Purpose:Cone-beam CT (CBCT) images are acquired repeatedly during a course of radiation therapy and a natural question to ask is whether CBCT images obtained earlier in the process can be utilized as prior knowledge to reduce patient imaging dose in subsequent scans. The purpose of this work is to develop an adaptive prior image constrained compressed sensing (APICCS) method to solve this problem.

Methods:The smoothed prior images are utilized as an initial guess and are incorporated into the objective function under the PICCS framework. The clustered prior images are additionally employed to detect any possible mismatched areas compared with the current images that are classified by the k-means algorithm at each iteration step. A distance transformation is then introduced to convert the mismatched information into a weighted relaxation map for an adaptive update. In constructing the relaxation map, the matched regions between the prior and current images are assigned with smaller values and thus are much less influenced by the sparse projections, thereby leading to fewer streaking artifacts. On the other hand, mismatched regions are associated with larger values and the regions are updated more by the new projections, thus avoiding any possible adverse effects of prior images. The APICCS approach was assessed by using patient data acquired under standard- and low-dose protocols.

Results:The APICCS method provides an effective way to enhance the image quality at the matched regions between the prior and current images compared to the existing PICCS algorithm. In addition, the APICCS algorithm allows an imaging dose reduction of 10 to 40 times due to the greatly reduced number of projections and X-ray tube current.

Conclusions:The APICCS technique allows us to effectively take advantage of previously obtained CBCT images and provides high quality CBCT images with sparse projections.

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