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# Comparison between two CBCT imaging protocols used for Image Guided Radiotherapy Quality Assurance

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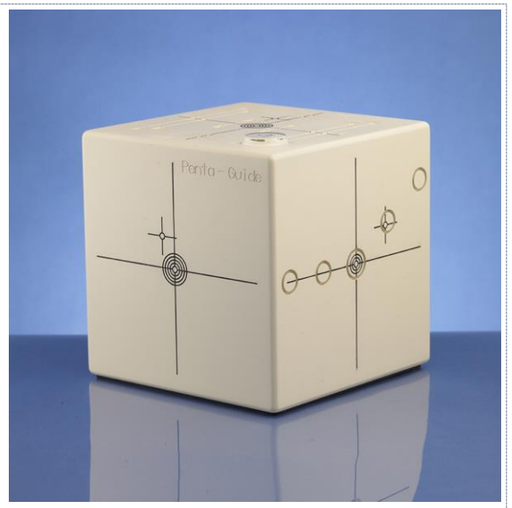
## 1. Background-Aim

- The present study compares two different Cone Beam Computed Tomography (CBCT) imaging protocols (default and fast) used in the Radiotherapy Department of AHEPA University Hospital, in patients undergoing head & neck (HN) and pelvis (P) Image Guided Radiotherapy (IGRT).

- The aim was to assess whether the images obtained using the two protocols for each region are equivalent and whether the image quality remained constant over time. Image comparison was based in two parameters, the Uniformity (U%) and the Contrast-to-Noise Ratio (CNR).

## 2. Materials & Methods

- All measurements were performed using the Quasar Penta phantom.




- Fast acquisition protocols were created for both anatomical sites (FHN S20, FP M20), by reducing the number of frames and total mAs by 50% compared on the default ones (HN S20, P M20) provided by the manufacturer.
- Imaging quality, and therefore the accuracy of 3D reconstruction, was tested by the acquisition of CBCT images of the phantom, which was deliberately misplaced, and by comparing them with CT reference images.
- The accuracy of the treatment couch shift and the consistency through time were also tested.
- Uniformity (U%) and Contrast-to-Noise Ratio (CNR) were calculated and their acceptable limits were set to 95% confidence intervals (CI) of their mean values.

# 2. Materials & Methods

- Acquisition parameters for Head and Neck S20 and Fast Head and Neck S20

| Protocols | Head and Neck S20 | Fast Head and Neck S20 |
|---|---|---|
| Start Angle | 320° | 320° |
| Stop Angle | 160° | 160° |
| Direction | CW | CW |
| Gantry Speed | 180 °/min | 360 °/min |
| kV | 100 kV | 100 kV |
| Frames | 366 | 183 |
| Total mAs | 36.6 mAs | 18.3 mAs |
| Nominal Scan Dose (CTDI) | 1 mGy | 0.5 mGy |

- Acquisition parameters for Pelvis M20 and Fast Pelvis M20

| Protocols | Pelvis M20 | Fast Pelvis M20 |
|---|---|---|
| Start Angle | 180° | 180° |
| Stop Angle | 180° | 180° |
| Direction | CW | CW |
| Gantry Speed | 180 °/min | 360 °/min |
| kV | 120 kV | 120 kV |
| Frames | 660 | 330 |
| Total mAs | 1056 mAs | 528 mAs |
| Nominal Scan Dose (CTDI) | 22 Gy | 11 Gy |

## 3. Results

- The detected deviations in couch shift for both protocols in both anatomical sites were found in accordance with those given by the phantom manufacturer [-1.0cm, 1.4cm, 1.2cm].

- Mean couch shift values showed no significant differences between the two protocols: HN S20: [-0.96cm, 1.44cm, 1.19cm], FHN S20: [-0.95cm, 1.44cm, 1.19cm], P M20: [-0.97cm, 1.39cm, 1.23cm], FP M20: [-0.97cm, 1.41cm, 1.22cm]. Calculated 95% CI for mean U% and CNR were: HN S20: [2.61-3.29] and [36.31-38.70], FHN S20: [2.68-3.30] and [23.04-25.32], P M20: [2.26-2.60] and [189.23-206.52], FP M20: [2.46-2.79] and [128.57-139.19].

