Accuracy of Head & Neck Radiotherapy using DSPS Prominent Shells with SGRT

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Are H&N Shells providing the stability you think they are?

Radiotherapy guidelines in the UK imply that a full head and neck shell should be utilised for immobilisation to "minimise movement" during treatment[1]. The move from kV paired images to CBCT bared the question of stability as movement and changes to soft tissue could be visualised.

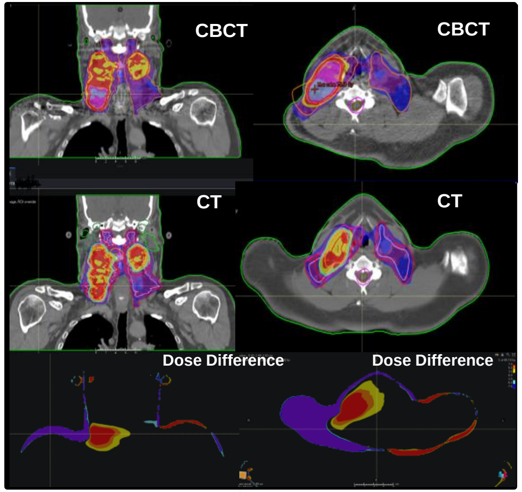

Figure 1. CT and CBCT images (Coronal and Axial) of Patient A in a full Head and Neck Shell with calculated dose difference

Figure 1 shows that after placement of the full head and neck shell, Patient A moved their right shoulder. CBCT calculation showed dose differences of up to 14% increasing DMAX by 6.75Gy from 68.76Gy to 75.51Gy.

Alongside CBCT, advancements in SGRT and EPID dosimetry technology have provided more insight into the complexity of head and neck radiotherapy [2][3]. Together with person-centred care, these advances have encouraged change to improve the patient experience without compromising on accuracy [4].

Aim:

To determine if DSPS prominent shells (shown in Figure 4) improve set-up accuracy and dose delivery of H&N radiotherapy patients using SGRT.

Method:

Twenty oropharynx patients receiving 30# of radiotherapy were analysed retrospectively. 10 were immobilised using the DSPS head only shell and 10 were immobilised using the DSPS prominent shell. All were set-up using SGRT and verified daily by online CBCT. Imaging shifts were recorded from weekly fractions (1,6,11,16,21,26) in 6DoF and CBCT dose calculations were performed to evaluate dose delivery through analysis of the dose difference between CT plan and CBCT clinical goals for PTV65, PTV54 and Cord PRV.

Results:

In set-up, the prominent shell reduced the range of movement (0.8cm,0.9cm,0.5cm,3.3°,3°,4°) compared to the head only shell (1.4cm,1.5cm,0.9cm,4.6°,3.6°,4.6°) in all 6DoFs. The root mean square (RMSQ) showed that the prominent shell (±0.2cm, ±0.2cm, ±0.1cm, ±1.4°, ±0.7°, ±0.8°) provided similar or improved accuracy in 5 of the 6DoFs compared to the DSPS Head only shell (±0.2cm, ±0.3cm, ±0.2cm, ±0.9°, ±0.9°, ±0.9°) shown in Figure 2.

Figure 2. Plot and whiskers chart of online imaging shifts in all 6DoFs for both immobilisation shells

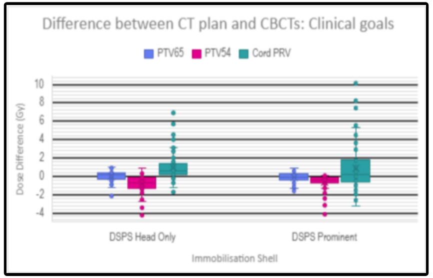

Figure 3. Plot and whiskers chart of clinical goal differences between CT plan and CBCT for both immobilisation shells

Three clinical goals were observed throughout this evaluation: 95% of Px to 95% volume for planPTV65 and planPTV54 and 50Gy to 0.1cm3 to cord PRV. The RMSQ of dose difference observed between the CT plan and the CBCT were smaller for the DSPS prominent shells PTV65=±0.55Gy PTV54= ±1.03Gy compared to PTV65= ±0.59Gy PTV54= ±1.28Gy for the DSPS Head only shells. The RMSQ for the Cord PRV clinical goal was larger in the prominent shell ±2.71 compared to ±1.78 within the DSPS Head only.

The Mann-Whitney U test was used to determine statistical significance in imaging shifts and clinical goals. A value of p=<0.01 is considered statistically significant. This found statistical significance in the pitch (p=0.00001).

Figure 4. Images of the DSPS prominent shell at CT and on the linac

Discussion:

- Reduced range of movement implies that the patients position is more stable using the DSPS prominent.
- Further investigation found the increase in pitch value was caused by the offset of the prominent board on the treatment couch. This was required to deliver non-coplanar plans and corrected for using the 6DoF couch.
- Dose differences were calculated from clinical goals using deformed registrations. This was due to anatomical changes visualised on CBCT images (weight loss/gain, tumour shrinkage). There is a possibility that the deformed volumes vary slightly from the oncologist drawn volumes on the CT however uncertainties were reduced by using this process for all patients in the study.
- Although the cord PRV dose difference was higher in the prominent shells, the average dose was lower and perhaps looking at more of the cord volume would be more appropriate in future research

Conclusion:

DSPS prominent shells alongside use of SGRT have shown to improve accuracy of set-up and treatment delivery while reducing the need for fully restrictive immobilisation.

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References

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