Novel Discoveries Using the NCI's Cancer Imaging Archive (TCIA) Public Data Sets

Head and Neck Squamous Cell Carcinoma (HNSCC)

THE UNIVERSITY OF TEXAS
MD Anderson
~~Cancer~~ Center

CANCER
IMAGING ARCHIVE

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OHSU
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- Have your badge scanned outside the course room & pick up the handout
- Scan the QR code or type in the URL to access the SAM test questions
- All SAM questions must be answered *during the live session*
- Attendees *also need to evaluate and finalize* all course CME credit claims via Credit Eval (access via the RSNA 2018 app or via Meeting Central online) or by contacting eval@rsna.org after Credit Eval closes.
- All SAM credit from the RSNA 2018 Annual Meeting will be able to be claimed until June 1, 2019.
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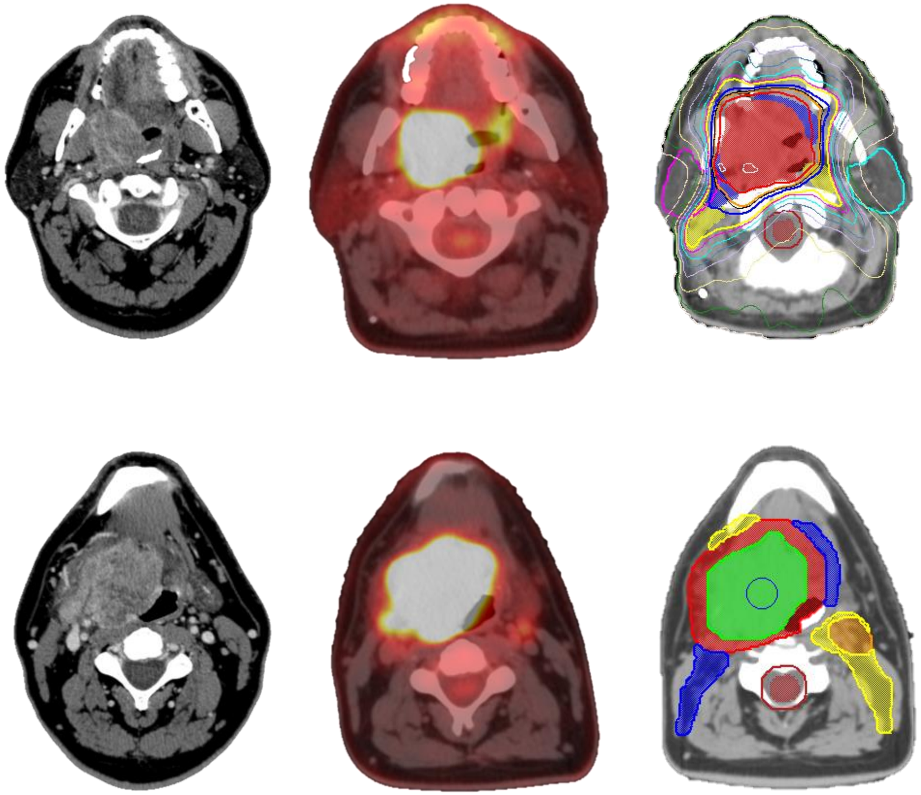
Overview

- Description of dataset
- Challenges and approaches
- CT-based body composition assessment
- Novel discoveries using this data set
- Future research opportunities



HNSCC Collection

Diagnostic, Treatment Planning, and Follow up imaging for Head and Neck Squamous Cell Carcinoma Patients Treated with Radiotherapy

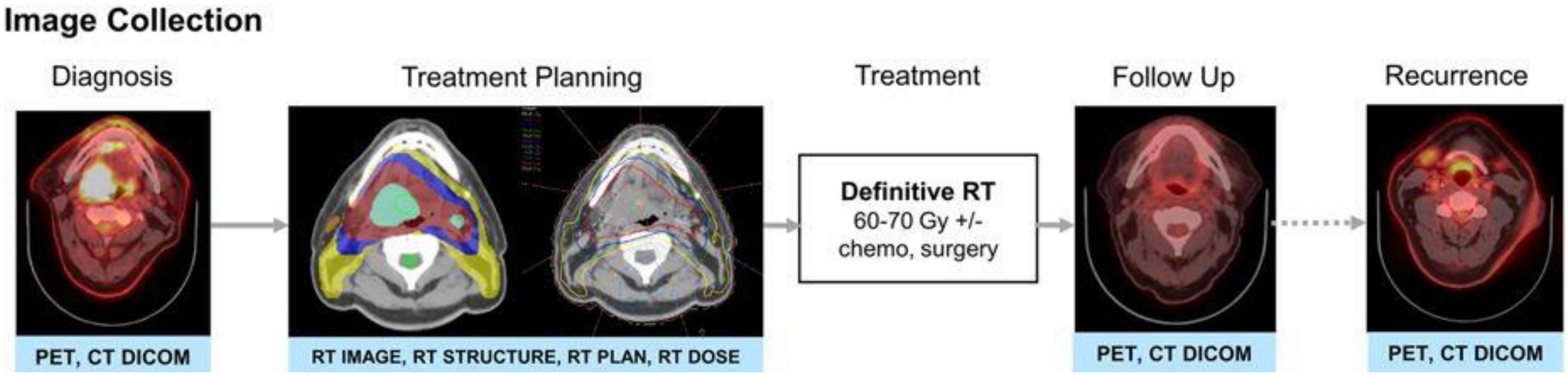


Image Collection
Diagnosis
Treatment Planning
Treatment
Follow Up
Recurrence
PET, CT DICOM
RT IMAGE, RT STRUCTURE, RT PLAN, RT DOSE
Definitive RT
60-70 Gy +/-
chemo, surgery
PET, CT DICOM
PET, CT DICOM