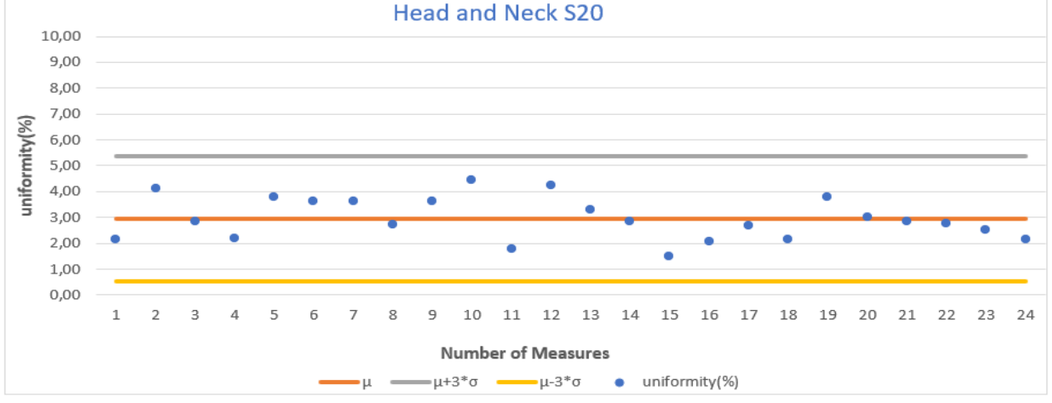
- U% values showed no significant differences between the two protocols.

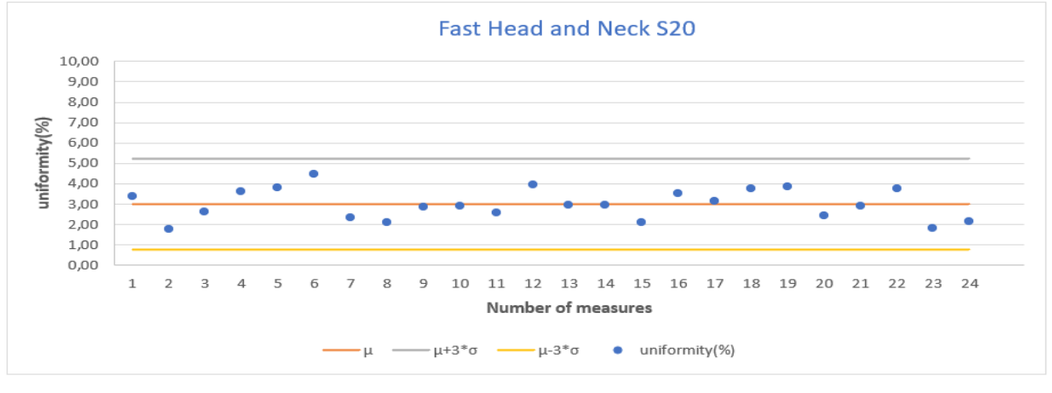
- CNR values were statistically lower for the fast protocol, though with respect to the overall image quality no significant differences were found.

# 3. Results

- Uniformity (%) for Head and Neck S20 and Fast Head and Neck S20

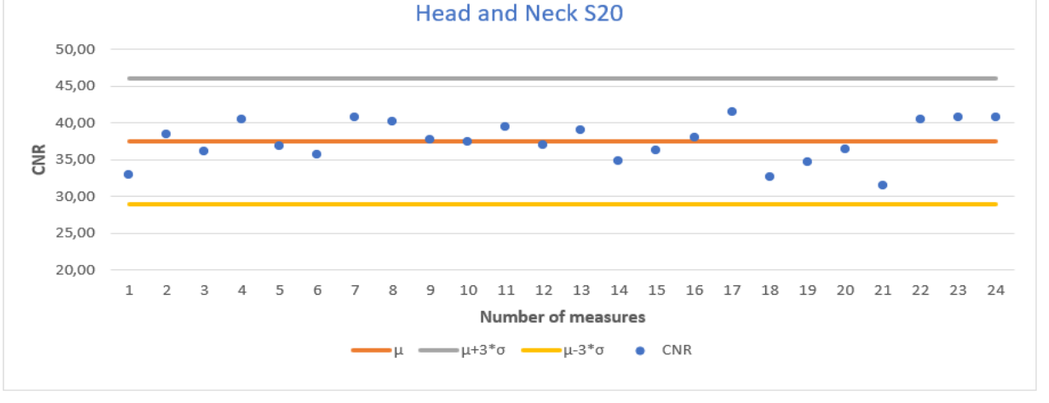
| protocols | mean (cm) | mean+3σ (cm) | mean-3σ (cm) |
|---|---|---|---|
| Head and Neck S20 | 2.95 | 5.38 | 0.52 |
| Fast Head and Neck S20 | 2.99 | 5.21 | 0.77 |

