

SBRT TEKNİĞİNİN TEMEL ÖZELLİKLERİ VE KULLANIM ALANLARI

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Medikal Fizik Uzmanı



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Daha ileriye... En İyiyeye...



**2. Uluslararası Katılımlı Radyoterapi Kongresi ve
Eğitim Seminerleri: 21-24 Nisan 2019, Antalya**

İÇERİK

- TANIM VE TEMEL ÖZELLİKLER
- SBRT UYGULAMA AŞAMALARI VE KULLANIM ALANLARI
- GÜNCEL GELİŞMELER
- ÖZET



TANIM VE TEMEL ÖZELLİKLER

Stereotaktik Beden Radyoterapisi (SBRT)-ACR/ASTRO

*Ekstrakranial hedeflere **YÜKSEK** doz radyasyonun **YÜKSEK** doğruluk ve isabetle uygulandığı bir radyoterapi metodudur.*

SBRT İÇİN GEREKLİLİKLER NELERDİR?

Revised 2011 (CSC/BOC)*

ACR-ASTRO PRACTICE GUIDELINE FOR THE PERFORMANCE OF
STEREOTACTIC RADIOSURGERY

Revised 2009 (Resolution 4)*

ACR-ASTRO PRACTICE GUIDELINE FOR THE PERFORMANCE OF
STEREOTACTIC BODY RADIATION THERAPY

Stereotactic body radiation therapy: The report of AAPM Task Group 101

Stanley H. Benedict, Chairman*
University of Virginia Health System, Charlottesville, Virginia 22908

Quality and Safety Considerations in Stereotactic
Radiosurgery and Stereotactic Body Radiation Therapy

SABR: A Resource

ACR 2006

ACR 2009

AAPM 2010

ASTRO 2011

 2014

AAPM TG 42 1995 – SRS
AAPM TG 142 2009 – Linac QA

AAPM TG 76 2006 – Respiratory Motion
IPEM Report 103 2010 – Small Field Photon Dosimetry

TANIM VE TEMEL ÖZELLİKLER

- **Yüksek hassasiyet**

Target ve radyasyon kaynağının uyumunda yüksek tekrarlanabilirlik

- **Yüksek doğruluk (<1mm)**

Planlanan pozisyonun 1mm içinde doğrulukla verilmesi

TANIM VE TEMEL ÖZELLİKLER



KONVANSİYONEL
YÖNTEMLER



ÇÖZÜM:
PTV EMNİYETİNİ
ARTTIRMAK



SBRT



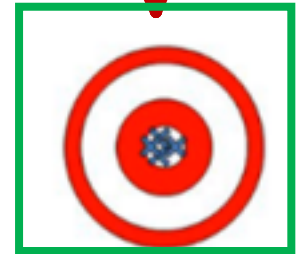
Not Accurate, not Precise



Accurate, not Precise

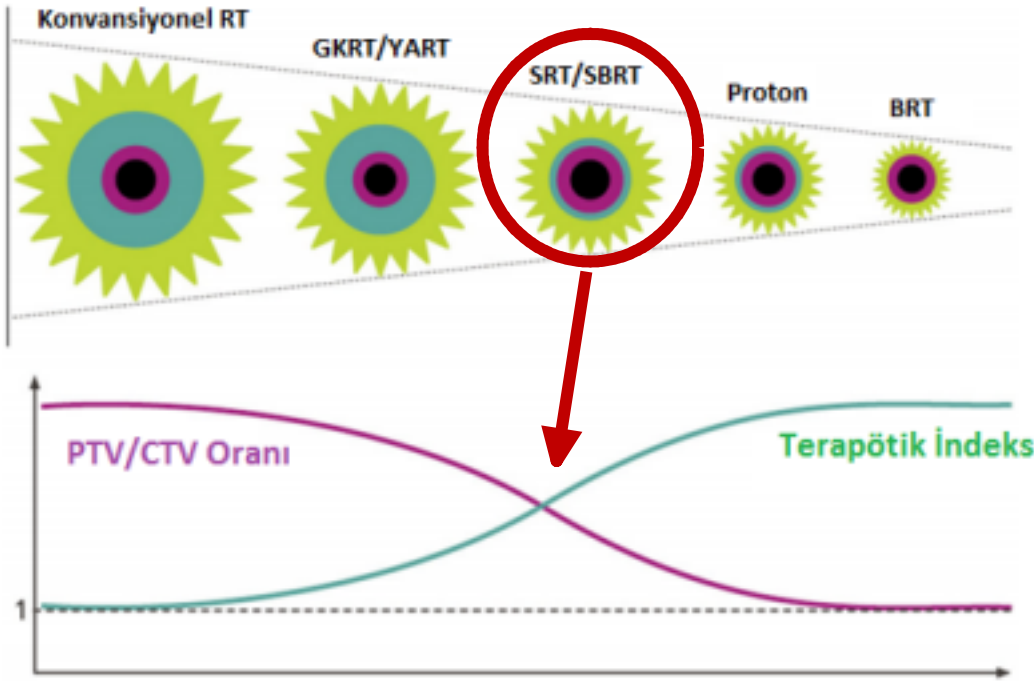


Precise, not Accurate



Precise, Accurate

TANIM VE TEMEL ÖZELLİKLER



TANIM VE TEMEL ÖZELLİKLER

KÜRESEL BİR KLİNİK HEDEF HACİM (CTV);

- ÇAP: 30 mm

- $V = \frac{4}{3}\pi r^3$

PTV EMNİYETİ:

-0 mm Emniyet

$$V \approx 15 \text{ cm}^3$$

-5 mm Emniyet

$$V \approx 30 \text{ cm}^3$$

2 X

-10 mm Emniyet

$$V \approx 60 \text{ cm}^3$$

4 X



TANIM VE TEMEL ÖZELLİKLER

- Yüksek doz konformalitesi
- Target dışında radyasyon dozunda hızlı düşüş

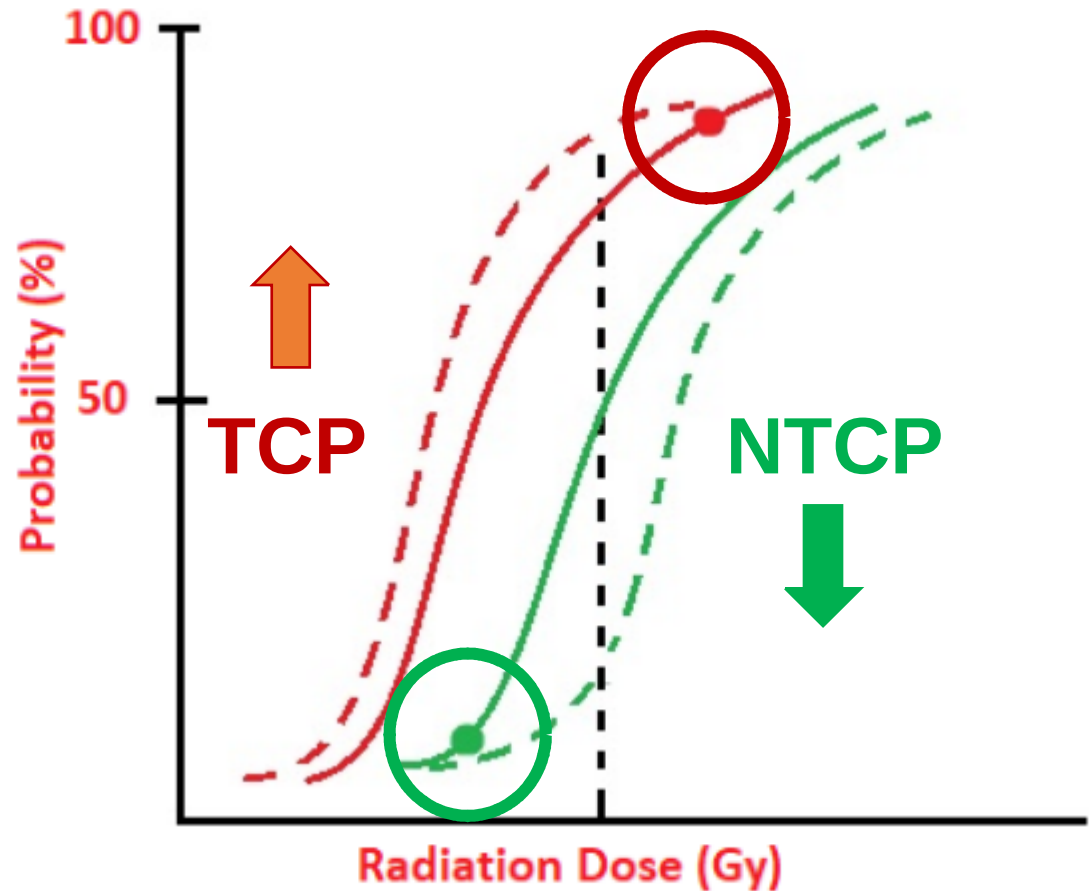
Target dışındaki normal dokularda dozun minimize edilmesi

DAHA YÜKSEK EŞDEĞER DOZ



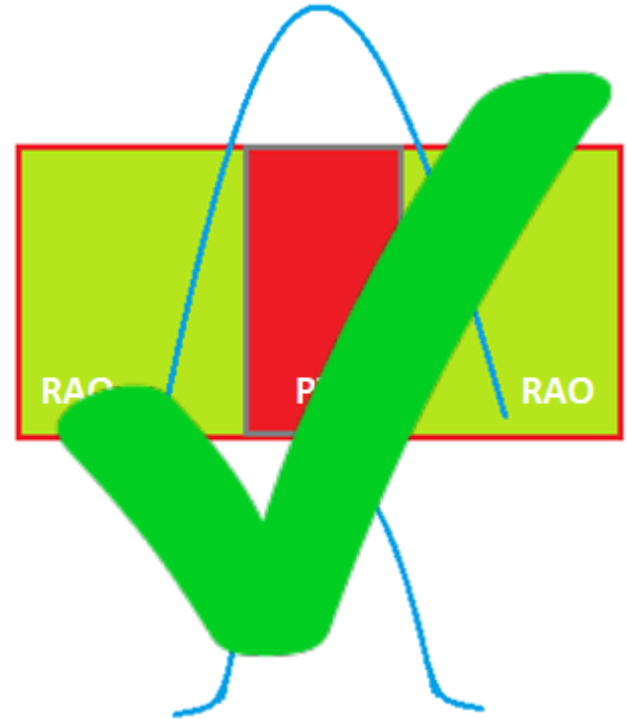
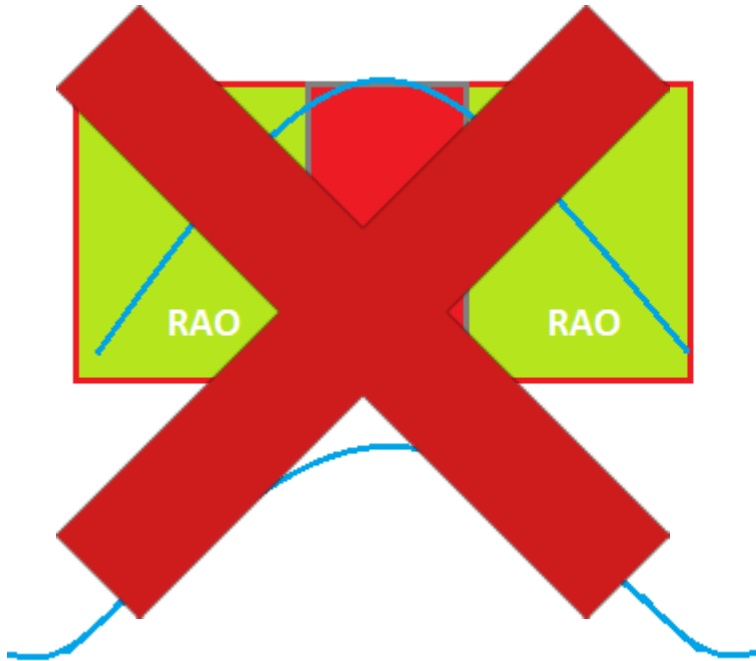
TANIM VE TEMEL ÖZELLİKLER