- **215 pts treated for HNSCC at MD Anderson between 2003-2011**
- **Stage I-IVB (TX, T1-4, N0-3, M0)**
- **Median follow up: 69.6 mo. (IQR 41.8-88.1 mo)**
- **Skull-to-thigh non-contrast anonymized CT scans extracted from routine diagnostic and follow up PET/CT scans**
- **RT image, RT structure, RT plan, and RT dose exported from Pinnacle^3 TPS**

Grossberg *Sci Data* 2018

HNSCC Collection

Diagnostic, Treatment Planning, and Follow up imaging for Head and Neck Squamous Cell Carcinoma Patients Treated with Radiotherapy

Goals

- **Establish public repository of fully anonymized and registered head and neck radiotherapy diagnostic and treatment data**
- **Investigate influence of anthropometrics and body composition on outcome in head and neck cancer**

Challenges

- **Anonymization of DICOM from multiple sources (i.e. treatment planning software)**
- **Registration of many layers of DICOM-RT data**
- **Identifying and Accounting for Missing Data**
- **Database management and culling of duplicates**

HNSCC Collection

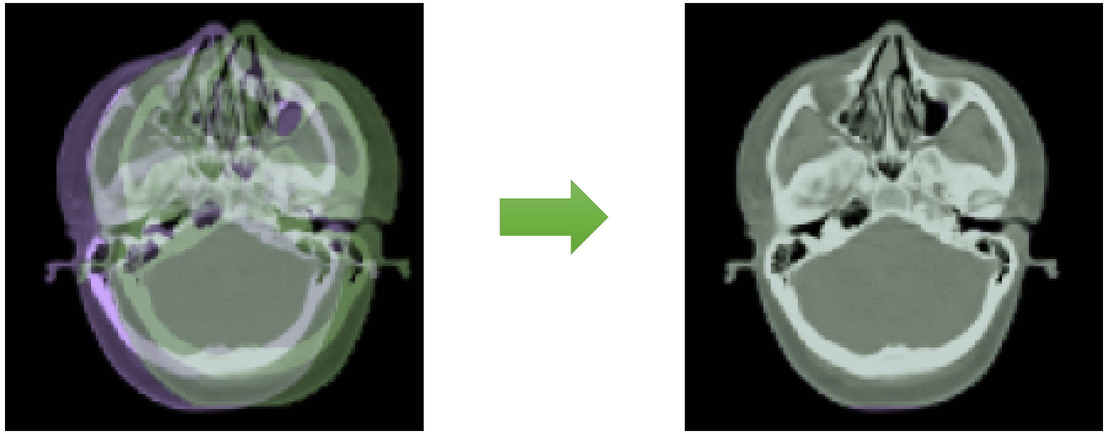
Diagnostic, Treatment Planning, and Follow up imaging for Head and Neck Squamous Cell Carcinoma Patients Treated with Radiotherapy

Approaches

- Anonymization
  - RSNA Clinical Trial Processor
  - Tag Sniffer
  - Manual Review
- Posda Tools
  - ID Errors & inconsistencies (incorrect field entry or number of entries)
  - Delete Duplicates
  - Verify registration
  - Extract Results

    195 of 215 pts had errors

    3.17 revisions/pt (range 2-6)

