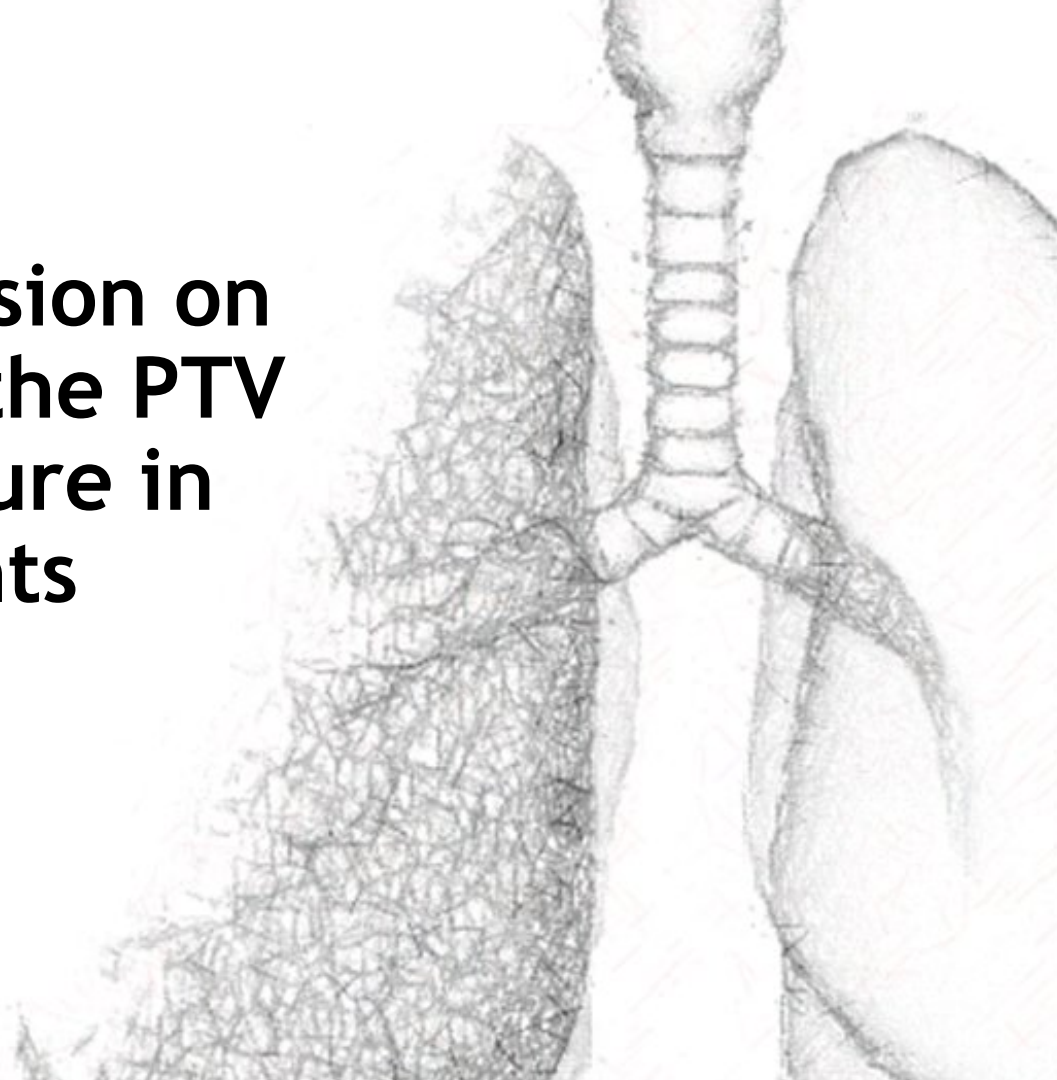
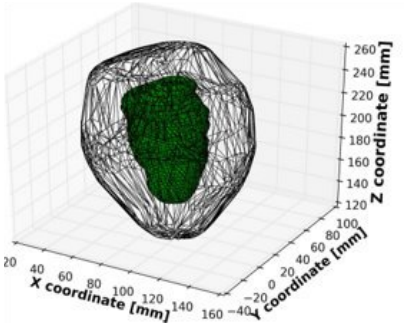
AI informed discussion on how dose outside the PTV affects distant failure in SBRT NSCLC patients



Motivation

Dose outside PTV and its impact on the risk of DM

- Multiple publications have discussed this topic.
- Dose in a **3cm margin around PTV**, and its correlation with the risk of distant metastasis, was investigated.
- Diamant et al. (2018), (2020)
  - Reported lower rate of DM for patients with higher dose delivered to a 3cm margin around PTV
  - It challenged the conventional practice that highly conformal dose distribution should be strictly limited to the PTV, with steep dose fall-off.