TCP/NTCP



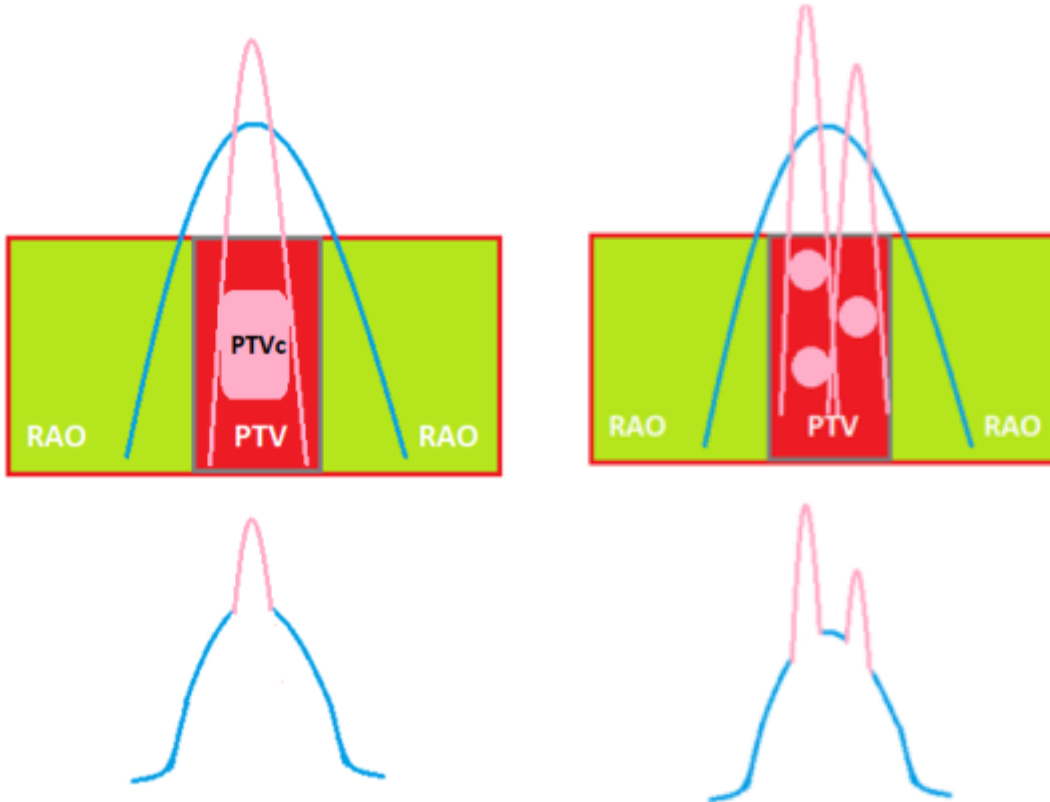
TANIM VE TEMEL ÖZELLİKLER

- DOZ DAĞILIMI NASIL OLMALI? HOMOJEN, HETEROJEN



TANIM VE TEMEL ÖZELLİKLER

TÜMÖR İÇİN (TCP): DOZ ARTTIRIMI NASIL YAPILABİLİR?



?

?

?



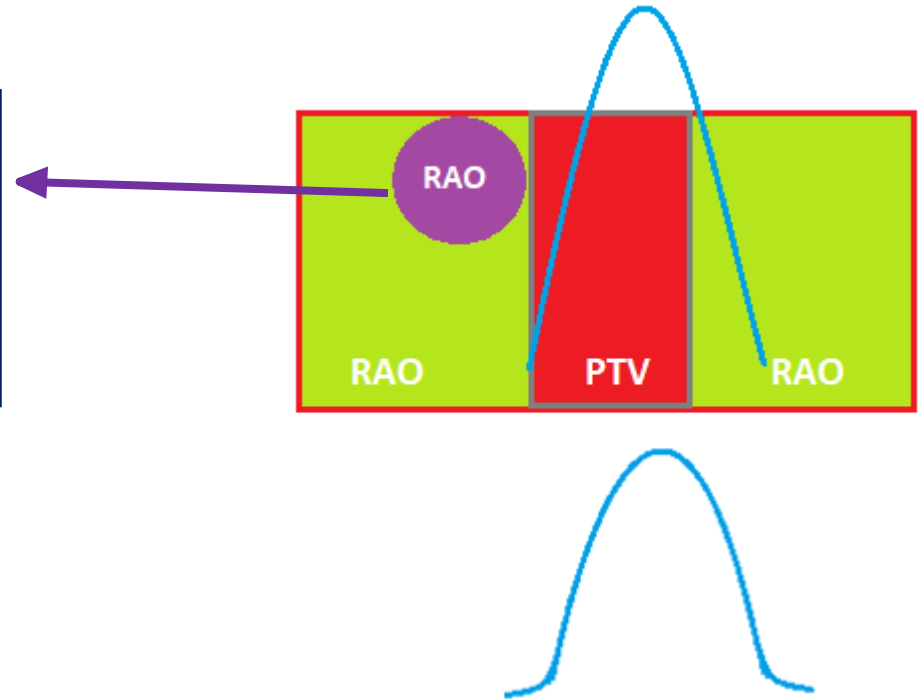
TANIM VE TEMEL ÖZELLİKLER

KRİTİK ORGAN İÇİN (NTCP): MİNİMUM DOZ NASIL SAĞLANIR?

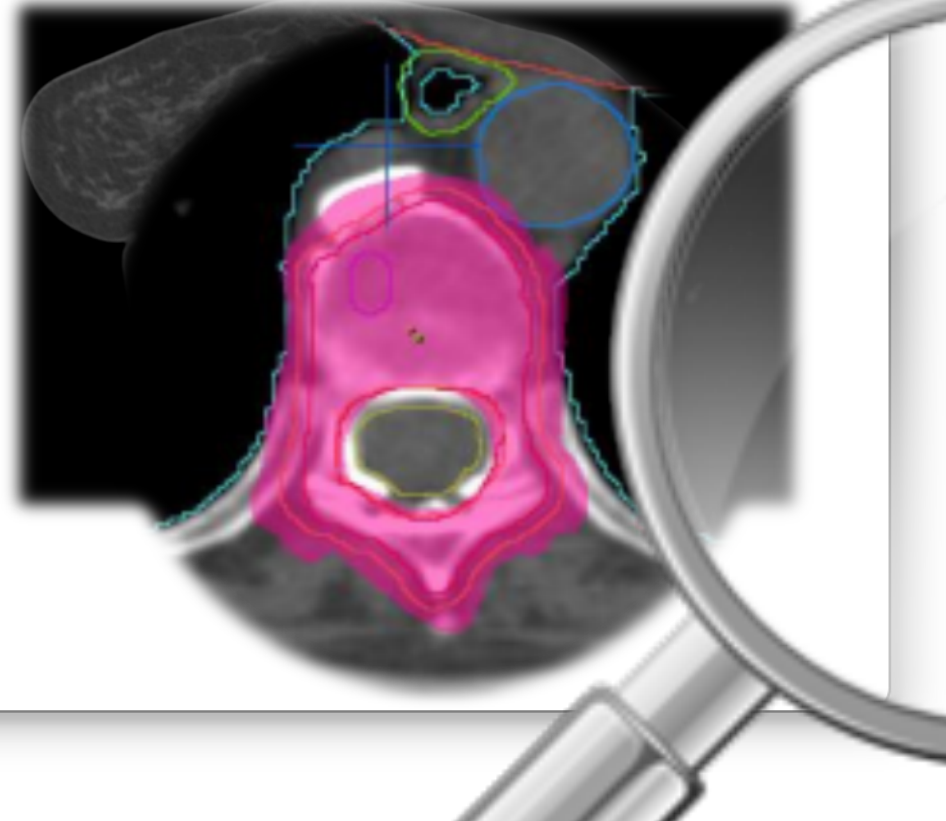
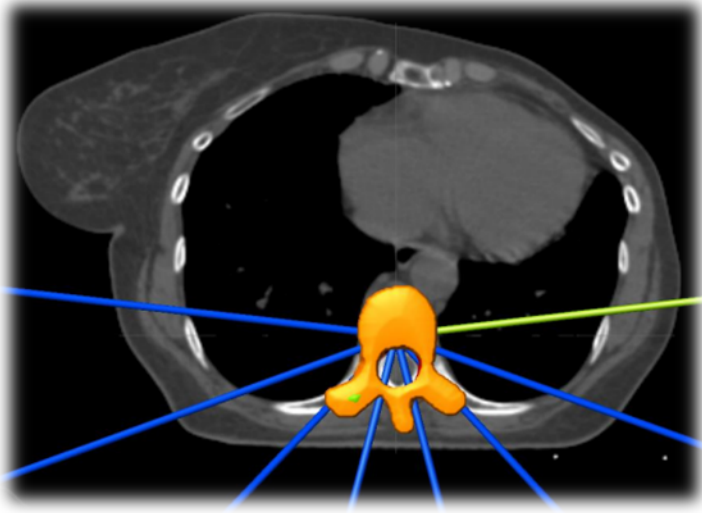
ÖNCELİK NE OLMALI ?