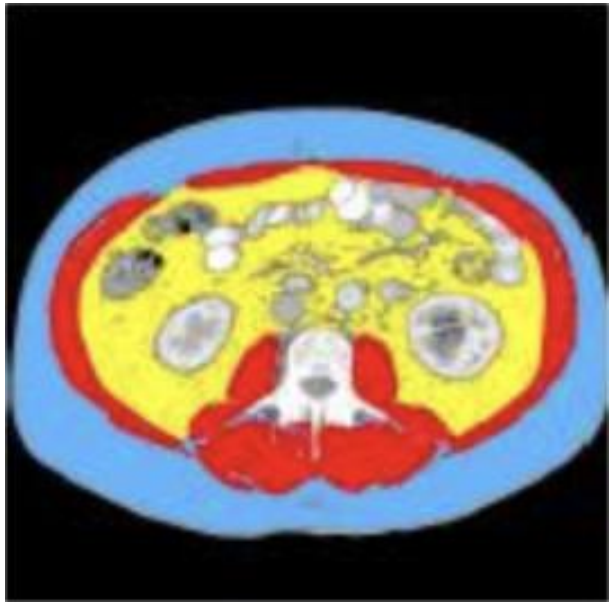


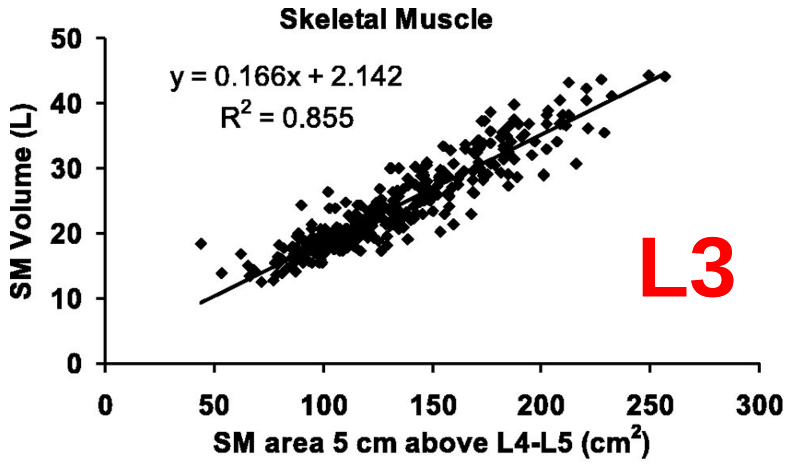
Imaging assessment of body composition

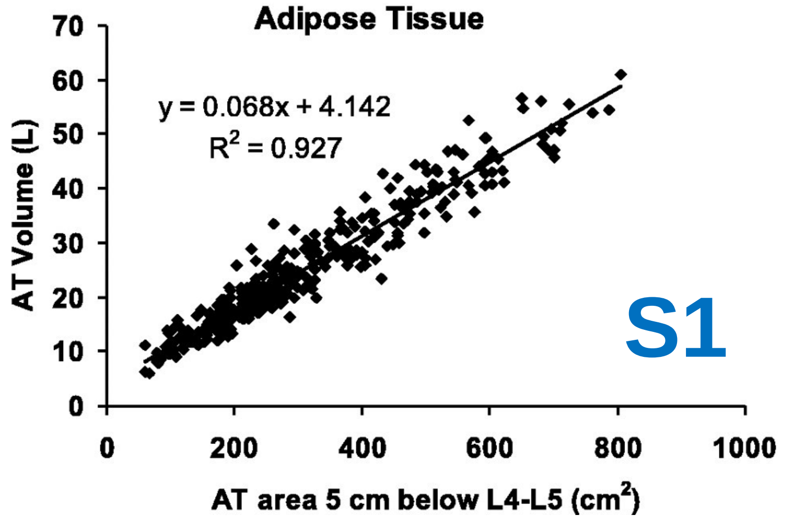
Cross sectional area

Skeletal muscle/lean mass
single axial slice at **L3**
(5 cm above L4/L5)

Adipose tissue
axial slice at **S1**
(5 cm below L4/L5)





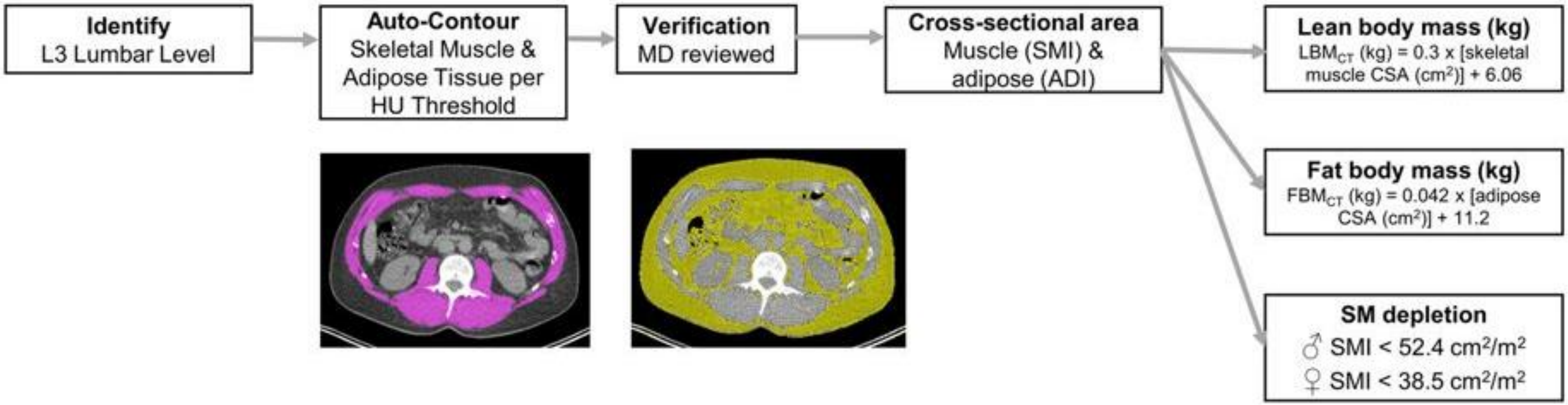


Shen *J Appl Physiol* 2004

HNSCC Collection

Diagnostic, Treatment Planning, and Follow up imaging for Head and Neck Squamous Cell Carcinoma Patients Treated with Radiotherapy

Calculate Body Composition



Identify
L3 Lumbar Level

Auto-Contour
Skeletal Muscle & Adipose Tissue per HU Threshold

Verification
MD reviewed

Cross-sectional area
Muscle (SMI) & adipose (ADI)

