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# How Localizer Orders Impact Image Quality and Radiation Dose in Computed Tomography - A Phantom Study


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## INTRODUCTION

Computed tomography (CT) utilization continues to increase in the United States due to its many applications[1]. A variety of technologies have been developed to decrease patient radiation dose from CT including automated tube current modulation, tube voltage selection software and bowtie filters[2,3]. Incorrect patient positioning in the CT gantry can impact dose in two important ways[4,5]:

I. Magnification influence topogram-based tube current modulation and tube voltage selection software.
II. Misalignment between the x-ray beam and the bowtie filters.

As a result, patient dose and image quality is affected. For this reason, a quantitative understanding of how CT systems behave when patient positioning is off-center is of clinical relevance.

## AIM

The purpose of this study was to investigate the effects of localizer order on image quality and radiation dose in computed tomography.

## METHOD

A semi-anthropomorphic liver phantom was scanned on a Siemens SOMATOM Force and a GE Discovery CT 750 HD CT scanner using a diagnostic abdominal CT protocol at different table heights to simulate patient off-centering. The height ranges from -100 mm to 100 mm from isocenter with intervals of 10 mm.

Reported CTDIvol values from each scanner were recorded while varying the order of paired localizer with tube current modulation (TCM) enabled. Four paired localizer combinations were evaluated for a supine patient: Lateral then anteroposterior (LAT+AP), lateral then posteroanterior (LAT+PA), anteroposterior then lateral (AP+LAT), and posteroanterior with lateral (PA+LAT).

The contrast-to-noise ratio (CNR) was computed from the comparison between a liver region of interest (ROI) and a simulated hyperdense liver nodule ROI across three consecutive images near the center of the phantom. The figure of merit (FOM), defined as $CNR^2/CTDIvol$, was calculated to facilitate optimization of low contrast performance.

## METHOD

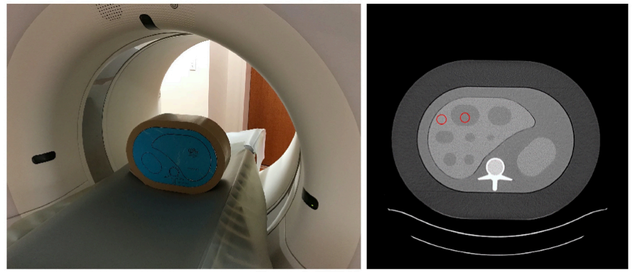



***Figure 1*** *Left: Image showing phantom positioning set up for experiment. Right: ROI locations for CNR measurements in a liver nodule. The hyperdense nodule was use to simulate HCC post contrast in the liver.*

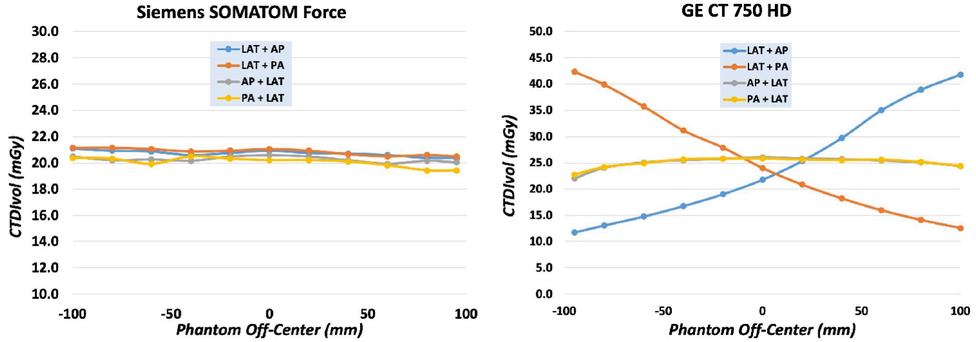


***Figure 2*** *CTDIvol as a function of phantom height with respect to isocenter for all four localizer pairs. Left: Siemens Force shows similar CTDIvol values at all table heights for all localizer orders. Right: GE 750 HD shows a strong dependency on patient positioning when lateral first localizer pairs were used. Overall, CTDIvol was about 2 mGy lower on the Force compared to the 750 HD.*

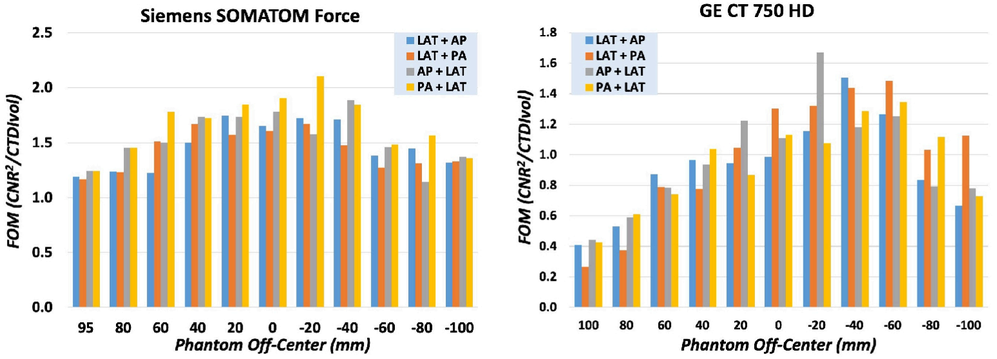


***Figure 3*** *FOM as a function of phantom height with respect to isocenter for all four localizer pairs. Even though, the Force system shows no difference in CTDIvol, FOM is reduced as off-centering increases. With respect to the 750 HD system, the image contrast is dramatically reduced when the phantom is positioned off-center in all localizer orders. Centering above isocenter causes the largest decrease in image quality.*

## RESULTS

For the CT 750 HD system CTDIvol decreased steeply with increasing off-centering of the phantom in the vertical direction, table height, when using lateral first localizer pairs. However, using AP or PA first localizer pairs reduced the impact of vertical off-centering on CTDIvol. In contrast, smaller differences between CTDIvol values were seen for the Force system regardless of localizer order or table height. The FOM was observed to be the highest with phantom at iso-center regardless of localizer order for the Force system. On the other hand, the FOM for the 750 HD system was observed to be highest with phantom slightly lower (~20mm) than iso-center.

## CONCLUSIONS

This study shows that the impact of localizer order and table height on image quality and radiation dose may vary, depending on the model of the system. Nevertheless, image quality is always compromised when patient positioning is off-center.

For the Siemens SOMATOM Force system, the table height does not have a substantial influence on CTDIvol. However, image contrast decreases as the off-center distance increases. As expected, optimal image quality, defined as the maximum FOM, always occurred when the phantom was centered regardless of localizer order.

Regarding the CT 750 HD system, the table height had a strong influence on radiation dose when lateral first paired localizers were used. Similarly, maximum FOM occurred when phantom was nearly centered and FOM decreased with increasing off-centering. However, CNR was decreased compared to the Force system. Thus, It is recommended to use AP or PA first paired localizers on the CT 750 HD system for protocol optimization. Further testing with other scanner models and measurement setups is currently in progress.

## ACKNOWLEDGEMENTS


We would like to gratefully acknowledge …


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