Detection of early cerebral ischemia using virtual monoenergetic images compared to conventional polyenergetic images

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Background and Purpose

Early cortical ischemic changes may be difficult to detect on conventional computer tomography (CT), but virtual monoenergetic images (VMIs) may improve detection rates through increased soft tissue contrast. We compared the ability of VMIs to detect early cerebral ischemia in patients with acute ischemic stroke to conventional polyenergetic images (CIs).

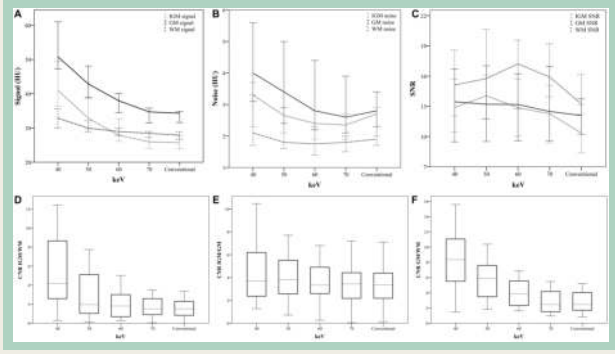
Methods

We screened all patients at our department who underwent brain CT in a Philips dual-layer IQon Spectral CT examined for clinical suspicion of acute stroke, last seen well <12 hours, and confirmed ischemic lesion verified by a follow-up CT or MRI.

The spectral files were used to reconstruct VMIs of 40, 50, 60 and 70 kiloelectron volt (keV) and polyenergetic 120 kV CIs. Attenuation and noise were measured in Regions of Interests (ROIs), and discrimination between grey and white matter (signal and noise measured in median Hounsfield Unit (HU), and contrast to noise ratio (CNR)) was compared. Subjective image quality was rated by neuroradiologists blinded to reconstruction details.

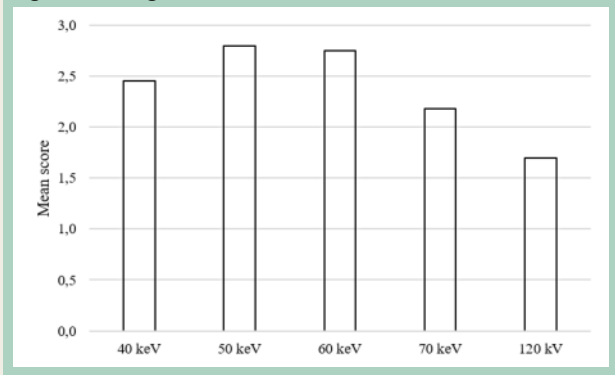
Results

The CNR were significantly increased in all VMIs compared to CIs, with peak values at 40 keV. The noise of VMIs showed a non-significant trend of being increased compared with CI in lower keV, with peak values at 40 keV.

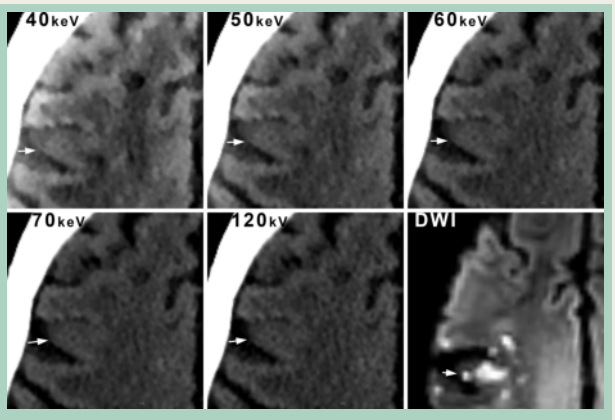


Quantitative Image Analysis Figure
Upper panels: Median values with 95% CI for signal (HU, **panel A**), noise (SD, **panel B**) and signal-to-noise ratio (SNR, **panel C**) in ischemic grey matter, normal grey matter and adjacent white matter for monoenergetic energy levels 40-70 keV, and conventional image.
Lower panels: Median values of the contrast to noise ratio (CNR) of Ischemic Grey Matter to White Matter (IGM to WM, **panel D**), Ischemic Grey Matter to normal Grey Matter (IGM to GM, **panel E**) and normal Grey Matter to White Matter (GM to WM, **panel F**) for monoenergetic energy levels 40-70 keV, and conventional image.

The subjective image quality analysis showed improved overall image quality for all reconstructions, with the highest ratings for 50 and 60 keV.



Subjective Image Quality Figure
Overall subjective image quality for both neuroradiologists for the blinded evaluation.



Illustrative example
Top panels from left: Virtual monoenergetic images at 40, 50 and 60 keV, respectively. Bottom row from left: Virtual monoenergetic images at 70 keV, conventional polyenergetic image at 120kV, and diffusion-weighted image (DWI) at the 24h follow-up MRI verifying the ischemic area. The white arrow indicates the ischemic lesion in the right hemisphere.

Conclusions

The use of VMIs may improve early lesion detection compared to conventional CT images, and thereby enhance diagnostic accuracy.

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