Dental Cone Beam CT – A review of our experience

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What is Dental cone beam CT?

“The new era of user-friendly, 3-dimensional digital radiography has just begun. 3D Accuitomo FPD is a cone beam x-ray CT (Computed Tomography) for Dento-Maxillo-Facial area by J. Morita Mfg. Corp.”
Other system available?

Newtom 9000
9000+

Kodak
Ilumina

Sirona
Galileos

Morita
Accuitomo

I-CAT

Ewoo
EPX-Impla

Hitachi
MercuRay
## What shall we test?

<table>
<thead>
<tr>
<th>Type of Test</th>
<th>Measurements</th>
</tr>
</thead>
</table>
| Treat it like an x-ray unit? | • Leakage  
• HVL  
• Focal spot …… |
| Treat it like a Panoral unit? | • Output measurements  
• DAP at tube  
• Beam Height / Width  
• Beam Alignment |
| Treat it like a CT Scanner? | • CTDI measurements  
• Slice thickness  
• Resolution  
• CT number linearity |
### Dose measurements

<table>
<thead>
<tr>
<th>System</th>
<th>System</th>
<th>Morita</th>
<th>E-woo</th>
<th>Sirona</th>
<th>Average Panoral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposure Settings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irradiated Area @ isocentre (cm²)</td>
<td>16</td>
<td>36</td>
<td>64</td>
<td>143</td>
<td>1.1</td>
</tr>
<tr>
<td>Output / rotation (mGy)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DAP (cGy.cm²)</td>
<td>448</td>
<td>915</td>
<td>1232</td>
<td>488</td>
<td>75</td>
</tr>
<tr>
<td>CTDIw (mGy/100mAs)</td>
<td>5.7</td>
<td>---</td>
<td>3.2</td>
<td>4.9</td>
<td>---</td>
</tr>
</tbody>
</table>
Image Quality Measurements
Imaged Slice Thickness

<table>
<thead>
<tr>
<th>Set (mm)</th>
<th>Morita</th>
<th>Ewoo</th>
<th>Sirona</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.125</td>
<td>0.71</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>0.3</td>
<td>-</td>
<td>-</td>
<td>0.6</td>
</tr>
<tr>
<td>0.5</td>
<td>0.72</td>
<td>0.53</td>
<td>-</td>
</tr>
<tr>
<td>1</td>
<td>1.1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>1.79</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
## Resolution

<table>
<thead>
<tr>
<th></th>
<th>Resolution (lp/mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morita</td>
<td>1.0</td>
</tr>
<tr>
<td>Ewoo</td>
<td>0.92</td>
</tr>
<tr>
<td>Sirona</td>
<td>1.0</td>
</tr>
</tbody>
</table>
Other Tests

Noise
• Difficult to quantify due to test objects available and scan parameters.
• Useful for annual consistency checks?

Positioning
• Only available on some systems with smaller FOV’s
• Requires a ‘scout’ image and therefore more dose.

CT Values
• No relationship with measured values on any system.
Cone Beam CT in Dentistry
A few issues…..

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Dental Cone Beam CT

Increasing number of makes and models

No standards or guidance

Protection requirements variable

Local QC

Wide range in doses

Separate OPG?
Dental CBCT Equipment

- Units available from most of the dental X-ray equipment manufacturers and some specialist companies
- Broad range of technologies and designs….
- Flat panel and image intensifiers
- FOV 4-22cm square or circular
- Pulsed or continuous exposure
- Built in panoramic option either true 2D or reconstructed 3D
Radiation Protection Aspects

Carestream (Kodak) Iluma:
Up to 120 kV up to 152 mAs (3.8 mA/40 sec) continuous

Sirona Galileos:
85kV up to 35 mAs pulsed

Different protection requirements?
Radiation Protection Aspects

- Protection issues not always clearly understood by installers
- Limited amount of scatter data available from suppliers
- Companies not in a position to complete critical examinations
- Significant time (and cost) to test thoroughly
Dental CBCT Panoramic Exposures

- Some CBCT have a secondary collimator and programming to produce a 2D image
- Other units produce a panoramic image from the CT data (with a cone beam CT dose)
- Typical panoramic dose ~70 mGycm²
- Remedial (IPEM 91) 100 mGycm²
- Sirona 85 kV 28 mAs ~ 500 mGycm²
- For panoramic imaging NOT ALARA! – use dedicated panoral instead.
### Wide range in doses

Ref. Dosimetry of recently introduced CBT Units for Oral and Maxillofacial Radiology. John B Ludlow, Laura E Davis-Ludlow, Andre Mol University of North Carolina

<table>
<thead>
<tr>
<th>Unit</th>
<th>Effective Dose $\mu$Sv</th>
</tr>
</thead>
<tbody>
<tr>
<td>Galileos (Default)</td>
<td>29.3 $\mu$Sv</td>
</tr>
<tr>
<td>Iluma (Standard)</td>
<td>331.0 $\mu$Sv</td>
</tr>
<tr>
<td>Promax 3D (small/large adult)</td>
<td>156.8/210.2 $\mu$Sv</td>
</tr>
</tbody>
</table>
Local QC Programmes

- QC of these systems is essential however no clear guidance yet
- Some manufacturers include a QC phantom and protocols – others do not
- E.g. Sirona recommend monthly checks using supplied phantom and a daily monitor check