Is measurement of CTDI$_{vol}$ with a helical scan an acceptable alternative to the standard single-slice methodology?

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Introduction

The standard method of measuring CTDI$_{vol}$ and the only method accepted by the ACR, requires using a single axial scan over a 100-mm pencil chamber.$^{1,2}$ Measuring the CTDI$_{vol}$ from a clinical helical protocol requires “converting” it to an axial protocol, which may lead to problems matching collimation (nxT) values and bowtie filter; consequently, the tested protocol may not be a good substitute to the clinical protocol. Additionally, some nuclear hybrid units are incapable of acquiring axial scans without entering service mode.

The purpose of this study was to determine whether CTDI$_{vol}$ can be accurately measured with a helical scan.

Methods

A total of 43 helical protocols from 15 CT scanners, representing all major manufacturers, were included in this study. First, the standard axial CTDI$_{vol}$ was measured using the methodology and equations required by the ACR.$^2$ A second helical measurement was acquired as follows:

- A tomodogram of the phantom with pencil chamber inserted was acquired.
- The clinical protocol was selected (unmodified except for setting a manual mA) and the scan range set equal to the active length of the chamber visible on the tomodogram (Figure 1).

- CTDI$_{vol}$ was calculated from the average of 3 measurements in the center phantom hole and 3 measurements in the 12:00 peripheral hole using:

$$CTDI_{vol}(mGy) = 0.0087 \times X(mR)$$

$$CTDI_{vol}(mGy) = 0.333 \times CTDI_{center}^{100} + 0.667 \times CTDI_{peripheral}^{100}$$

Results

The differences between the axial measurements, helical measurements, and scanner-displayed values are summarized in Table 1. It was not possible to match collimation between the axial and helical acquisition modes in 10 of 43 protocols; the correlation between the helical CTDI$_{vol}$ and the axial CTDI$_{vol}$ was $R^2=0.98$ across all protocols and $R^2=0.99$ when restricted to protocols with matched collimation (Figure 2). A Bland-Altman graph shows excellent agreement between the measurement methods when collimation is matched; a few outliers occur when collimation is unmatched (Figure 3).

![Figure 1. Topogram of the CTDI phantom with pencil chamber inserted. The air volume of the chamber is used to set the scan range.](image1)

![Figure 2. Correlation between axial and helical CTDI$_{vol}$ values.](image2)

![Figure 3. Bland-Altman plot showing differences between the axial and helical measurement methods.](image3)

![Figure 4. CTDI$_{vol}$ values for the adult abdomen protocol.](image4)

Conclusions

There was excellent agreement between the two measurement methods and to the displayed CTDI$_{vol}$. The helical measurement method can be accomplished more easily than the axial method on many scanners and is a reasonable testing method for QC purposes.

References