a.) HEDEF KAPSAMASI

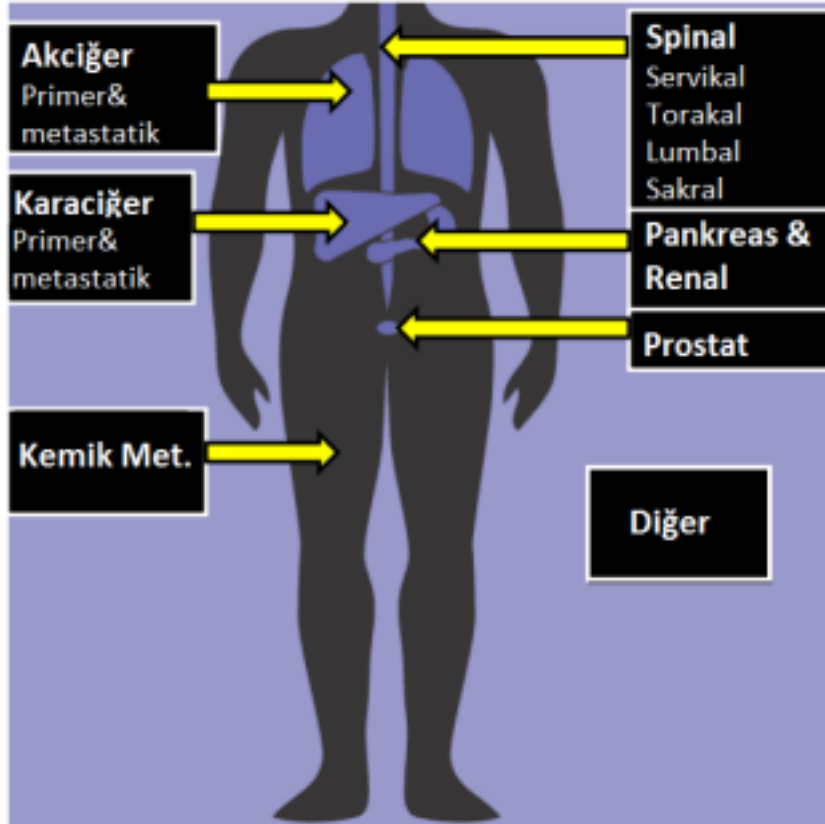
b.) KRİTİK ORGAN KORUMASI



SBRT UYGULAMA AŞAMALARI VE KULLANIM ALANLARI



SBRT UYGULAMA AŞAMALARI VE KULLANIM ALANLARI



SBRT UYGULAMA AŞAMALARI VE KULLANIM ALANLARI

- **İMMOBİLİZASYON**
- **SİMÜLASYON**
- **TEDAVİ PLANLAMA**
- **TEDAVİ**

SBRT UYGULAMA AŞAMALARI VE KULLANIM ALANLARI

İMMOBİLİZASYON



BodyFix by Medical
Intelligence



Body Pro-Lok
by CIVCO



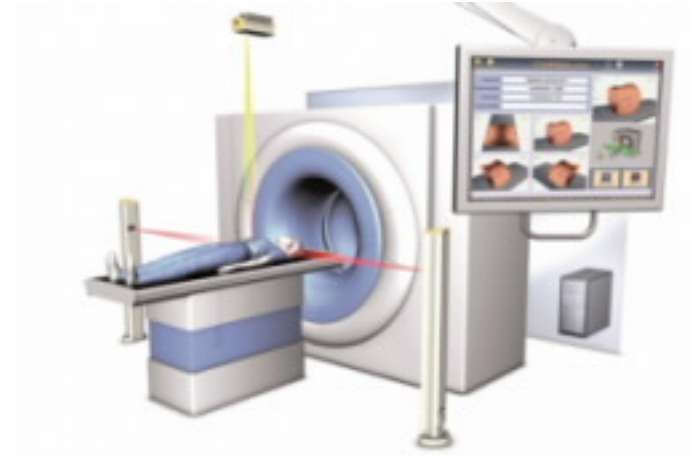
Stradivarius by
Q Fix



SBRT UYGULAMA AŞAMALARI VE KULLANIM ALANLARI

SİMÜLASYON

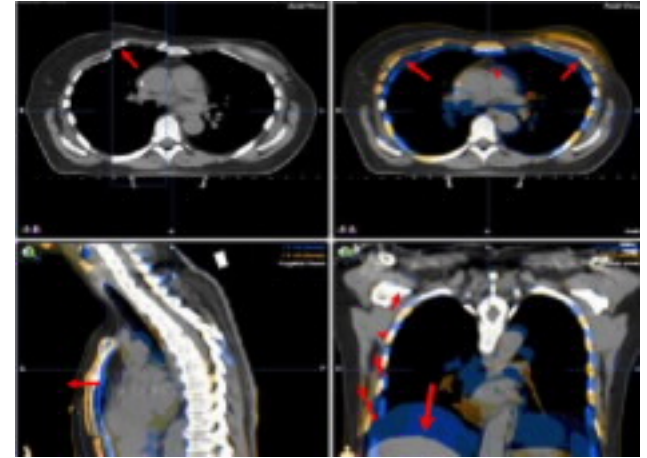
- Tekrarlanabilir Setup Pozisyonu
- Uygun BT Çekim Protokolü
(Kesit Kalınlığı SBRT: 1-3 mm)



