# Spatial Characterisation of Skin Dose for Head and Neck Cancer Patients Treated with IMRT and VMAT

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## 1 Introduction

Radiation dermatitis occurs in ~95% of head and neck radiotherapy cases (Sauder et al. [1]) and is graded **spatially** , by whether the skin reaction becomes confluent and how far it spreads.

In clinic, skin dose is traditionally evaluated with dose-volume (DVH) and dose-surface (DSH) histograms. These record **how much** skin is irradiated, but not **where** the dose falls , which is what the grading actually depends on.

As a step towards improving the link between dose to the skin and radiation-induced dermatitis we developed a method that **preserves** the **spatial structure of skin dose**, and applied it across a clinical cohort.

## 2 Methods

Body surface was reconstructed from planning contours as a mesh of the patient's external surface [3]. Planned dose was then sampled inward over a 3 mm shell along vertices normal (consistent with skin-dose depths reported in the literature [2]); the high-dose surface was thresholded and segmented into discrete regions (islands) characterised by area, dose, shape, and location [4].

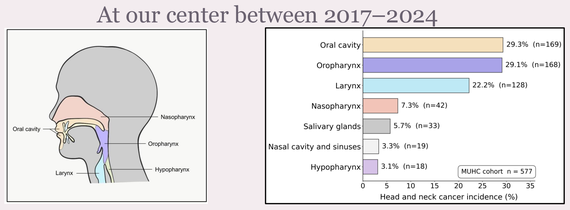
This was retrospectively applied to 577 head and neck cancer patients using routine procedure data.

### Cohort

**577 Head and Neck Cancer Patients**

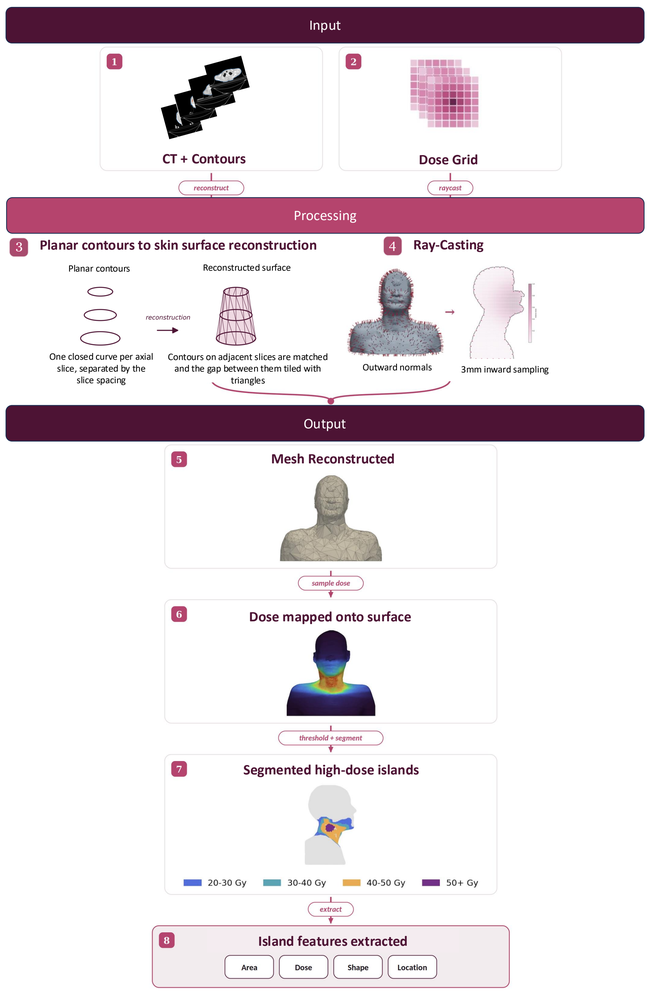
Treated with IMRT / VMAT

At our center between 2017–2024



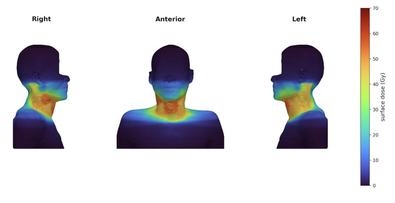

*Head and neck cancer by subsite in our cohort ; oral cavity, oropharynx and larynx predominate.*

