Triggering adaptive intervention for H&N weight loss cases, using an EPID in-vivo dosimetry solution

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Introduction and Objectives

Over 300 Head & Neck (H&N) patients/year are treated at Clatterbridge Cancer Centre (CCC) using VMAT. H&N patients often lose weight during the course of treatment. If weight loss is significant, there may be dosimetric changes which affect the CTV and/ or OARs. This can result in a treatment re-plan (RP).

Patients are referred to physics for Adaptive Assessment (AA) if radiographers observe a change in body contour of ~1.5cm in CBCTs due to weight loss. Physics review the CBCT; if the change in contour is ≥1.5cm, or if the anatomy outlined as CTV is now outside the PTV a recalculation is carried out. The coverage of the CTV and OAR sparing are assessed to determine if a re-plan is required [1]. 18% of H&N patients are referred an AA but only 5% require a RP.

The aim of this project was to assess the feasibility of using the Sun Nuclear [3] EPID based in-vivo monitoring system, PerFRACTION (PF), to identify more efficiently which with H&N patients require AA.

PF provides verification of treatment delivery by comparing integrated images from each fraction against a baseline image acquired at fraction 1, and generates 2D γ-analysis values for each arc delivered (Figure 1). This software has previously been shown to be capable of flagging set-up errors, changes in delivery or anatomical changes [2 & 3]. Similar software has also been used to monitor anatomical changes [4 - 6].

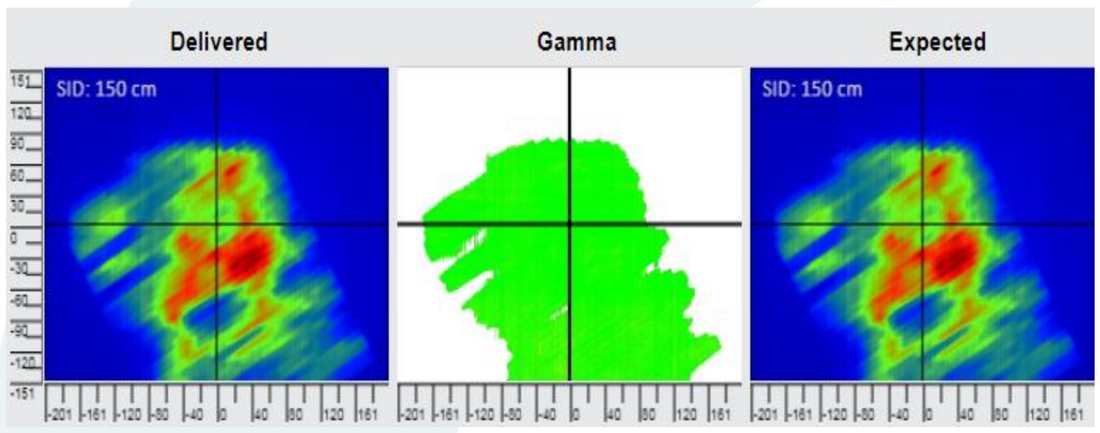

Figure 1: Screenshot of comparison view from PF, of delivered EPID image 2D γ-analysis and the expected EPID from the baseline.

Method

5x3mm water equivalent plastic layers were vacuum moulded to an anthropomorphic H&N phantom (Figure 2). Each layer represented an effective 6mm lateral weight loss. The layered phantom was scanned, outlined and planned using a CCC H&N protocol. The plan was delivered to the phantom on a Varian TrueBeam and integrated images acquired on an AS1000 EPID. To simulate weight loss, one layer was removed each fraction, until no layers remained.

Figure 2: Photograph of the anthropomorphic H&N phantom with the vacuum moulded plastic layers.

Results

2D γ-analysis against the fraction 1 baseline image was automatically performed by PF, and showed the γ(%) decreased with increasing weight loss (Figure 3). Figure 3 shows that a clinically significant weight loss of 1.5cm corresponds to an 80% pass tolerance for settings of 4% diff and 2mm, with a threshold of 20% and local normalisation.