SBRT UYGULAMA AŞAMALARI VE KULLANIM ALANLARI

SİMÜLASYON- SOLUNUM HAREKETİ

- YAVAŞ CT
- INHALE/EXHALE POZİSYONUNDA CT
- 4D CT

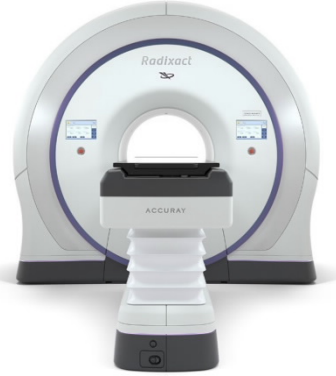


SBRT UYGULAMA AŞAMALARI VE KULLANIM ALANLARI

TEDAVİ PLANLAMA

- CİHAZ (C-ARM, ROBOTIC, RING-MOUNTED, GAMMA KNIFE, ...)
- KON VEYA MLC TABANLI (≤ 5 mm)
- GKRT (2D, 3D, 4D)
- ENERJİ SEÇİMİ (FF VE FFF); DOZ GRADİENT $\geq 5\%/mm$
- TEDAVİ MODALİTE SEÇENEĞİ (3D-CRT, IMRT, VMAT)
- DEMET YÖNELİMİ (COPLANAR VE NON-COPLANAR (4π , DTRT,...))
- KÜÇÜK ALAN DOZİMETRESİ (BEAM DATA VE QA)
- TPS ALGORİTMASI
-

SBRT UYGULAMA AŞAMALARI VE KULLANIM ALANLARI



SBRT UYGULAMA AŞAMALARI VE KULLANIM ALANLARI

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- TPS ALGORİTMASI
-

SBRT UYGULAMA AŞAMALARI VE KULLANIM ALANLARI

HAREKET YÖNETİMİ- (MOTION MANAGEMENT)

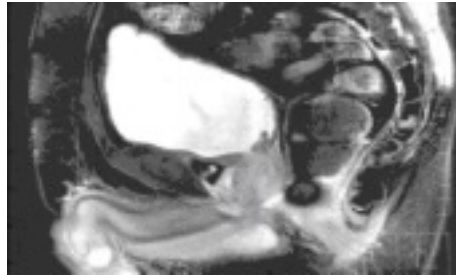
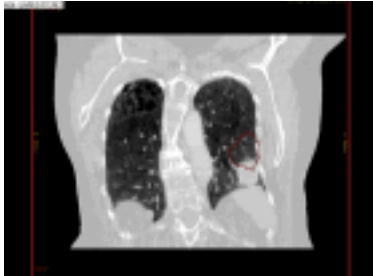
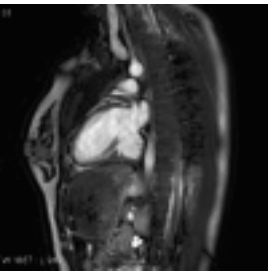
RADYOTERAPİ SIRASINDA HASTA/TÜMÖR HAREKETİNE BAĞLI BELİRSİZLİKLERİN TAMAMEN ORTADAN KALDIRILMASI VEYA AZALTILMASINA YÖNELİK KULLANILAN YÖNTEMLERİ KAPSAMAKTADIR.



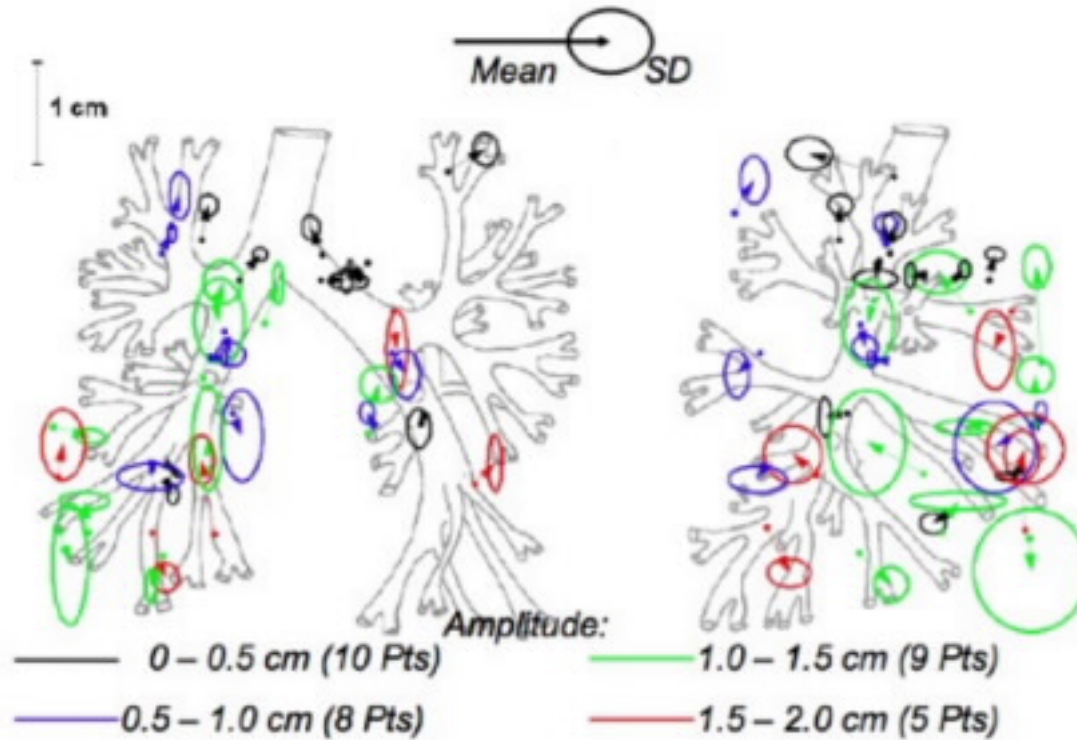
SBRT UYGULAMA AŞAMALARI VE KULLANIM ALANLARI

TÜMÖR HAREKETİNİN NEDENLERİ

- KALP ATIŞI
- SOLUNUM
- REKTUM VE MESANE DOLULUĞU



SBRT UYGULAMA AŞAMALARI VE KULLANIM ALANLARI

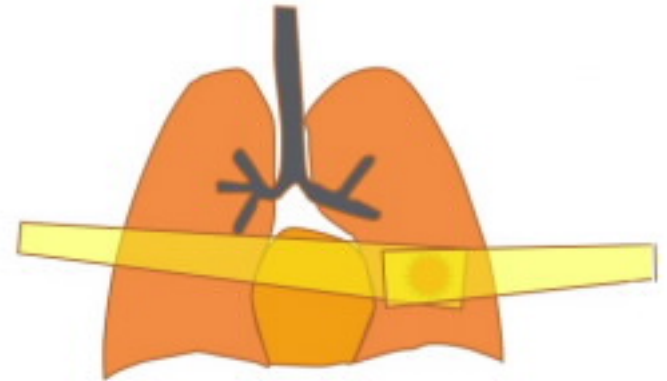
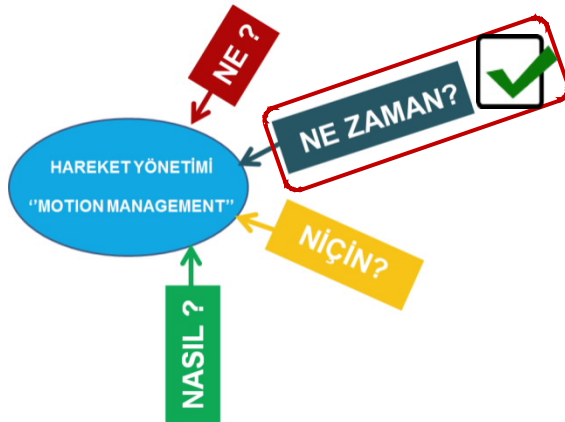


