

Enhancing Precision in Abdominal External Beam Radiation Therapy: Exhale Breath Hold Technique for Respiratory Motion Management

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Abstract : The Exhale Breath Hold (EBH) technique presents a promising approach to enhance the precision and efficacy of External Beam Radiation Therapy (EBRT) for abdominal tumours, which include liver, pancreas, kidney, and adrenal glands. These tumours are challenging to treat due to their proximity to organs at risk (OARs) and the significant motion induced by respiration and physiological variations, such as stomach filling. Respiratory motion can cause up to 40mm of displacement in abdominal organs, complicating accurate targeting. While current practices like limiting fasting help reduce motion related to digestive processes, they do not address respiratory motion. 4DCT scans are used to assess this motion, but they require extensive workflow time and expose patients to higher doses of radiation. The EBH technique, which involves holding the breath in an exhale with no air in the lungs, stabilizes internal organ motion, thereby reducing respiratory-induced motion. The primary benefit of EBH is the reduction in treatment volume sizes, specifically the Internal Target Volume (ITV) and Planning Target Volume (PTV), as demonstrated by smaller ITVs when gated in EBH. This reduction also improves the quality of 3D Cone Beam CT (CBCT) images by minimizing respiratory artifacts, facilitating soft tissue matching akin to stereotactic treatments. Patients suitable for EBH must meet criteria including the ability to hold their breath for at least 15 seconds and maintain a consistent breathing pattern. For those who do not qualify, the traditional 4DCT protocol will be used. The implementation involves an EBH planning scan and additional short EBH scans to ensure reproducibility and assist in contouring and volume expansions, with a Free Breathing (FB) scan used for setup purposes. Treatment planning on EBH scans leads to smaller PTVs, though intrafractional and interfractional breath hold variations must be accounted for in margins. The treatment decision process includes performing CBCT in EBH intervals, with careful matching and adjustment based on soft tissue and fiducial markers. Initial studies at two sites will evaluate the necessity of multiple CBCTs, assessing shifts and the benefits of initial versus mid-treatment CBCT. Considerations for successful implementation include thorough patient coaching, staff training, and verification of breath holds, despite potential disadvantages such as longer treatment times and patient exhaustion. Overall, the EBH technique offers significant improvements in the accuracy and quality of abdominal EBRT, paving the way for more effective and safer treatments for patients.

Keywords : abdominal cancers, exhale breath hold, radiation therapy, respiratory motion

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