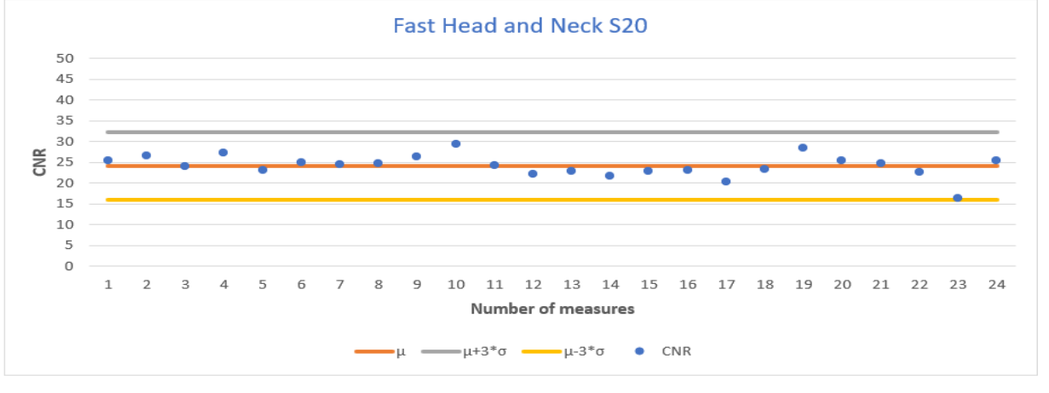



- CNR for Head and Neck S20 and Fast Head and Neck S20

| protocols | mean (cm) | mean+3σ (cm) | mean-3σ (cm) |
|---|---|---|---|
| Head and Neck S20 | 37.50 | 45.99 | 29.01 |
| Fast Head and Neck S20 | 24.18 | 32.25 | 16.11 |