J-J Sonke et al, 2005

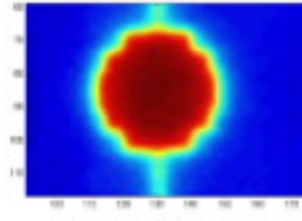
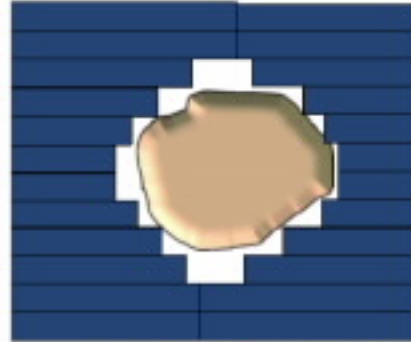
SBRT UYGULAMA AŞAMALARI VE KULLANIM ALANLARI

TÜMÖR HAREKETİ > 5 mm

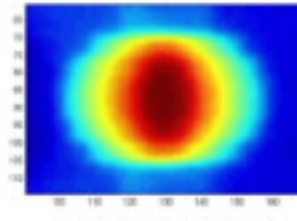
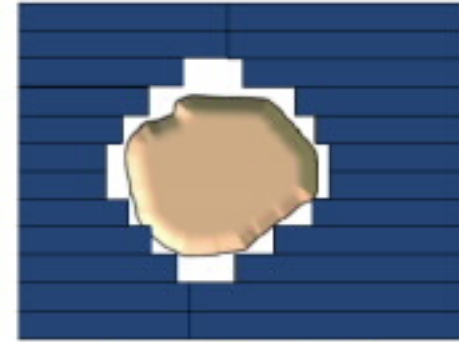
*P Keall et al Medical Physics 33(2006)
The management of respiratory motion in radiation
oncology report of AAPM Task Group 76*



SBRT UYGULAMA AŞAMALARI VE KULLANIM ALANLARI



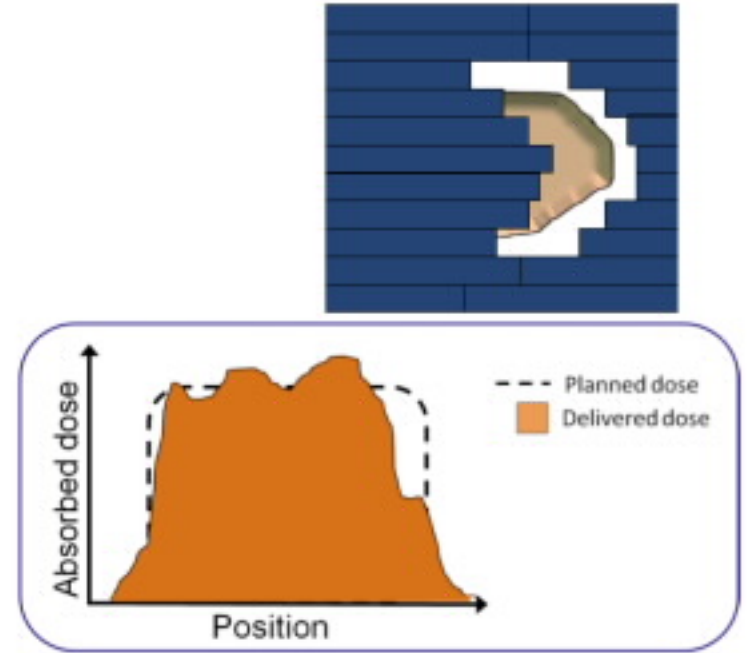
**STATİK İŞINLAMA
SABİT HEDEF**



**STATİK İŞINLAMA
HAREKETLİ HEDEF**

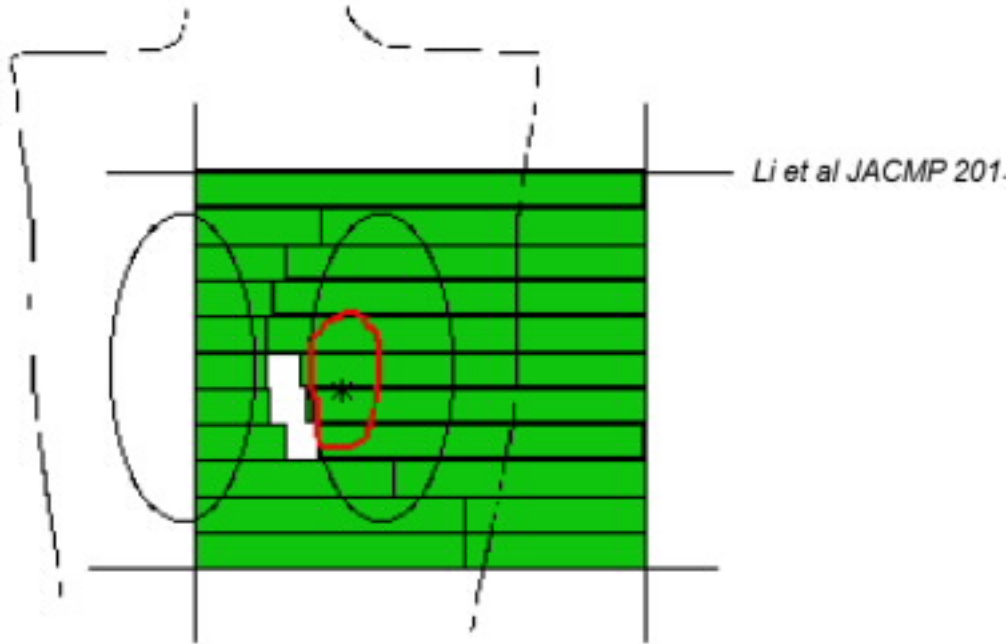
SBRT UYGULAMA AŞAMALARI VE KULLANIM ALANLARI