Lean body mass (kg)
LBM_{CT} (kg) = 0.3 x [skeletal muscle CSA (cm^2)] + 6.06

Fat body mass (kg)
FBM_{CT} (kg) = 0.042 x [adipose CSA (cm^2)] + 11.2

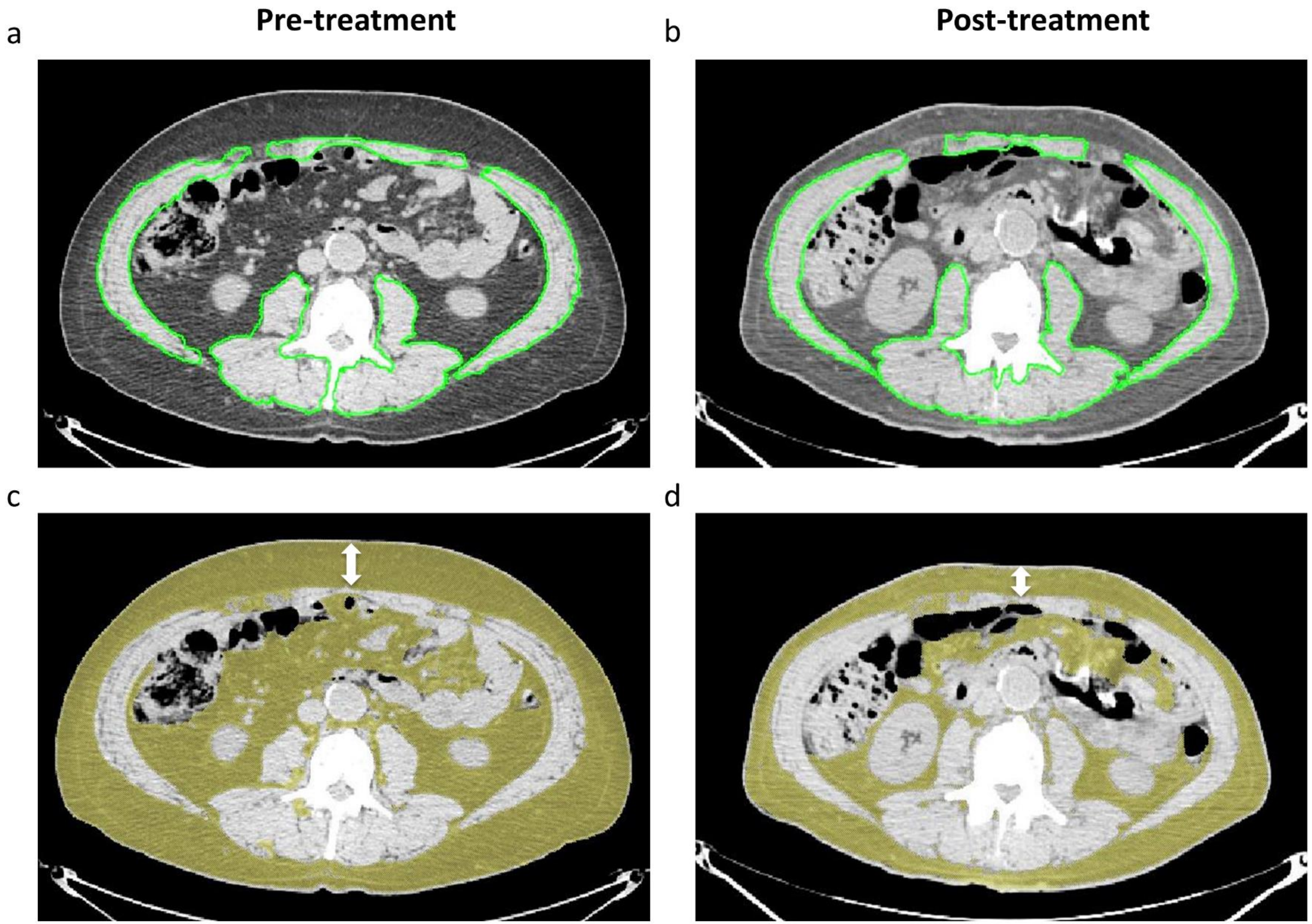
SM depletion
♂ SMI < 52.4 cm^2/m^2
♀ SMI < 38.5 cm^2/m^2

Grossberg *Sci Data* 2018

Weight loss vs muscle loss

Weight-based metrics *do not* reliably predict underlying body composition

Skeletal muscle mass normally preserved, except in conditions of cachexia or critical undernutrition

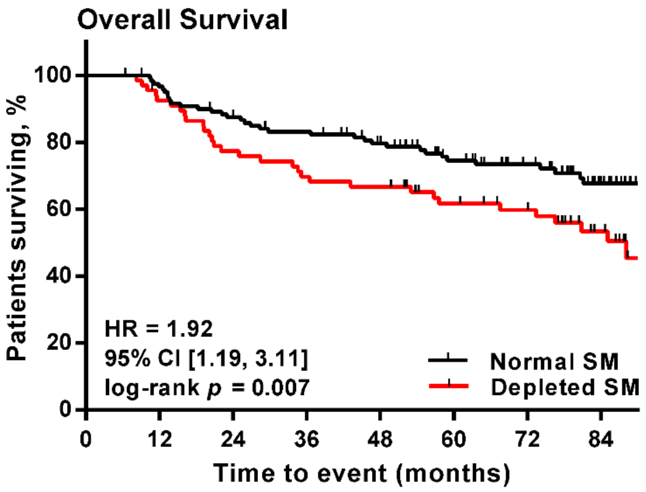

a
Pre-treatment
b
Post-treatment
c
d

Chamchod *Oral Oncol*. 2016

Depleted Skeletal Muscle Mass in HNC

OS, DSS, and LRC in 190 pts treated at MDACC 2003-2013

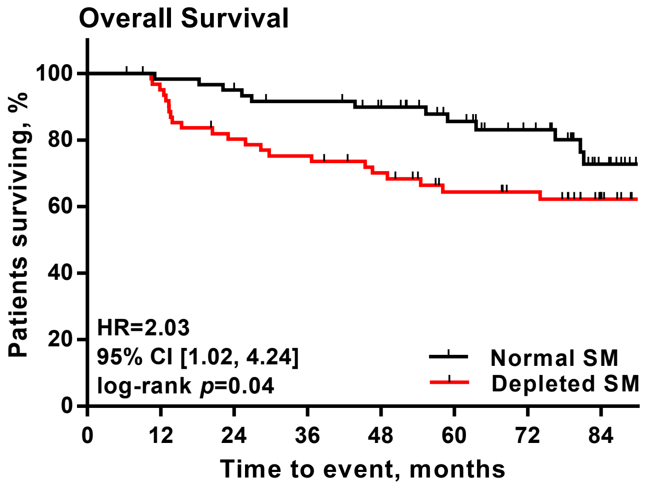
Pre-RT


Overall Survival

HR = 1.92
95% CI [1.19, 3.11]
log-rank *p* = 0.007

Number at risk								
Normal SM	123	118	105	98	88	70	60	32
Depleted SM	67	62	52	46	45	37	32	18

