**Evaluation and extension of *in vivo* detectability index to deep-learning and photon counting CT techniques**

Francesco Ria, Corey Jensen, Mojtaba Zarei, Xinming Liu, Fides R. Schwartz, Ehsan Samei

Max: 2200 characters

**Purpose**

The assessment of detectability index (d') *in vivo* provides a new dimension in the performance assessment of CT systems. The purpose of this study was to evaluate and extend the *in vivo* d' metrology to the state-of-the-art CT technologies, photon counting detector (PCCT) and deep learning reconstruction (DL).

**Materials and Methods**

Under IRB approval, 51 contrast-enhanced abdominal studies for the investigation of colorectal liver metastases were prospectively performed using standard dose (SD) and reduced dose (RD, 65%) exposure in the same breath-hold (Revolution, GE Healthcare). Scans were reconstructed with FBP and DL algorithms. Three radiologists participated in a detection study of lesions in standard dose FBP (SD-FBP) and in reduced dose DL (RD-DL). The results were parsed as a function of lesion size (≤5mm, 6-10mm, and ≥10mm). All cases were then assessed using a validated, automated *in vivo* image quality characterization in terms of adjusted detectability index ($d_{adj}$') for each evaluated lesion based on the Fisher-Hotelling observer model as a function of lesion size at 60HU using MTF and NPS normalized by the related integrals. Both d' and $d_{adj}$' were compared with radiologists results for SD-FBP and RD-DL images. The two d' methods were further applied and compared across 126 CT image datasets acquired with PCCT (Naeotom Alpha, Siemens) using three different reconstruction kernels (Br40f, Br48f, and Br56f).

**Results**

Across SD-FBP and RD-DL cases, both d' methodologies indicated correlation with observer results, with the $d_{adj}$' offering a marked advantage with 103% improvement in predictive performance as a function of lesion size and dose. The two models also indicated correlative prediction for PCCT data with $d_{adj}$' yielding a closer range of applicability across cases (0.13-2.54 versus 1.38-113.90 for conventional d').

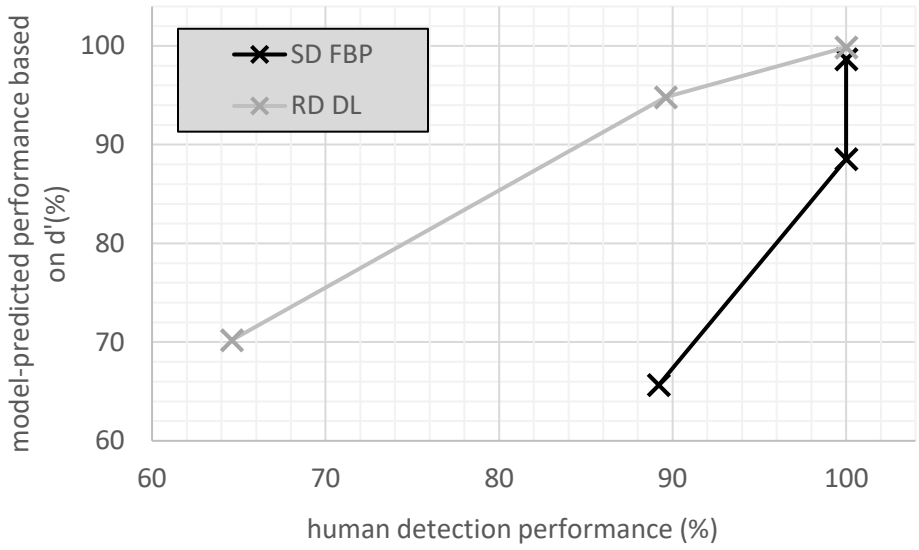
**Conclusion**

The newly devised $d_{adj}$' offers a better prediction of diagnostic quality across CT imaging techniques. The *in vivo* application of the new metric to PCCT studies enables efficient assessment of this emerging technology. Investigators should exercise care when comparing different CT technologies using d' definitions that are not generalized to the examined technique.

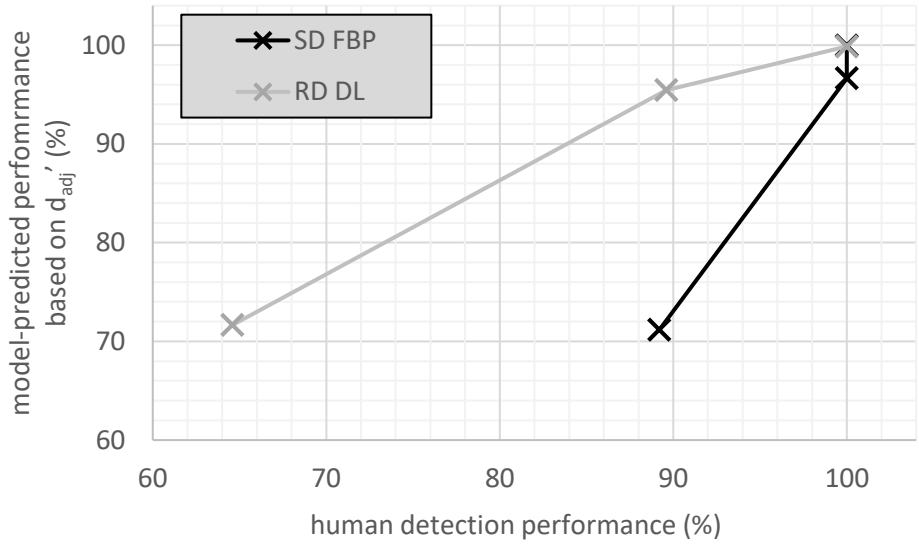
*Acknowledgment. NIH/NIBIB P41-EB028744 and NIH/NIBIB R44-EB031658.*

**Clinical Relevance statement** (max: 200 characters)

Automated *in vivo* image quality metrologies has the potential to serve as a predictive surrogate of diagnostic quality in PCCT with application to practice monitoring and optimization.




(a)




(b)

Figure 1. Model predicted performance and human detection performance for standard dose FBP and reduced dose DL reconstructions and three lesion sizes for d' (a) and $d_{adj}$' (b).