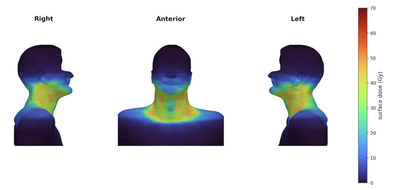
### Pipeline



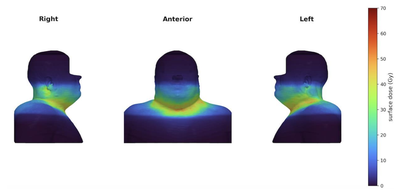

## 3 Results

### Larynx cancer patients



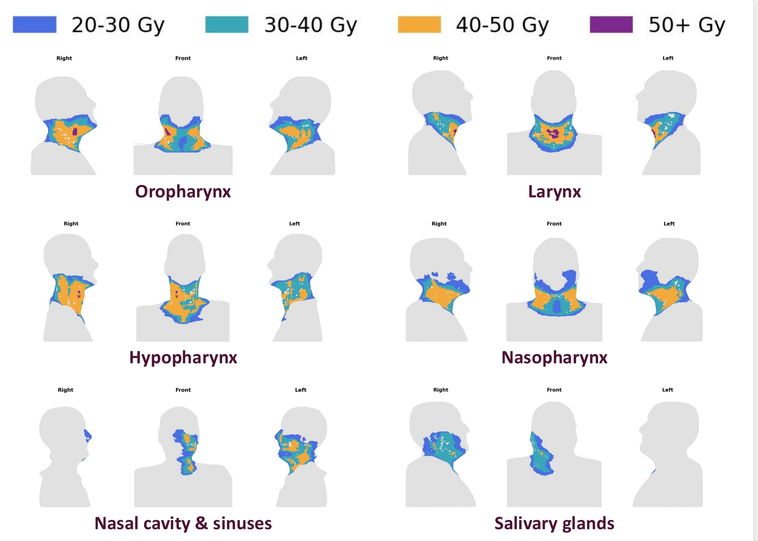




### Oropharynx cancer patient



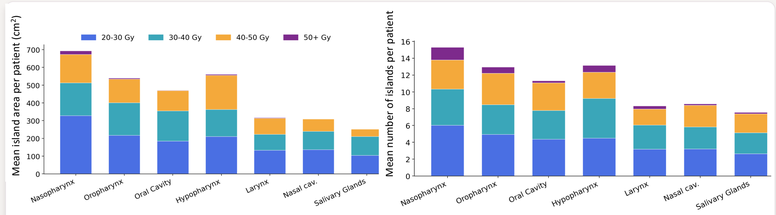

*Planned dose mapped onto the reconstructed surface (right / anterior / left). High dose concentrates on the anterior lower neck. Images defaced to preserved anonymity*

### High-dose islands by subsite




*Representative patient per subsite (right / front / left). Spatial arrangement of high-dose islands varies systematically with tumour subsite.*

### Island burden by subsite and dose band

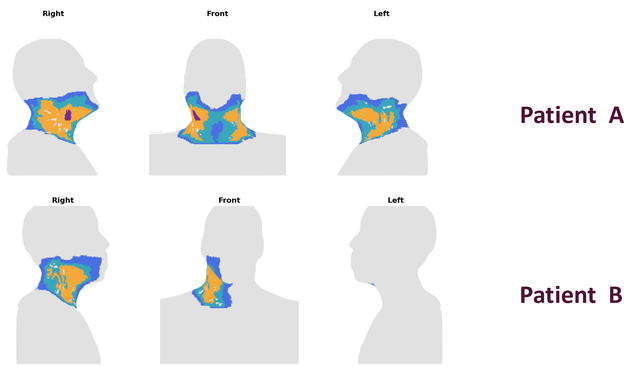



*Mean island area per patient.* *Mean island count per patient.*

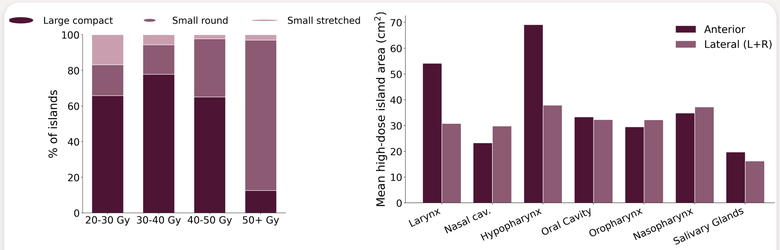
Both total island area and island count are highest in nasopharynx and lowest in the salivary glands patients, with the 20-40 Gy bands contributing most of the burden across all subsites.

### Same dose, different distribution

Both oropharynx cancers, patients A and B share near-identical **maximum skin dose (59.8 vs 60.0 Gy)** and similar **mean skin dose (8.2 vs 9.3 Gy)**, yet their distributions diverge : bilateral across the neck (A) **versus** confined to the right side (B). Showing that dose summaries alone can hide distinct skin-dose topographies.




### Island shape and location vary with dose and subsite




*Island shape composition across dose levels: large compact regions dominate at lower doses and give way to small, rounded islands at 50+ Gy.*

*Mean high-dose island area by subsite and location. Anterior islands are largest in laryngeal and hypopharyngeal disease; other subsites show comparable anterior and lateral island sizes. High-dose islands are skin regions receiving >40 Gy.*

## 4 Discussion

**A descriptive method.** This work characterises the spatial distribution of planned skin dose. It does not measure absolute dose independently of the planning system, nor claim to predict dermatitis. However, it provides the spatial dose description that such a future outcome study would require.

## 5 Take-away

- Spatial structure of skin dose is measurable and reproducible at cohort scale, from planning data alone.
- It varies systematically with tumour subsite.
- It complements dose-volume histograms and adds new spatial information that may be relevant in future dose-dermatitis studies.

## References

1. Sauder et al., *Skin Therapy Letter*, 2021. CaSMO algorithm for acute radiation dermatitis.
2. Basu et al., *Rep Pract Oncol Radiother*, 2024;29(5):579–587.
3. Sunderland et al., *Proc SPIE Medical Imaging*, 2015;9415:94151R. doi:10.1117/12.2081436.
4. Buettner et al., *Phys Med Biol*, 2009;54(21):6535–6548. doi:10.1088/0031-9155/54/21/006.