DİNAMİK İŞINLAMA + HAREKETLİ HEDEF



SBRT UYGULAMA AŞAMALARI VE KULLANIM ALANLARI

INTERPLAY EFFECT



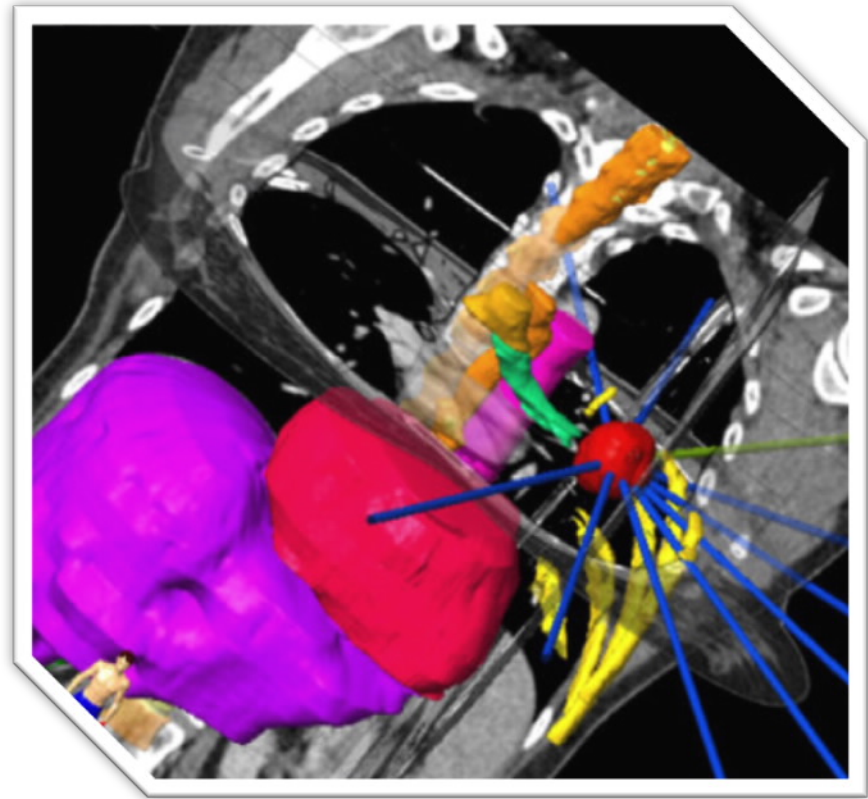
INTERPLAY EFFECT



**-TÜMÖR HAREKETİ
-DOZ GRADİENTİ**



SBRT UYGULAMA AŞAMALARI VE KULLANIM ALANLARI



SBRT UYGULAMA AŞAMALARI VE KULLANIM ALANLARI

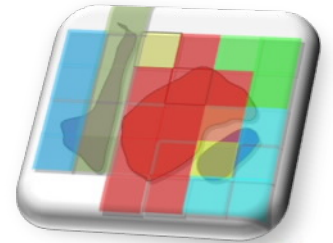
GÖRÜNTÜLEME

NEFES KONTROLÜ

ABDOMİNAL KOMPRESYON

GATING

TRACKING



SBRT UYGULAMA AŞAMALARI VE KULLANIM ALANLARI

Radiotherapy and Oncology 121 (2016) 19–25



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journal homepage: www.thegreenjournal.com



First in man

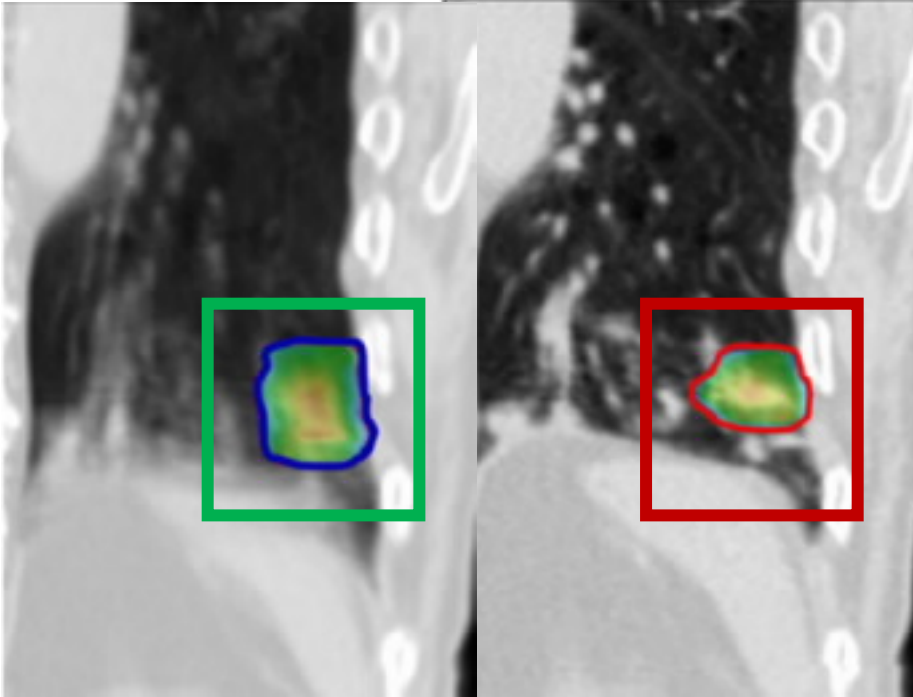
The first patient treatment of electromagnetic-guided real time adaptive radiotherapy using MLC tracking for lung SABR