Diamant et al., Radiother Oncol, *2018.*

Can dose outside the PTV influence the risk of distant metastases in stage I lung cancer patients treated with stereotactic body radiotherapy (SBRT)?

André Diamant • Avishek Chatterjee • Sergio Faria • ... Cliff Robinson • Hani Al-Halabi • Jan Seuntjens • Show all authors

Published: May 22, 2018 • DOI: https://doi.org/10.1016/j.radonc.2018.05.012 • Check for updates

Comparing local control and distant metastasis in NSCLC patients between CyberKnife and conventional SBRT

André Diamant [1] • Veng Jean Heng [1] • Avishek Chatterjee • ... Farzin Khosrow-Khavar • Issam El Naqa • Jan Seuntjens • Show all authors • Show footnotes

Published: February 07, 2020 • DOI: https://doi.org/10.1016/j.radonc.2020.01.017 • Check for updates

Motivation

Dose outside PTV and its impact on the risk of DM

- Hughes et al. (2021)
  - Did not confirm earlier results

- Lalonde et al. (2022)
  - Did not confirm earlier results
  - Presented conflicting results - higher rate of DM for patients with higher dose delivered to a 3cm margin around PTV

- This work reconciles previous conflicting studies, providing an independent analysis of a large institutional patient cohort

Materials and methods

Patient dataset, Data analysis

- Dataset of 478 patients
  - Early stage NSCLC
  - SBRT (VMAT-323/IMRT-155)
  - PTV Volumes, Stages, Histology
  - Median follow-up = 572 days (IQR: 207-1282)

- Data analysis
  - Deep learning DM modelling
  - Statistical DM modelling in cohorts stratified according to various confounding variables

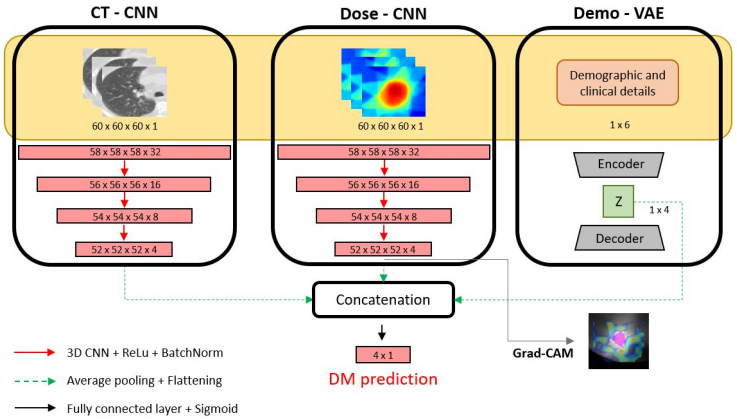
	All patients (n = 478)	DM (n = 91)
PTV volume [ccm]		
< 25	172	34
25 - 50	160	24
50 - 100	103	24
> 100	43	9
Stage		
T1	398	73
T2	69	17
T3	11	1
Histology		
Adenocarcinoma	194	39
Squamous cell	110	16
Malignancy, NOS	63	13
Neuroendocrine	7	2
Negative biopsy	9	3
No biopsy	95	18

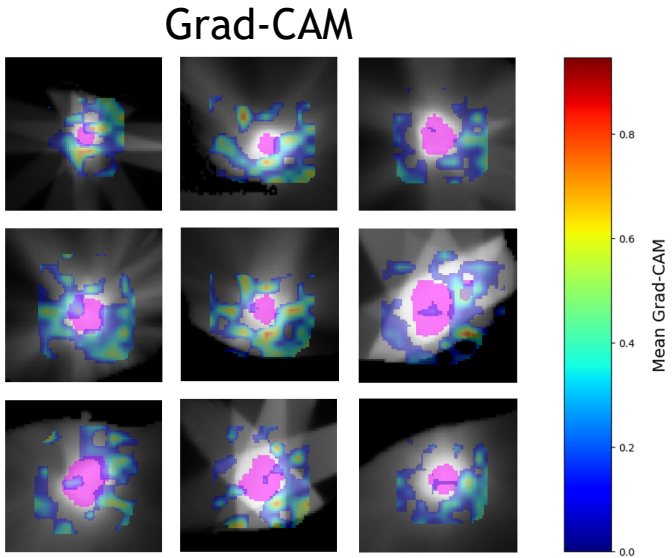
Results

Deep learning model

- Deep learning model providing the risk of DM
  - c-index ~0.61

- Grad-CAM showed the most relevant part of the input data regarding decision-making