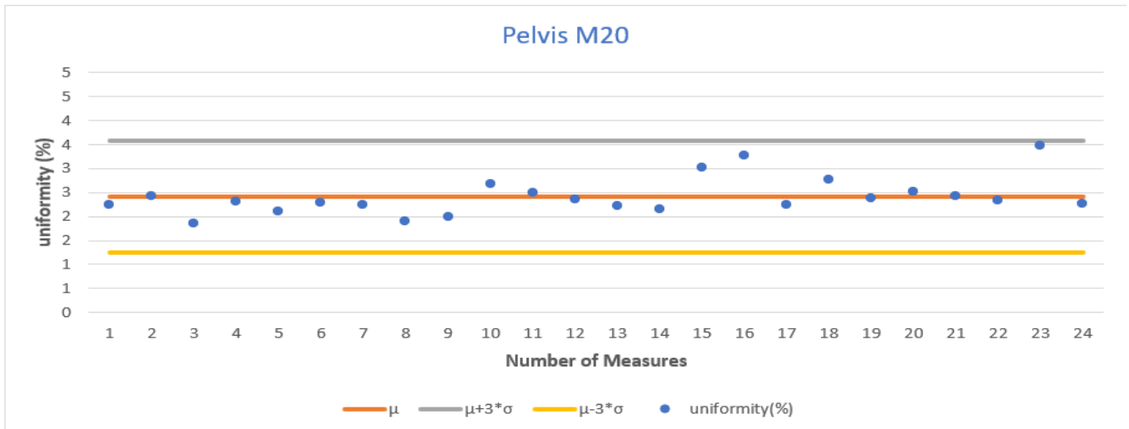


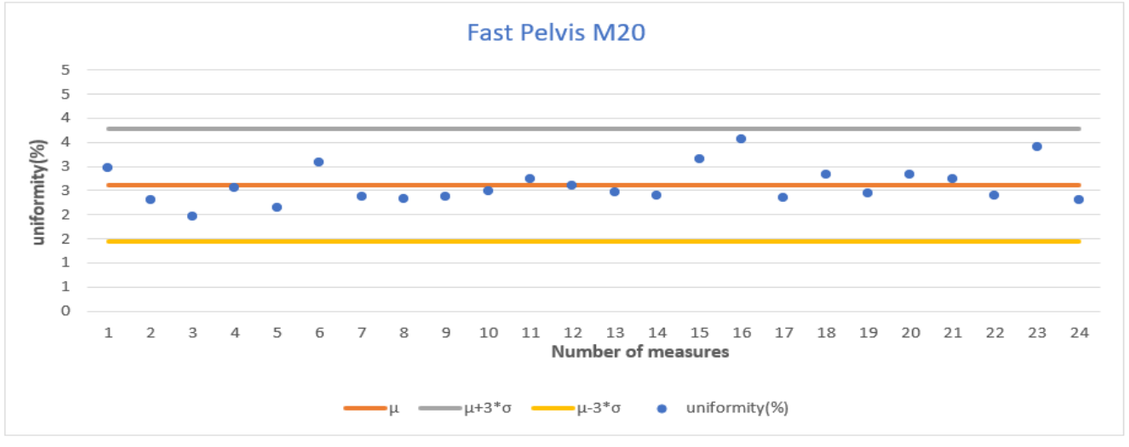



# 3. Results

- Uniformity (%) for Pelvis M20 and Fast Pelvis M20

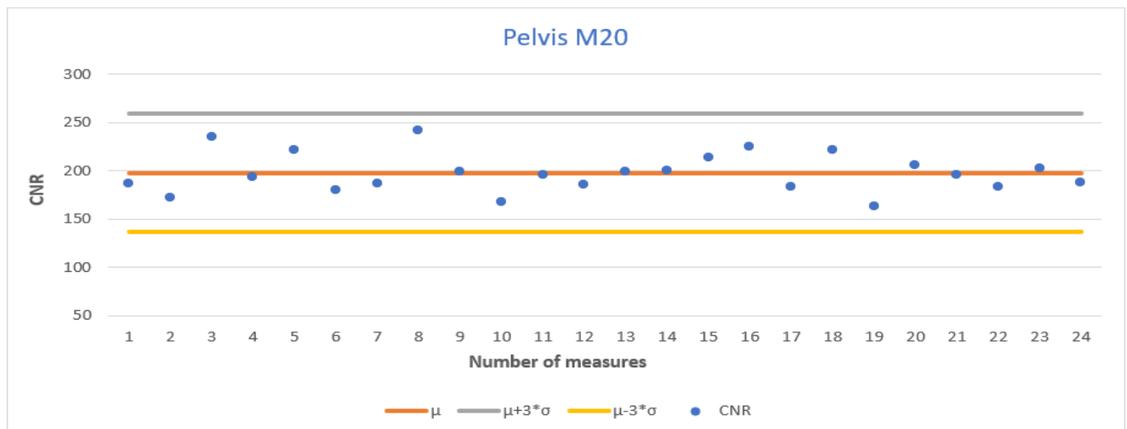
| protocols | mean (cm) | mean+3σ (cm) | mean-3σ (cm) |
|---|---|---|---|
| Pelvis M20 | 2.42 | 3.59 | 1.25 |
| Fast Pelvis M20 | 2.62 | 3.79 | 1.45 |

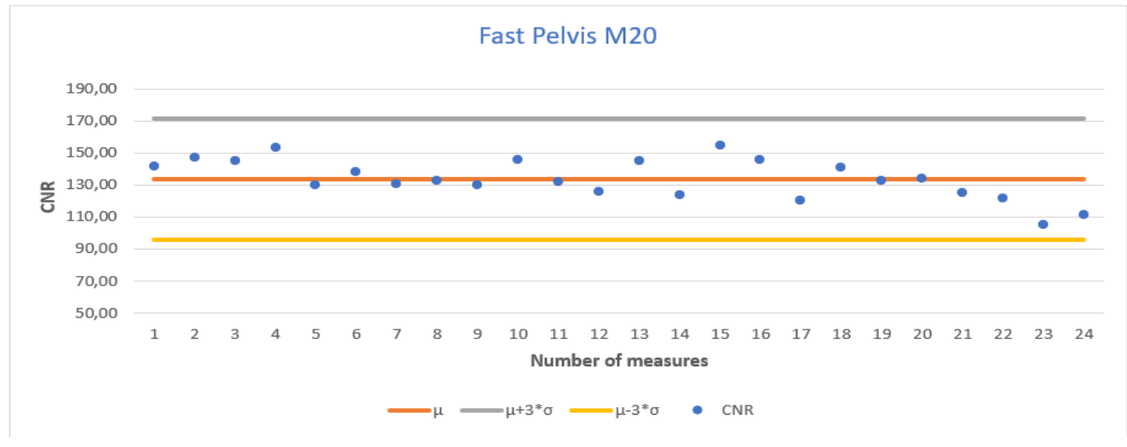



- CNR for Pelvis M20 and Fast Pelvis M20

| protocols | mean (cm) | mean+3σ (cm) | mean-3σ (cm) |
|---|---|---|---|
| Pelvis M20 | 197.86 | 259.27 | 136.45 |
| Fast Pelvis M20 | 133.88 | 196.17 | 171.59 |



## 4. Conclusions

- The equivalency of the two protocols allows for the routine clinical use of the fast one, which minimizes imaging time and reduces radiation exposure.

- The focusing and alignment of the external lasers on the eccentric crosses of the phantom are done correctly an all protocols. The intentional misalignment of the phantom was correctly detected by the system and the values were close to the expected ones, as set by the manufacturer.

- Movements of the treatment table are carried out correctly in both the default and fast protocols for the head and neck and pelvis, therefore the phantom is correctly positioned in the central crosses.

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