Post-RT


Overall Survival

HR=2.03
95% CI [1.02, 4.24]
log-rank *p*=0.04

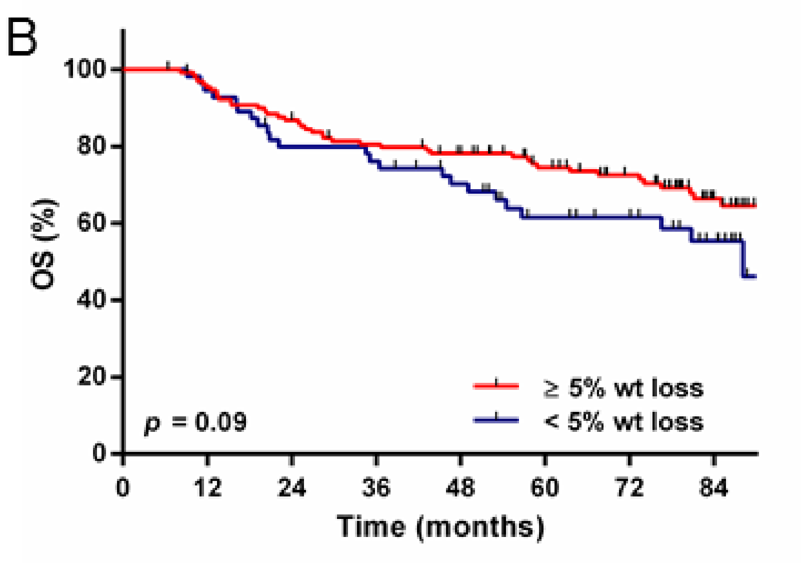
Number at risk								
Normal SM	62	60	58	54	49	39	31	16
Depleted SM	61	59	49	46	41	33	30	20

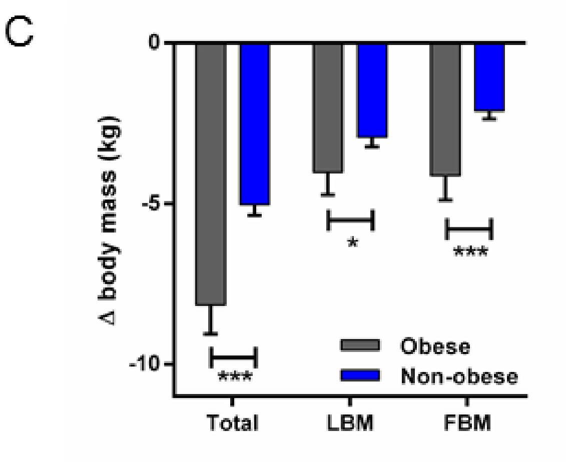
Skeletal muscle mass (pre- or post-RT) was prognostic for survival, independent of other known risk factors.

Better defined mortality risk than stage, smoking history, HPV status.

Grossberg *JAMA Oncol.* 2016

Weight Loss not prognostic

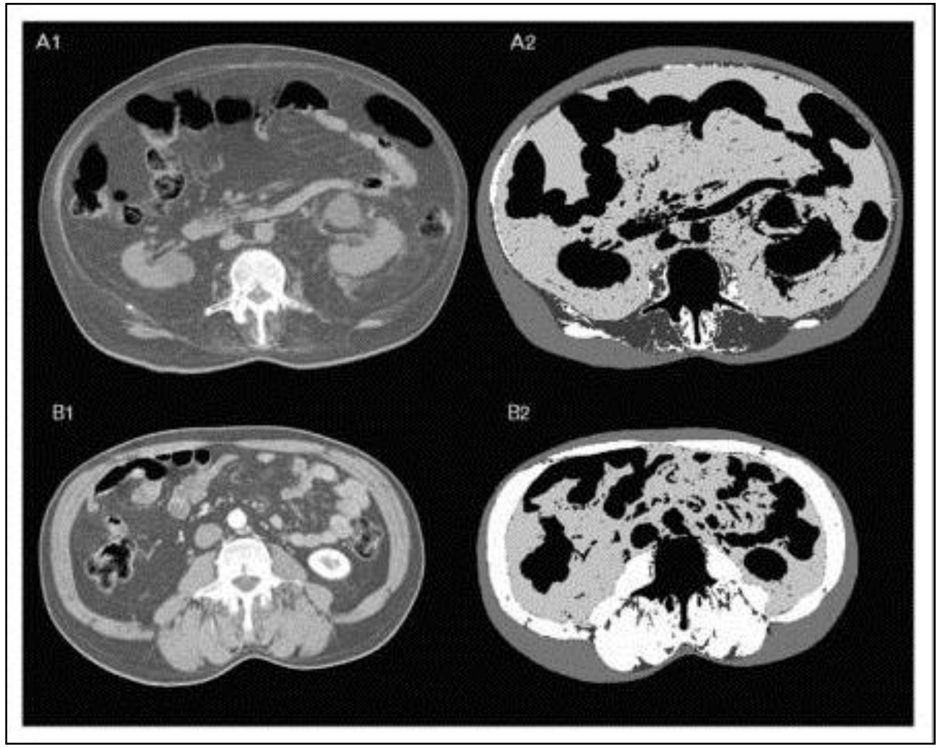




Grossberg *JAMA Oncol.* 2016

Obese patients lost significantly more weight, whereas patients with skeletal muscle depletion preserved their body weight

Lumbar cross-sectional images of two cancer patients with identical BMI of 24.3 kg/m2