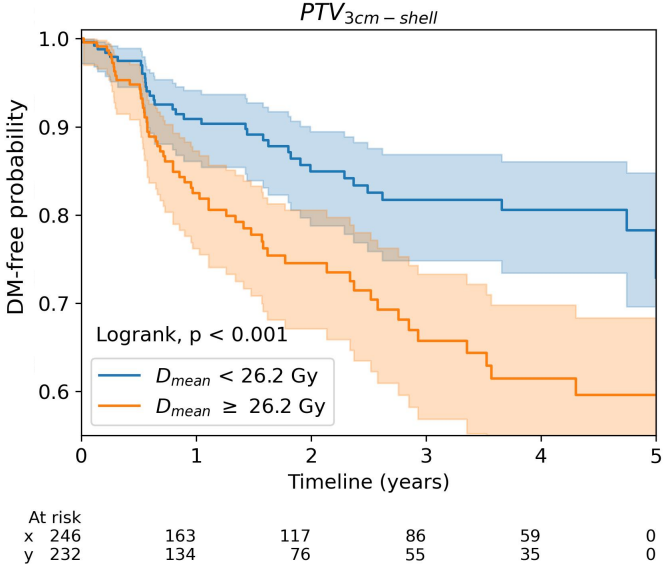


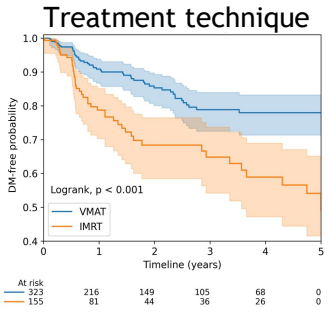


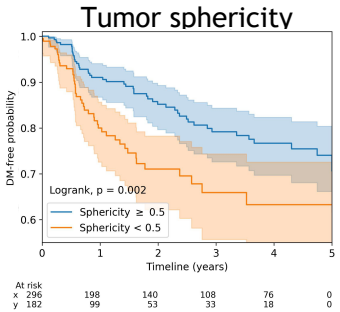
Results

CoxPH-regression

- Higher rate of DM in patients with higher dose to a 3cm margin around PTV was found.
  - It is in conflict with Diamant et al., although it agrees with Lalonde.
  - Significant confounding variables – e.g. treatment technique, tumor sphericity







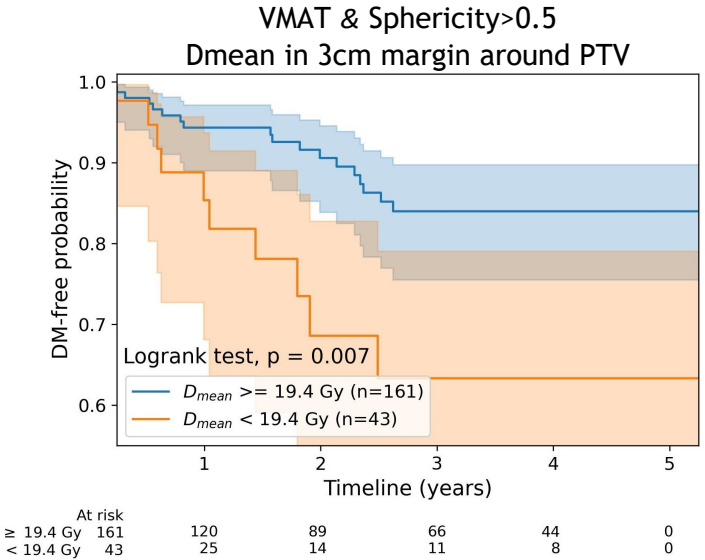
Results

CoxPH-regression (IMRT/VMAT & Sphericity>0.5 stratified)

- Patients were stratified into 4 groups:
  - IMRT & Sphericity>0.5
  - IMRT & Sphericity<0.5
  - **VMAT & Sphericity>0.5**
  - VMAT & Sphericity<0.5

- No confounding variables were identified after this stratification

- **The only significant predictor of DM was D_{mean} in the 3cm margin around PTV**
  - **Optimal cut-point 19.4 Gy (BED)**



Conclusions

- Conflicting conclusions in previous studies - inconsistent datasets and insufficiently considered confounding variables.
- There is no clear correlation between the risk of DM and dose outside the PTV.
- The probability of DM decreases for higher doses outside the PTV in small spherical tumors treated with VMAT.
- This might imply larger PTV margins for smaller tumors.
  - e.g., if IGTV > 2 cm, then margin ≤ 7 mm, else margin>7 mm
  - Verification on an independent dataset is needed.

Děkuji za pozornost.