CBCT CONSTANCY CONTROLS:
HOW USER FRIENDLY IS THE NEW PHANTOM? A PILOT STUDY

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Introduction and objectives

• Why image quality assurance?
• Why constancy controls?
• Available equipment and methods
  – Manufacturer based
  – Other equipment
• Requirements of user-friendliness
  – The procedure has to be easy
  – The procedure has to be fast
Introduction and objectives

• The objective was to test if the phantom and software are user-friendly tools for Image Quality Assurance (IQA) performed by dental staff.
  – Can it be done in less than 15 minutes?
The phantom

- Plexiglas (PMMA) body
- Most structures contained in 4 x 4 cm volume
- Solid PMMA inset in the second cavity
The Tests

• Evaluations
  – Uniformity (inter/intraslice)
  – Noise power spectrum
  – Contrast linearity
  – Modulation transfer function (MTF)
  – Geometric linearity

• Easy to add other analyses
The software

• Based on ImageJ
  – Free open source image analysis program
• Can be run from a USB-stick
• Stack loaded automatically
• The user has to scroll to slice containing metal beads
• Analysis is done automatically
The software

Visual control of report:

Arendal-Malmö-Oslo Phantom CBCT QA
Central-Osie-Beam CBCT QA
QA phantom protocol based on Arendal-Malmö-Oslo phantom and method

Machine and protocol information
Date and time of analysis: Thu Apr 05 15:46:39 CEST 2015
Equipment: QA
Institution: NA, Department: NA
Manufacturer: Panomax Model: PMAX Serial number: TR6P-0220
Scan data
Tube voltage: 60 kVp
Tube current: 5 mA
Exposure: NA Wks
Exposure time: 14000 ms
Visual area: 0.4 mm, Slice thickness: 5.4 mm
Field of view (FOV): 200 x 200 mm

Analyses
Analysis of uniformity
All slices between slice nr 162 and slice nr 214 where measured.
Average values of HU mean value and HU standard deviation:

<table>
<thead>
<tr>
<th>ROI nr</th>
<th>Mean (HU)</th>
<th>StdDev (HU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
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<tr>
<td>4</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>5</td>
<td>80</td>
<td>90</td>
</tr>
</tbody>
</table>

Radially integrated profile of HU value in center slice:

Contrast Detail Diagram (CDD)
The line contrast detectability limit is given by 3 times the standard deviation between random ROIs of size.

Contrast Linearity
Density values in slices, the center slice with the ROIs is shown.

Modulation Transfer Function (MTF)
Area around ideal wire to obtain the the point spread function (PSF) (middle of three circles shown)
60 cm MTF at 0.07, 16 % MTF at 0.12 lp/mm

Geometric Linearity
Center slice of beams

Legend: ROI 1: red, ROI 2: blue, ROI 3: black, ROI 4: green, ROI 5: orange
Equipment and Participants

• 4 different CBCT-machines
  – Instrumentarium OP300
  – Planmeca Scanora 3D Mid
  – Morita Veraviewepocs R100
  – Gendex GXCB-500

• 4 Test persons
  – Specialist in prostodontics
  – Specialis in maxillofacial radiology
  – Dental service technician
  – Dental hygienist
The Study Setup

1. T receives a printed step by step manual
2. The procedure was demonstrated once by P
3. T repeats the procedure twice (1\textsuperscript{st} and 2\textsuperscript{nd} run)

P = Physicist

T = Test person
The Study Setup and Results

The procedure steps
1. Phantom placed in FOV
2. FOV adjusted, scout image if available
3. Scan of phantom
4. Export stack to USB-stick
5. Run QA-software
6. Visual control of report

Total time for procedure
Some observations from test scans

**HU values of different materials**

- Teflon
- Nylon
- Acetal
- Polyethen
- PMMA

**Uniform plexiglass - 5 ROI's average**

Errorbars represent ± 1 StDev
Conclusions

• The whole procedure can be done in less than 15 minutes and the training requirements are minimal.
• The presented phantom is user-friendly and can be used by clinical staff to perform constancy IQA.
• With adequate tools IQA can be performed regularly and easily.
Thank you for your attention.
References

The phantom


Our institutions

- [Karolinska Institutet](http://www.ki.se), Stockholm, Sweden
- [Malmö University](http://www.mah.se), Malmö, Sweden
- [Oral Health Centre of Expertise in Southern Norway](http://www.odont.uio.no/english/people/adm/fac/gerald) (Norwegian only)
- [Faculty of dentistry](http://www.odont.uio.no/english/people/adm/fac/gerald), University of Oslo, Norway

ImageJ

- Fiji version of ImageJ used in pilot: [http://fiji.sc/Fiji](http://fiji.sc/Fiji)

Contact:

[http://www.odont.uio.no/english/people/adm/fac/gerald](http://www.odont.uio.no/english/people/adm/fac/gerald)