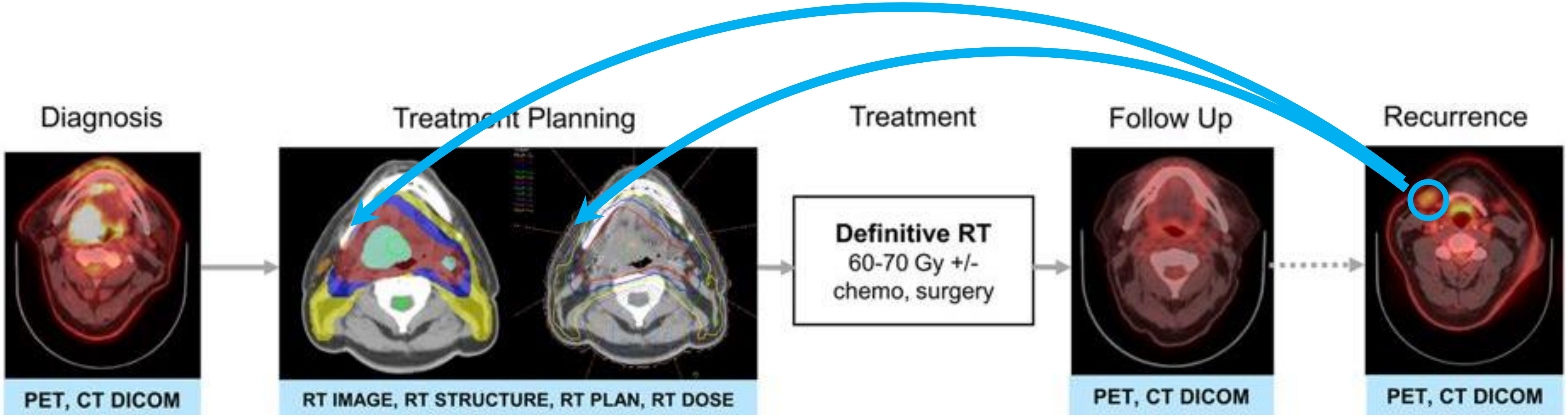
Prado *Current Opinion in Supp & Palliative Care* 2009

HNSCC COLLECTION

DIAGNOSTIC, TREATMENT PLANNING, AND FOLLOW UP IMAGING FOR HEAD AND NECK SQUAMOUS CELL CARCINOMA PATIENTS TREATED WITH RADIOTHERAPY

RESEARCH APPLICATIONS

- **RADIOTHERAPY AND OUTCOME**
  - **INFLUENCE OF INDIVIDUAL TREATMENT DESIGN AND DELIVERY ON ONCOLOGIC AND FUNCTIONAL OUTCOMES**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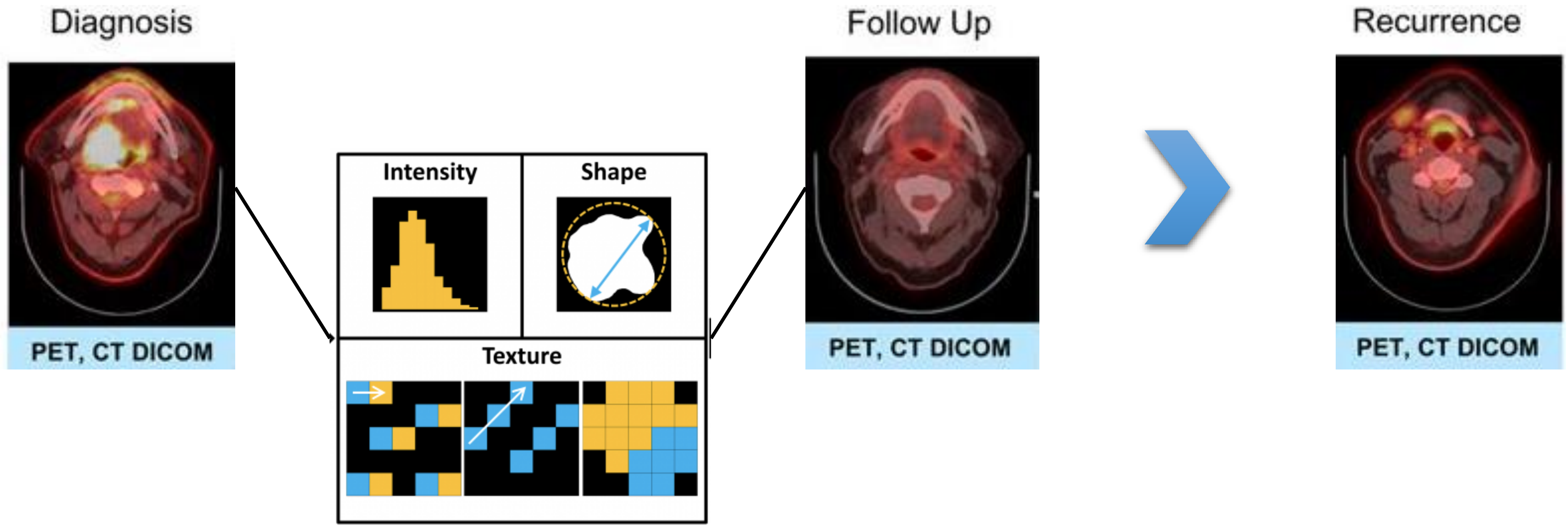
Research Applications

- Radiomics
  - Pre- and post-treatment radiomics signatures


Diagnosis
PET, CT DICOM
Intensity
Shape
Texture
Follow Up
PET, CT DICOM
Recurrence
PET, CT DICOM

