-64 KV, 4-6 mA and 15 sec. Digital panoramic images were manipulated for optimal image quality using the Dimaxis software (Planmeca Oy, Helsinki), based on the operator's judgment.

Conventional radiographs were made with Orthophos Plus CD (Sirona Dental Systems GmbH, Bensheim, Germany) Exposure parameters were set at 60 KV, 9-12 mA, and 14.1 sec in accordance with patient size. Films were processed immediately after exposure using the same automated processing unit.

All images were evaluated under standardized conditions (same room, dimmed indirect light): on a super VGA monitor (1024x768 and 256 gray levels) for the digital images and on the same masked viewbox for the conventional ones.

Eight observers (four pediatric dentists and four oral radiologists) evaluated all images for diagnostic quality using a 4-point rating scale (Table 1-Lit.). To be more specific, each image was evaluated in 12 pre-determined areas that included periapical bone sites, inter-

**TABLE 1 (Molander et al.<sup>28</sup>-1995)**

EVALUATION SCALE	RATE 1-4
No clear image, no details visualized, no diagnosis possible	1
Moderately clear image, broad details visualized, diagnosis doubtful	2
Clear image, details visualized, diagnosis probably possible	3
Very clear image, fine details visualized, diagnosis definitely possible	4

**TABLE 2**

<b>Interproximal right region</b>
1. right maxillary molar
2. right maxillary primary molar
3. right mandibular molar
4. right mandibular primary molar
<b>Periapical bone region</b>
5. anterior maxilla
6. anterior mandible
7. right posterior maxilla
8. right posterior mandible
<b>Permanent teeth germs</b>
9. anterior maxilla
10. anterior mandible
11. right posterior maxilla
12. right posterior mandible

proximal sites and tooth germs (Table 2).

There were two rating sessions (one session for the digital panoramic images and one for the conventional panoramic radiographs) with a one-month interval in between. The order of the images was randomized for every observer. The data were collected on data-sheets provided to the rater prior to each evaluation sessions.

Repeated measures ANOVA and paired t-tests were used for the statistical analysis of the data collected (p=0,05).

**RESULTS**

Table 3 reports means and SD of the scores of the two imaging modalities per region of interest for all observers (oral radiologists and pediatric dentists). Digital and conventional panoramic radiography performed almost similarly as far as it concerns the specific diagnostic tasks rated with the exception of the interproximal contacts of mandibular molars where digital panoramic radiography was scored significantly higher and the periapical region of anterior mandible and anterior mandibular tooth germs where conventional panoramic radiography was found to be significantly better.

**TABLE 3**  
MEAN and STANDARD DEVIATION (S.D.) PER REGION OF INTEREST

REGION OF INTEREST	DIGITAL		CONVENTIONAL		P, <0,05		
Interproximal Region	N (D)	Mean	S.D.	N(C)	Mean	S.D.	Pvalue
Maxillary Molar	400	3,62	0,53	400	3,66	0,50	0,73
Maxillary Primary Molars	400	3,19	0,48	400	3,09	0,37	0,39
Mandibular Molars	400	3,62	0,42	400	3,35	0,54	0,039*
Mandibular Primary Molars	400	3,35	0,48	400	3,17	0,35	0,19
<b>Periapical Bone Region</b>							
Anterior Maxilla	400	3,03	0,73	400	3,21	0,52	0,57
Anterior Mandible	400	2,56	0,55	400	3,35	0,38	0,0001*
Right Posterior Maxilla	400	3,17	0,60	400	3,14	0,52	0,90
Right Posterior Mandible	400	3,87	0,16	400	3,84	0,16	0,60
<b>Permanent Teeth Germs</b>							
Anterior Maxilla	400	3,44	0,66	400	3,63	0,41	0,51
Anterior Mandible	400	3,30	0,49	400	3,82	0,16	0,019*
Right Posterior Maxilla	400	3,41	0,56	400	3,52	0,49	0,69
Right Posterior Mandible	400	3,97	0,03	400	3,99	0,01	0,13

When raw data were analyzed separately for the two groups of specialists served as observers, no statistically significant differences found between digital and conventional panoramic images for the radiologists regardless of the diagnostic task. On the contrary, pediatric dentists found the image quality of conventional panoramic images in the anterior mandible to be significantly higher than that of digital images. Tables (6) and (7) demonstrate that there were no significantly statistical differences between oral radiologists and pediatric dentists for neither digital nor conventional panoramic images. In other words, both graded digital and conventional radiographs similarly for a variety of diagnostic tasks.