Data for 45 patients (2xRP; 18xAA; and 25x No Weight Loss (NWL)) were retrospectively reviewed (44% had been referred for review). The patient plans and CBCTs were reviewed, with 27% showing weight loss ≥1.5cm.

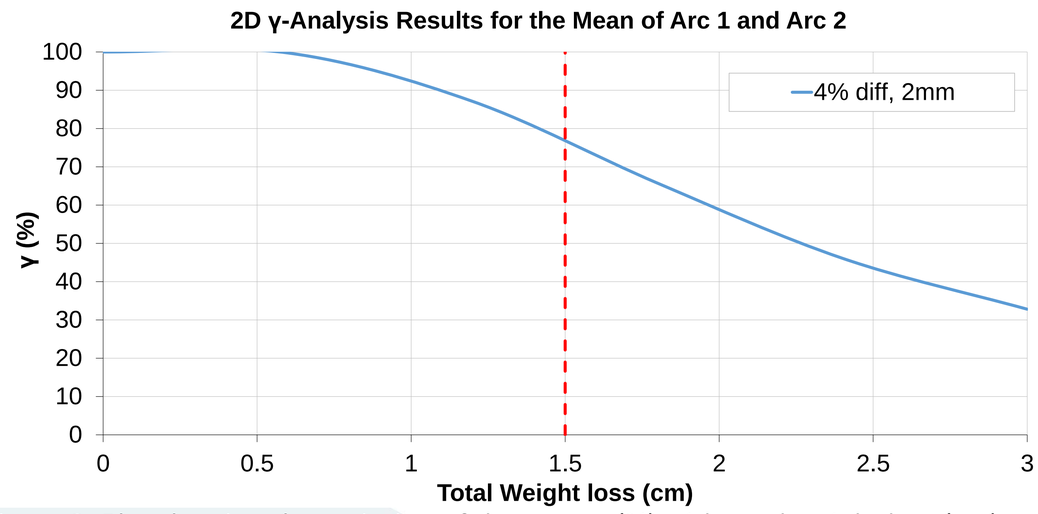

Figure 3: Plot showing the variation of the mean γ(%) with total weight loss (cm).

The PF data was then analysed, with γ<80% identified as True Positive – TP or False Positive –FP, and results with γ>80% were identified as True Negative –TN or False Negative –FN. The Sensitivity (0.75) and Specificity (0.85) were calculated for the 80% threshold, PF identified 20% of patients as having ≥1.5cm weight loss.

Review of the patient data for the 80% threshold identified FNs including a RP patient. Further investigation showed the site of weight loss to be inferior to edge of the EPID panel (Figure 4), due to the panel offsets preventing exposure of the electronics. Some FPs results were also identified, commonly caused poor patient positioning, e.g. a shoulder shift.