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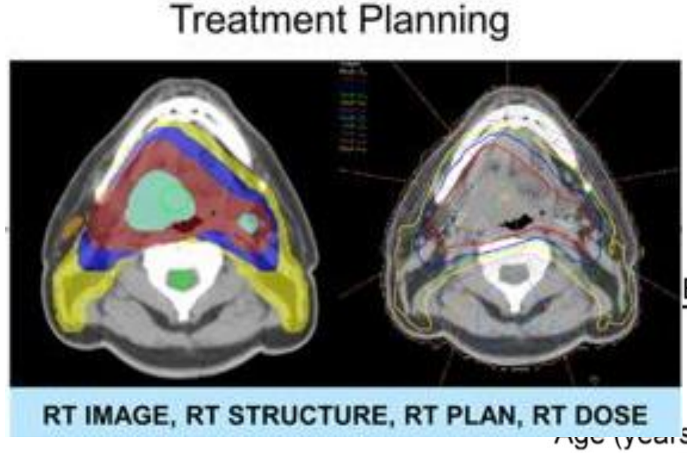
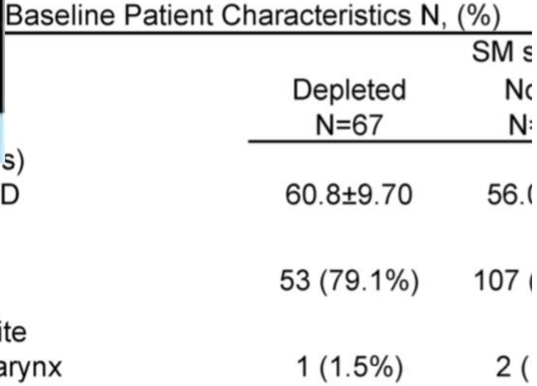
Research Applications

- **Interaction between individuals' treatment factors, risk factors, and physiologic reserve**

Treatment Planning

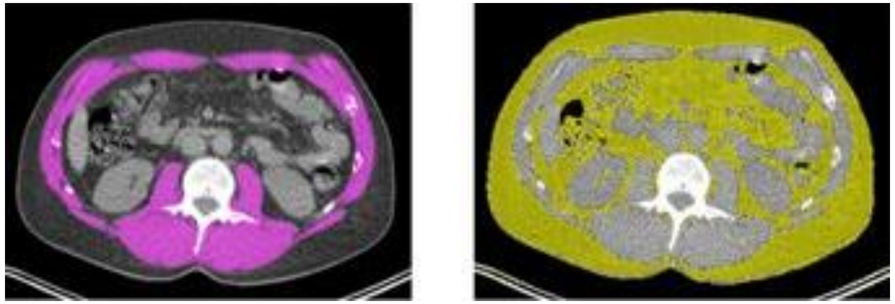


RT IMAGE, RT STRUCTURE, RT PLAN, RT DOSE



Baseline Patient Characteristics N, (%)

		SM s
	Depleted N=67	Nc N
Age (years)		
Mean±SD	60.8±9.70	56.
Sex		
Male	53 (79.1%)	107
Cancer Site		
Nasopharynx	1 (1.5%)	2 (



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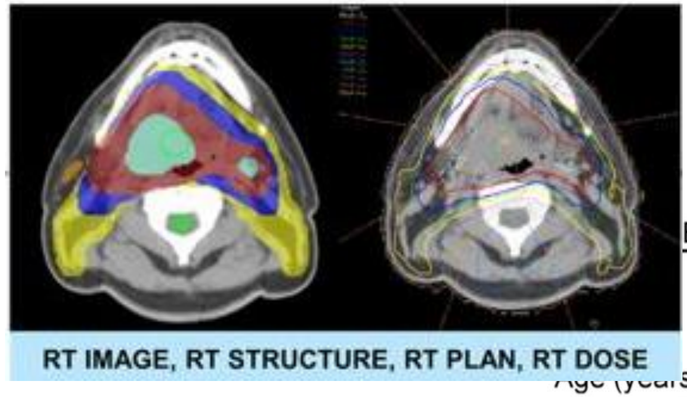
DIAGNOSTIC, TREATMENT PLANNING, AND FOLLOW UP IMAGING FOR HEAD AND NECK
SQUAMOUS CELL CARCINOMA PATIENTS TREATED WITH RADIOTHERAPY

RESEARCH APPLICATIONS

- INTERACTION BETWEEN INDIVIDUALS' TREATMENT FACTORS, RISK FACTORS, AND PHYSIOLOGIC RESERVE

Treatment Planning



RT IMAGE, RT STRUCTURE, RT PLAN, RT DOSE

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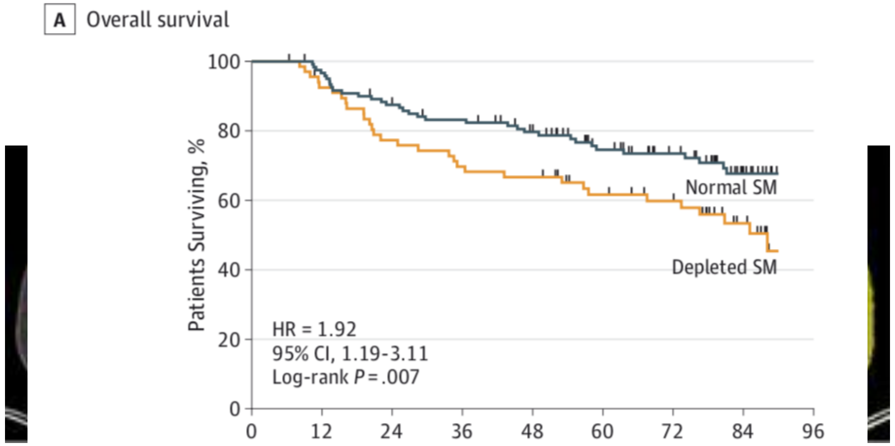