**DISCUSSION**

The purpose of this study was to assess the subjective image quality of the two different panoramic modalities (direct digital and film-based) and to investigate the performance of two different observer groups (pediatric dentists and oral radiologists). The two different groups were chosen in order to evaluate possible differences between the "expert" and the "clinical" image interpretation. The material of this study consisted of radiographs taken from pediatric patients, as they are more vulnerable to absorbed radiation doses and they require more frequently modifications of standard intra-oral techniques.<sup>26</sup>

The results of this study show that the two different panoramic techniques are at least equal and adequate for clinical use as the results of the statistical analysis of scorings between the two groups of images were not substantially different. These results are in accordance to most previous similar studies that support this conclusion although different hardware, material and methodology were used<sup>24,26,28-30</sup>, whereas one study found that image quality of conventional panoramic radiographs was superior to image quality of digital images.<sup>27</sup>

There was no statistical difference between the ratings of the two different groups of observers. Other studies<sup>19</sup> have demonstrated that Radiologists performed significantly better than less experienced

groups, but this is not supported from the results of our study. Both groups scored the two systems consistently high (3-4) but the lack of a gold standard cannot support the implying high validity of the panoramic techniques for pediatric purposes. The use of a 4-point rating scale was chosen in order to evaluate image quality, as it is a simple, well-documented index that has been previously used in similar studies.<sup>12,27,31</sup> The lowest scorings were recorded at the periapical bone region of the anterior mandible for the digital images and at the interproximal region of the primary maxillary molars for the conventional radiographs.

The main dilemma encountered was the presentation and manipulation of direct digital images. Direct digital panoramic radiographs were shown on a normal resolution monitor usually found in common clinical practice avoiding the potential influence of printer output on image quality<sup>3,25</sup>, although this meant that observers were not blinded. Direct digital images were manipulated by a skilled operator in order to take full advantage of the digital system, while the observers were not allowed to manipulate or magnify the images, as individual adjustments would be difficult to record. Previous studies have shown that such adjustments do not seem to lead necessarily to better image interpretation and diagnosis.<sup>11,26,27,32</sup> Studies concerning the processed images report that wrong adjustments of brightness and contrast may either cause non-existent lesions to be produced or present lesions to fade away<sup>10</sup> and that an increased rate of true positive diagnosis can be neutralized by an increase in the false positive rate.<sup>11</sup> Therefore, users should carefully apply the appropriate filters in order to avoid the possible misinterpretation of the processed images.

**TABLE 6**  
MEANS and STANDARD DEVIATIONS (SD) for digital radiographs among Oral Radiologists and Pediatric Dentists

REGION OF INTEREST	Oral Radiologists			Pedodontists			P, <0,05
	N(OR)	Mean	S.D.	N (P)	Mean	S.D.	
<b>Interproximal Region</b>							
Maxillary Molars	200	3,87	0,07	200	3,37	0,69	0,20
Maxillary Primary Molars	200	3,26	0,22	200	3,13	0,69	0,73
Mandibular Molars	200	3,83	0,18	200	3,42	0,53	0,19
Mandibular Primary Molars	200	3,60	0,30	200	3,10	0,53	0,19
<b>Periapical Bone Region</b>							
Anterior Maxilla	200	2,79	0,79	200	3,26	0,69	0,41
Anterior Mandible	200	2,34	0,29	200	2,78	0,71	0,30
Right Posterior Maxilla	200	3,12	0,65	200	3,22	0,64	0,83
Right Posterior Mandible	200	3,94	0,11	200	3,80	0,19	0,25
<b>Permanent Teeth Germs</b>							
Anterior Maxilla	200	3,25	0,63	200	3,63	0,39	0,35
Anterior Mandible	200	3,07	0,49	200	3,53	0,44	0,22
Right Posterior Maxilla	200	3,19	0,64	200	3,63	0,43	0,30
Right Posterior Mandible	200	3,97	0,04	200	3,98	0,03	0,57

**TABLE 7**  
MEANS and STANDARD DEVIATIONS (SD) for conventional radiographs among Oral Radiologists and Pediatric Dentists