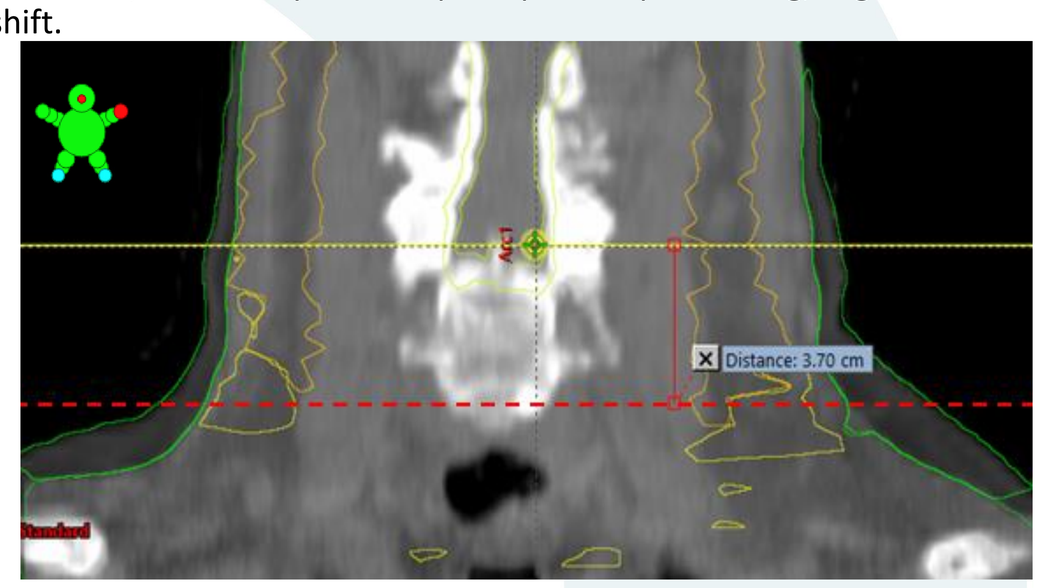

Figure 4: Image taken from the FN re-planned patient, showing the most significant weight loss to be below the edge of the EPID panel, shown by the red dashed line.

Receiver Operating Characteristic (ROC) curve was then generated (Figure 5), with the Area Under the Curve (AUC) calculated, AUC=0.84. This test is therefore considered robust for identifying weight loss ≥1.5cm.

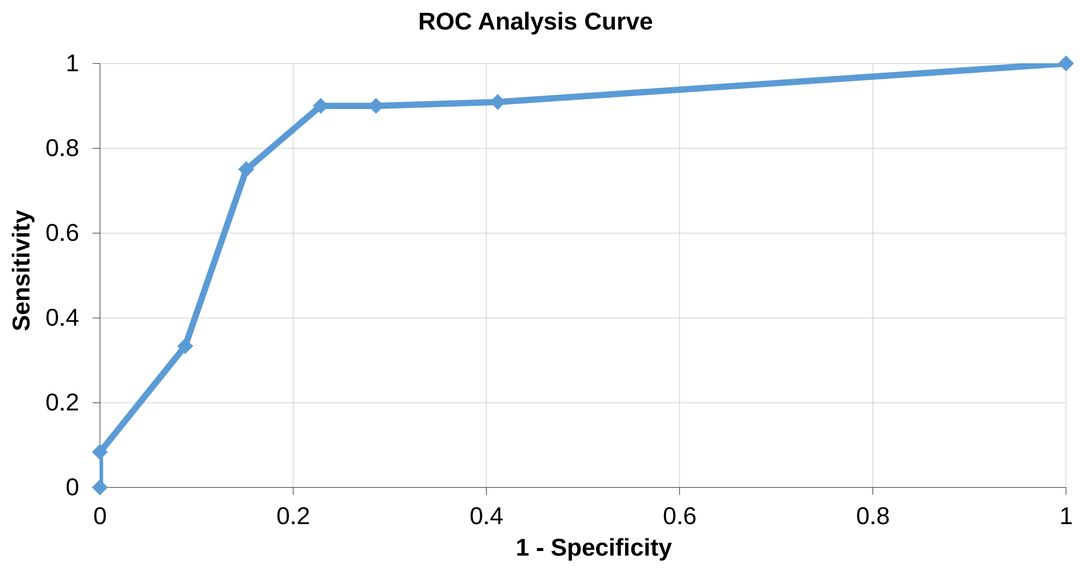

Figure 5: ROC Analysis Curve for the use of PF to identify ≥1.5cm of weight loss.

Conclusions

PF offers a less subjective way of identifying significant weight loss in H&N patients, and has been shown to reduce the number of patients that would be referred for review. Statistical analysis of patient data showed PF to be a useful tool for identifying ≥1.5cm of weight loss. However, PF failed to identify weight loss in some patients, due to the off-set of the EPID, this could result in patients who need a re-plan to be missed. Therefore, further work is needed to resolve the FNs prior to implementation.

References

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