Purpose:
X-ray differential phase contrast (DPC) projection imaging has shown promise for superior image contrast. In the field of medical imaging, however, its differential nature makes the projection image difficult to use for direct diagnosis. In this study, a phase retrieval method is introduced to generate phase images, which are compared with absorption images to demonstrate the benefits of phase contrast projection imaging.

Methods:
The method involves the minimization of a cost function that includes two terms: a quadratic norm that enforces consistency between the phase image and the DPC image, and a nonconvex norm of the phase image's gradient in the direction perpendicular to the stripes. A weighting parameter α is applied to the second term to tailor the content of stripes. This cost function is minimized to solve for the phase image. A grating-based DPC system was used to acquire the DPC and absorption images of a cylindrical phantom. The DPC, absorption, directly-integrated phase and regularized phase images were compared. To evaluate the image quality, simulated spheres of different contrasts and diameters were added to the experimental data. CNR of the beads in the integrated image was used as the figure of merit to optimize the regularization.

Results:
The retrieved phase image provides complementary information of the phantom that is otherwise lost in the direct-integrated images because of the presence of stripe noise. Regularized integration improved image quality in terms of CNR and the content of stripe noise. The optimal regularization parameter can be determined from the peaks of the CNR-α curves and is dependent on the object’s contrast.

Conclusions:
Regularized integration allows for artifact-free phase retrieval from DPC images and a fair comparison between phase contrast and absorption images. DPC imaging's potential application in medical imaging is highlighted by the complementary information provided by the phase image.