Abstract

Stereotactic ablative radiotherapy (SABR) is an important part of treatment for certain upper abdominal cancers, such as primary liver cancer. However, the impact of respiratory motion on precision SABR delivery remains a challenge particularly for critical organs at risk (OARs) in close proximity of the target.

While numerous respiratory motion management strategies exist in radiotherapy, there are benefits and drawbacks to each. Although these strategies, including abdominal compression (AC), breath hold (BH) and free-breathing (FB) with an internal target volume (ITV) approach, have been evaluated, it is still not clear which patients benefit most from each strategy, and which strategy is most suitable for different radiotherapy delivery platforms. The work in this thesis summarises attempts to stratify patients undergoing abdominal radiotherapy to the most appropriate motion management strategy and treatment delivery system.

First, a systematic review of the literature surrounding motion reduction with AC was conducted. We found limited literature demonstrating AC effectiveness within individual patients, as well as contraindications or patient factors impacting effectiveness. We also found that male sex and high body mass index (BMI) were factors suggested to impact AC effectiveness.

Second, we assessed the relationship between abdominal fat measured on 3D MRI and BMI on motion reduction with AC. This work found no reduction of the effectiveness of an abdominal compression belt, suggesting that a more complicated relationship between patient factors and AC effectiveness is likely.

Next, we assessed the impact of three motion management strategies (AC, BH, FB) on abdominal OAR delineation between four observers using MRI. The results identified challenges with conducting inter-observer studies such as time and number of observers, and the results suggested that no strategy was superior with regard to OAR delineation. Although further investigation with a larger dataset and observer cohort is warranted.

Then, we assessed AC, BH and FB strategies for treatment planning on the C-arm and MR Linac to determine if an ideal strategy per platform can be identified. This work found that clinically acceptable plans could be generated for all, however BH offered the best overall target coverage and OAR sparing on both platforms.

Finally, we evaluated three deformable image registration (DIR) workflows to identify the most reliable for pancreatic dose accumulation on the MR Linac for patients treated with AC. This work found that both organ-wise (OW) workflows showed better DIR geometric accuracy, particularly for non-gastrointestinal (GI) OARs. Accuracy is still a challenge in GI OAR DIR, therefore further work is required to optimise these workflows. Additionally, dose accumulation presents an opportunity to evaluate the dosimetric benefit of different motion management strategies at scale.

Full thesis available through the University of Manchester: Evaluation of abdominal motion management strategies across radiotherapy platforms - Research Explorer The University of Manchester