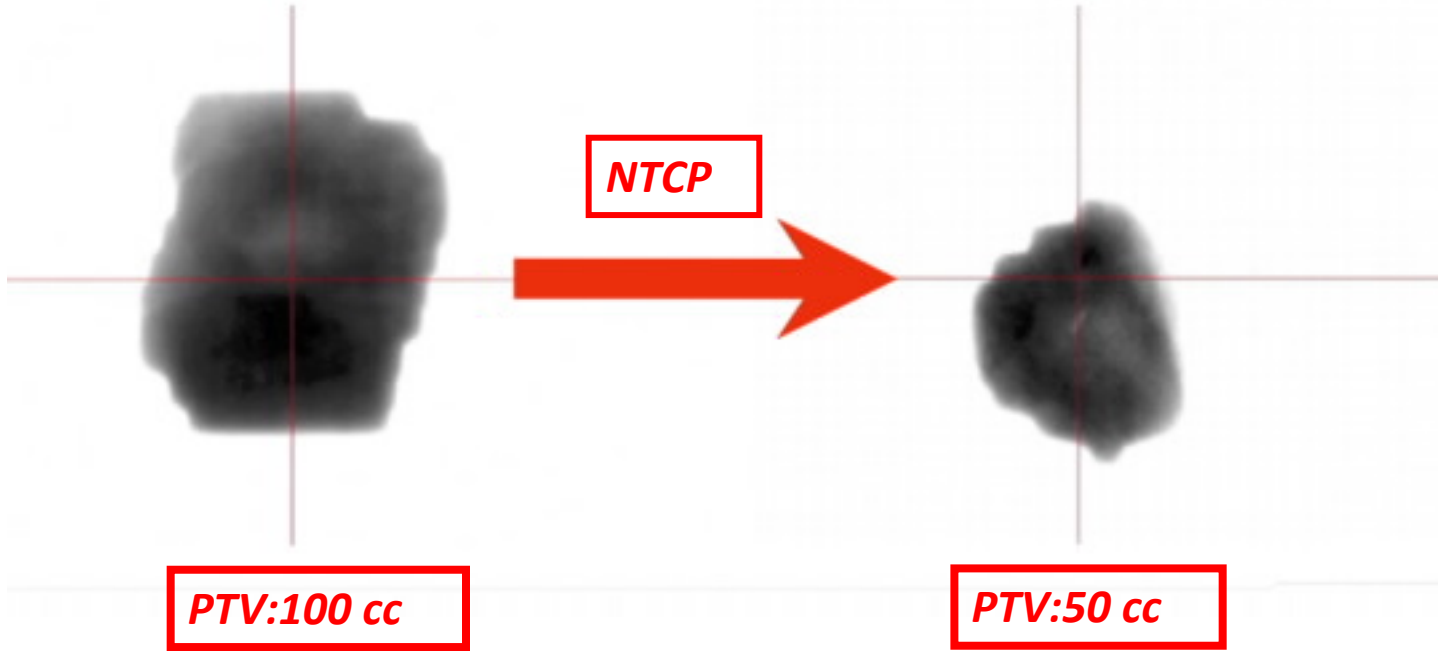
Jeremy T. Booth^{a,b,*}, Vincent Caillet^{a,b}, Nicholas Hardcastle^{a,c}, Ricky O'Brien^b, Kathryn Szymura^a, Charlene Crasta^a, Benjamin Harris^a, Carol Haddad^a, Thomas Eade^a, Paul J. Keall^b

^a Northern Sydney Cancer Centre, Level 1 Royal North Shore Hospital; ^b University of Sydney, Schools of Physics or Medicine, Sydney; and ^c Centre for Medical Radiation Physics, University of Wollongong, Wollongong, Australia

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Radiotherapy and Oncology 127 (2018) 6–11



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First in human

The first clinical implementation of real-time image-guided adaptive radiotherapy using a standard linear accelerator



Paul J. Keall ^{a,*}, Doan Trang Nguyen ^a, Ricky O'Brien ^a, Vincent Caillet ^{a,b}, Emily Hewson ^a,
Per Rugaard Poulsen ^c, Regina Bromley ^b, Linda Bell ^b, Thomas Eade ^{b,a}, Andrew Kneebone ^{b,a},
Jarad Martin ^d, Jeremy T. Booth ^{b,a}

^a University of Sydney; ^b Royal North Shore Hospital, Sydney, Australia; ^c Aarhus University Hospital, Denmark; ^d Calvary Mater Newcastle Hospital, Australia

SBRT UYGULAMA AŞAMALARI VE KULLANIM ALANLARI

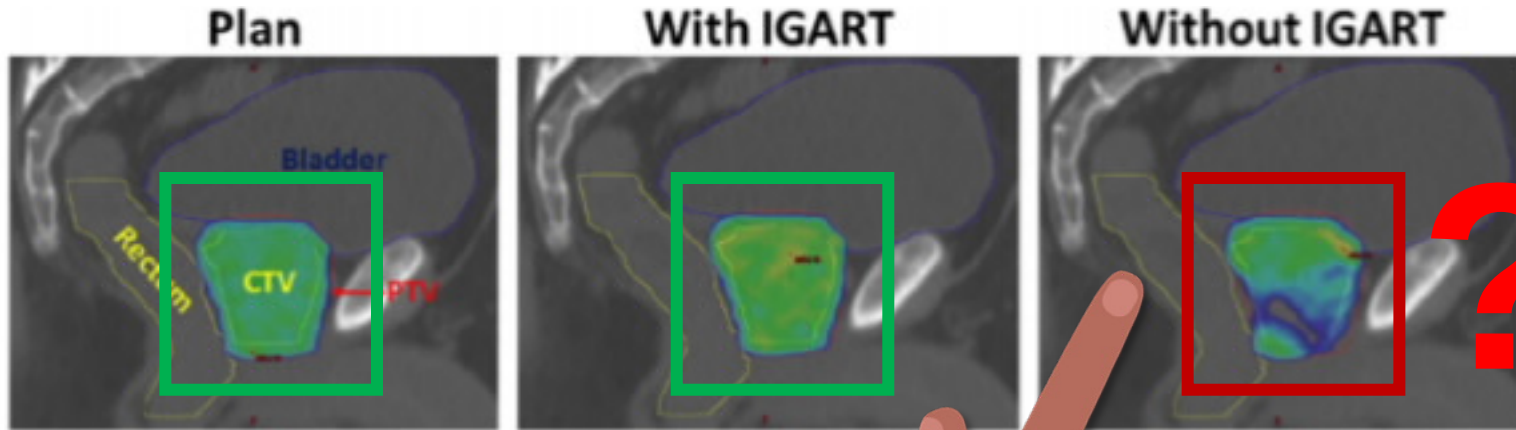


Fig. 4. Isodose distributions for planned (left), delivered with real-time IGART (middle), and estimated without IGART (right) for the fraction with the motion shown in Fig. 3. The isodose range is from the PTV 95% (prescribed dose) to 110%.

SBRT UYGULAMA AŞAMALARI VE KULLANIM ALANLARI



Fig. 5. Dose-volume histograms of the planned (continuous line), delivered with real-time IGART (dashed line), and estimated without real-time IGART (dotted line) for the organs shown in Figs. 3 and 4.

GÜNCEL GELİŞMELER

- ☐ FRAKSİYONLAR ARASI İN-VİVO DOZİMETRE (iViewDose, Mobius, ...)
- ☐ DEFORMABLE FÜZYON VE OTOMATİK KONTURLAMA (“DOSE MAPPING AND TRACKING”)
- ☐ MRG PLANLAMA / MRG-LİNAK
- ☐ SRC/SRT VE SBRT İÇİN BİYOLOJİK OPTİMİZASYON
- ☐ KONVANSİYONEL LİNAK: “DYNAMIC TRAJECTORY RADIOTHERAPY”
- ☐ YÜKSEK ENERJİLİ ELEKTRON DEMETLERİNİN KULLANIMI (> 100 MeV)
- ☐ ULTRA HIGH DOSE RATE (FLASH RADYOTERAPİ) (Dose Rate $\geq 40\text{Gy/s}$)



ÖZET

How is SBRT different for Physicists?

Conventional RT

Give the right dose to
the right place.*

*if your not sure, add a safety margin

SBRT

Give the right dose to
the right place.**

**if your not sure, don't do it

TEŞEKKÜRLER

