Purpose
Fluoroscopic x-ray units with 3D and CT-like imaging capabilities have recently been introduced. Due to their portability (1D on a mobile C-arm or 3D in Interventional Radiology suites or operating rooms), 3D imaging modalities have been adopted for some clinical studies in lieu of conventional 2D imaging or CT. However, radiation dose reduction options on these 3D imaging modalities are limited.

In our institution, flat panel cone-beam CT have been routinely used for treatments of vascular anomalies, Temporomandibular Joint (TMJ) Disorder in Interventional Radiology Suites; 3D Rotation Angiography are used for better visualization of vascular structures. A portable O-arm has been utilized for orthopedic surgical procedures in the operating rooms. This study compares the radiation doses of various 3D modalities. Guidelines are provided for optimizing a balanced choice of radiation dose reduction with clinical imaging needs.

Methods

Utilizing the x-ray manufacturer’s suggested techniques, radiation doses were measured in the phantom’s head, thorax, abdomen and pelvis. These techniques produced acceptable images for the intended clinical applications.

The study included two IR 3D modalities (Philips Allura 3D-RA, installed in 2003, Siemens AXIOM Artis Dyna CT, installed in 2007), and one portable 3D C-arm (Medtronic O-arm, purchased in 2007) used in operating rooms. The CTDI values were compared to our optimized routine scan values on the same phantom pediatric.

Results

The dose from 3D imaging modalities varied between vendors. In some cases, CTDI were higher than routine CT scans due to the limitations on the available selections of dose, pulse rate, and collimation. The standard techniques provided by the 3D modality manufacturers yield CTDI’s in the range of 5%-29% for routine CT scans due to the limitations on the available selections of dose, pulse rate, and collimation.

The dose from 3D imaging modalities varied between vendors. In our institution, flat panel cone-beam CT, 3D Rotation Angiography, and a portable O-arm have been utilized for orthopedic surgical procedures in the operating rooms.

The study compared the radiation doses of various 3D modalities. Guidelines are provided for optimizing a balanced choice of radiation dose reduction with clinical imaging needs.

Table 1 Measured CTDIvol of 3D Modalities in Comparison with that of Optimized CT Studies

<table>
<thead>
<tr>
<th>Measurement No.</th>
<th>Siemens Sensation 64 CT</th>
<th>Philips Allura 3DRA</th>
<th>Medtronic O-arm 3D</th>
<th>Siemens Artis Dyna CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement 1</td>
<td>1.7</td>
<td>0.8</td>
<td>0.6</td>
<td>4.0</td>
</tr>
<tr>
<td>Measurement 2</td>
<td>0.9</td>
<td>0.9</td>
<td>0.6</td>
<td>4.0</td>
</tr>
<tr>
<td>Measurement 3</td>
<td>1.7</td>
<td>0.8</td>
<td>0.6</td>
<td>4.0</td>
</tr>
<tr>
<td>Measurement 4</td>
<td>0.9</td>
<td>0.9</td>
<td>0.6</td>
<td>4.0</td>
</tr>
</tbody>
</table>

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Routine Protocols of:
- Siemens Sensation 64 CT
- Philips Allura 3DRA
- Medtronic O-arm 3D
- Siemens Artis Dyna CT

Only the optimized 5sec Low setting was used for TMJ

Conclusion

Based on these phantom studies, our institution has made progressive improvements in modifying 3D imaging techniques to reduce radiation dose while maintaining the clinical integrity of the images.

References