REGION OF INTEREST	Oral Radiologists			Pedodontists			P, <0,05
	N(OR)	Mean	S.D.	N (P)	Mean	S.D.	
<b>Interproximal Region</b>							
Maxillary Molars	200	3,84	0,04	200	3,47	0,69	0,32
Maxillary Primary Molars	200	3,01	0,29	200	3,17	0,46	0,59
Mandibular Molars	200	3,64	0,10	200	3,05	0,66	0,13
Mandibular Primary Molars	200	3,28	0,20	200	3,05	0,46	0,40
<b>Periapical Bone Region</b>							
Anterior Maxilla	200	3,18	0,44	200	3,24	0,67	0,91
Anterior Mandible	200	3,34	0,33	200	3,36	0,49	0,97
Right Posterior Maxilla	200	2,98	0,40	200	3,30	0,64	0,43
Right Posterior Mandible	200	3,89	0,08	200	3,80	0,22	0,46
<b>Permanent Teeth Germs</b>							
Anterior Maxilla	200	3,41	0,48	200	3,85	0,17	0,13
Anterior Mandible	200	3,74	0,14	200	3,90	0,14	0,16
Right Posterior Maxilla	200	3,22	0,50	200	3,82	0,25	0,08
Right Posterior Mandible	200	3,99	0,01	200	4,00	0,01	0,54

**TABLE 4**  
MEANS and STANDARD DEVIATIONS (S.D.) of digital and conventional radiographs examined by Oral Radiologists

REGION OF INTEREST	DIGITAL			CONVENTIONAL			P, <0,05
	N (D)	Mean	S.D.	N (C)	Mean	S.D.	
<b>Interproximal Region</b>							
Maxillary Molars	200	3,87	0,07	200	3,84	0,04	0,61
Maxillary Primary Molars	200	3,26	0,22	200	3,01	0,29	0,09
Mandibular Molars	200	3,83	0,18	200	3,64	0,10	0,11
Mandibular Primary Molars	200	3,60	0,30	200	3,28	0,20	0,25
<b>Periapical Bone Region</b>							
Anterior Maxilla	200	2,79	0,79	200	3,18	0,44	0,56
Anterior Mandible	200	2,34	0,29	200	3,34	0,33	0,008*
Right Posterior Maxilla	200	3,12	0,65	200	2,98	0,40	0,79
Right Posterior Mandible	200	3,94	0,11	200	3,89	0,08	0,61
<b>Permanent Teeth Germs</b>							
Anterior Maxilla	200	3,25	0,63	200	3,41	0,14	0,79
Anterior Mandible	200	3,07	0,49	200	3,74	0,14	0,11
Right Posterior Maxilla	200	3,19	0,64	200	3,22	0,50	0,96
Right Posterior Mandible	200	3,97	0,04	200	3,99	0,01	0,31

**TABLE 5**  
MEANS and STANDARD DEVIATIONS (S.D.) of digital and conventional radiographs examined by Pediatric Dentists

REGION OF INTEREST	DIGITAL			CONVENTIONAL			P, <0,05
	N (D)	Mean	S.D.	N (C)	Mean	S.D.	
<b>Interproximal Region</b>							
Maxillary Molars	200	3,37	0,69	200	3,47	0,69	0,65
Maxillary Primary Molars	200	3,13	0,69	200	3,17	0,46	0,85
Mandibular Molars	200	3,42	0,53	200	3,05	0,46	0,15
Mandibular Primary Molars	200	3,10	0,53	200	3,05	0,46	0,66
<b>Periapical Bone Region</b>							
Anterior Maxilla	200	3,26	0,69	200	3,24	0,67	0,78
Anterior Mandible	200	2,78	0,71	200	3,36	0,49	0,039*
Right Posterior Maxilla	200	3,22	0,64	200	3,30	0,64	0,67
Right Posterior Mandible	200	3,80	0,19	200	3,80	0,22	0,92
<b>Permanent Teeth Germs</b>							
Anterior Maxilla	200	3,63	0,39	200	3,85	0,17	0,15
Anterior Mandible	200	3,53	0,44	200	3,90	0,14	0,09
Right Posterior Maxilla	200	3,63	0,43	200	3,82	0,25	0,12
Right Posterior Mandible	200	3,98	0,03	200	4,00	0,01	0,22

**CONCLUSIONS**

It can be concluded that diagnostic image quality obtained with the digital orthopantomograph unit Planmeca 2000 cc Proline was generally equal to image quality obtained with the conventional orthopantomograph unit Orthophos Plus CD. Image interpretation between oral radiologists and pediatric dentists was not substantially different.

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