No. at risk

With normal SM	123	118	105	98	88	70	60	32
With depleted SM	67	62	52	46	45	37	32	18

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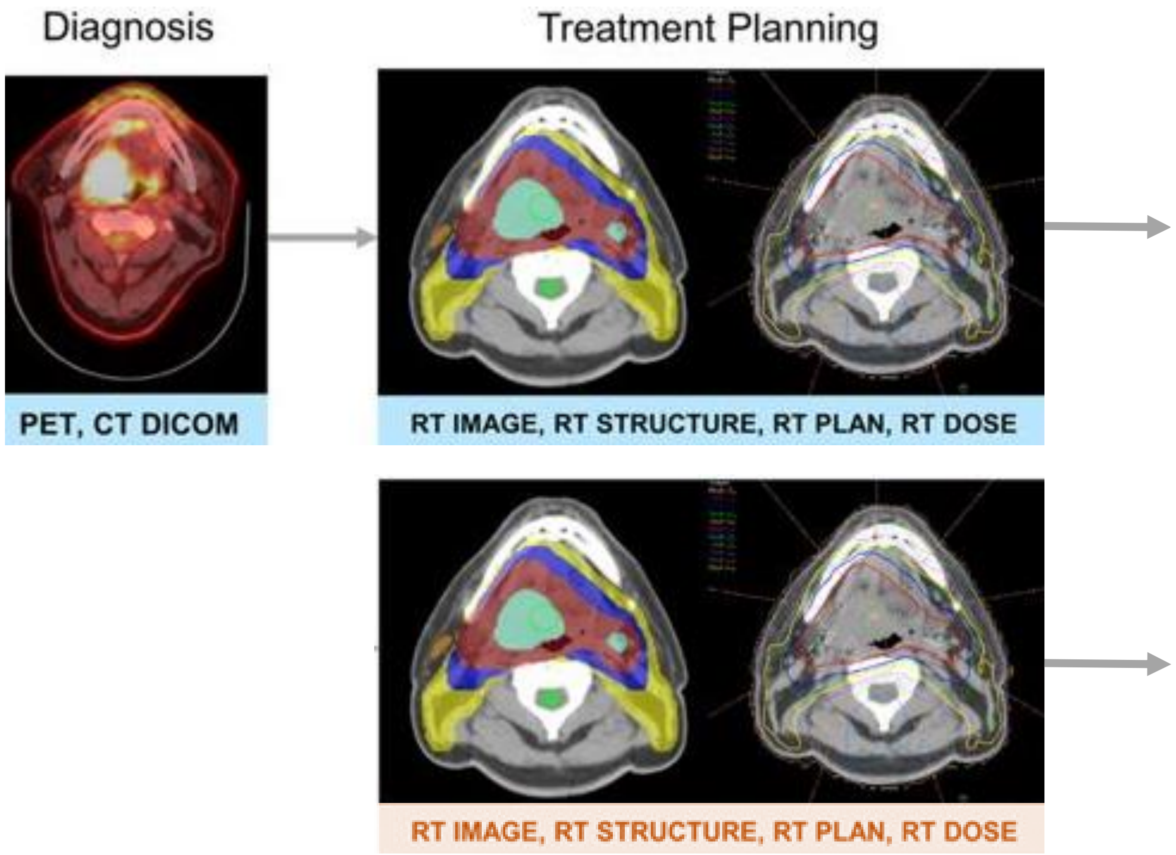
DIAGNOSTIC, TREATMENT PLANNING, AND FOLLOW UP IMAGING FOR HEAD AND NECK SQUAMOUS CELL CARCINOMA PATIENTS TREATED WITH RADIOTHERAPY

RESEARCH APPLICATIONS

- **VALIDATION DATA SET FOR DOSIMETRIC ANALYSES OF H&N CANCER RADIOTHERAPY**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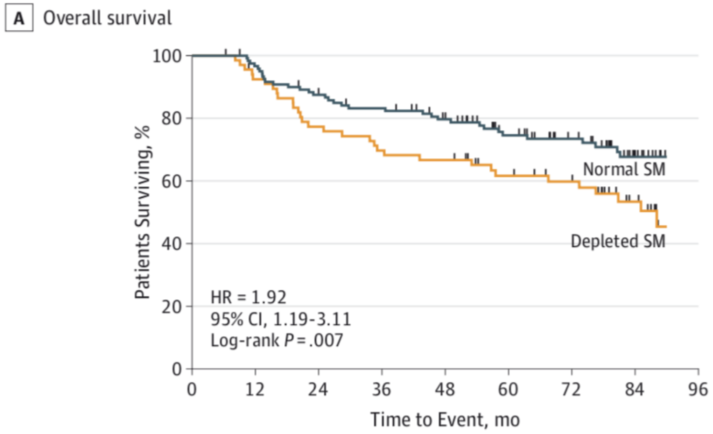

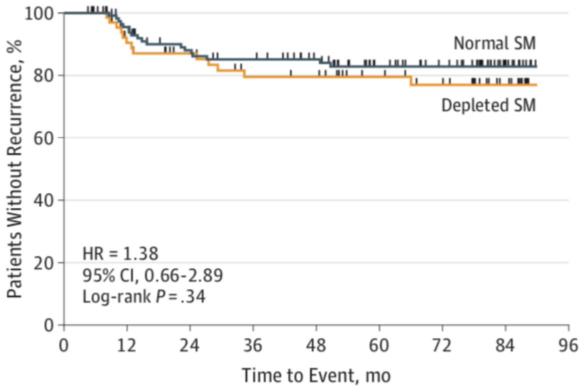

Acknowledgements

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