Purpose: We have developed a method of tracking irregularly shaped implanted markers using KV projection images acquired in rotational mode and assess its potential for detecting intra-fractional target motion. This is a feasibility study directed toward long-range goals of acquiring such images during rotational treatment and using them for motion correction.

Methods: KV projection images were acquired (Varian TrueBeam) during seven cone beam scans of two gastroesophageal and two pancreas cancer patients (IRB-approved protocol). Each had at least one irregularly shaped radiopaque marker (Visicoil) implanted in or near the tumor. Specialized digitally reconstructed radiographs (DRRs) used for template based tracking were created from a breath-hold planning CT at end expiration, in which the ray tracing was confined to a small volume of interest surrounding each marker. Sobel filter preprocessing of KV images served to enhance marker visibility and suppress background features. DRRs were matched with processed KV images both manually (ground truth) and automatically (normalized cross-correlation with simplex minimization). Anthropomorphic phantom studies were also done to evaluate measurement uncertainty.

Results: The mean (over patient scans) and standard deviation of the differences (Auto-manual) were $-0.04 \pm 0.68$ mm and $0.08 \pm 0.89$ mm in transverse and superior-inferior (SI) directions respectively. The percentages of matches with difference exceeding 2 mm were 1.8% transverse and 5.0% SI. Intra-observer consistency of manual registration was checked by repeating the manual registration for all 657 projections in one patient; the standard deviation of the difference was 0.4 mm. Phantom studies showed the measurement uncertainty of automatic registration to be approximately 0.15 mm.

Conclusions: The proposed method can track arbitrary marker shapes using templates generated from a breath-hold CT or alternatively, respiration-correlated CT scan at one phase. Preliminary results indicate accuracy and robustness are adequate for clinical application but confirmation in larger numbers of patients is required.

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