# Prostat Ca: SBRT uygulanan olgularda hareket yönetimi

Dr Şefik İğdem
Istanbul Bilim Üniversitesi

RTTDER 2019, Antalya

# Günün Konusu

- 69 yaşında erkek hasta
- PSA 5.8ng/ml
- TRUS bx: adenoca, Gleason 3+4, 6/14 kor+
- IPSS 6/35
- T2, iyi orta risk grubu

# ACR Appropriateness Criteria® external beam radiation therapy treatment planning for clinically localized prostate cancer, part I of II

| | | |
|---|---|---|
| Treatment planning | | |
| IMRT (nonarc) | 8 | |
| IMRT (arc) | 8 | |
| Proton beam | 6 | This reflects recognized controversy in the field. This procedure is unlikely to have worse outcomes than IMRT. Treatment on protocol is encouraged. |
| 3D-CRT | 5 | This procedure is acceptable if dose-volume histogram constraints are met or if IMRT is not available. |
| Image guidance | | |
| Use of radiofrequency transponders | 7 | See references[34,102,138,147,163-173] |
| CBCT with fiducial markers, aligned to PTV | 8 | |
| CBCT without fiducial markers, aligned to PTV | 7 | |
| CBCT, aligned to bony anatomy | 3 | The prostate gland is recognized to move independently of bony anatomy, so alignment based on the prostate PTV is recommended. |
| 2D imaging with fiducial markers | 7 | |
| Ultrasound | 7 | |
| None | 3 | |
| RT fractionation | | |
| CFRT (ie, 1.8-2.0 Gy/fraction) | 8 | |
| HFRT (ie, 2.1-3.5 Gy/fraction) | 6 | This procedure is per previous protocol (eg, RTOG 0415[149]). |
| Stereotactic RT (ie, >3.5 Gy/fraction) | 6 | This procedure is probably acceptable, but head-to-head comparisons are limited currently. This procedure is per previous protocol (eg, RTOG 0938[150]). |

Advances in Radiation Oncology, 2017

# Comparison of outcomes and toxicities among radiation therapy treatment options for prostate cancer

Nicholas G. Zaorsky *, Talha Shaikh, Colin T. Murphy, Mark A. Hallman, Shelly B. Hayes, Mark L. Sobczak, Eric M. Horwitz

*Department of Radiation Oncology, Fox Chase Cancer Center, Philadelphia, PA, USA*

RT treatment options for men with NCCN risk group-stratified prostate cancer, in relation to other treatment options [2].

| Options and subtypes | | NCCN risk group | | | |
|---|---|---|---|---|---|
| | | **Low** Gleason score ≤ 6, *and* PSA < 10 ng/ml, *and* clinical tumor classification T1, T2a | **Intermediate** Gleason score 7, *or* PSA ≥ 10 ng/ml ≤ 20 ng/ml *or* clinical tumor classification of T2b, T2c | **High** Gleason score 8 – 10, or PSA > 20 ng/ml, or clinical tumor classification of T3a | **Post-RP RT** [5] **Adjuvant indications**: pT3; positive SMs **Salvage indications**: suspected LR (e.g. rising PSA, imaging, biopsy-proven) |
| Active surveillance / watchful waiting / observation | | Yes | Typically no | Typically no | N/A |
| Radical prostatectomy (RP) | open, laparoscopic, robotic approaches [78] | Monotherapy | Monotherapy | Monotherapy | N/A |
| Brachytherapy | low dose rate [41] | Monotherapy or boost | Boost or monotherapy | Boost > monotherapy | No |
| | high dose rate [62, 75] | Monotherapy | Boost or monotherapy | Boost > monotherapy | No |
| External beam radiation therapy (EBRT) | conventional fractionation [49, 50] | Monotherapy | Monotherapy or boost | Monotherapy or boost | Yes |
| | hypofractionation [60] | Monotherapy | Monotherapy or boost | Monotherapy or boost | No |
| | stereotactic body radiation therapy (SBRT) [61, 64] | Monotherapy* (sometimes) | Monotherapy* (sometimes) | Monotherapy (infrequently) * | No |
| ± Androgen deprivation therapy | | No | Sometimes* [57] | Almost always, for 24-36 m [58, 59] | Sometimes* [56] |

*Abbreviations:* PSA, prostate specific antigen; SBRT, stereotactic body radiation therapy; SMs, surgical margins.

Cancer Treatment Reviews 48 (2016) 50–60

# Contemporary prostate cancer radiation therapy in the United States: Patterns of care and compliance with quality measures

Daniel J. Lee MD, MS [a,*], Daniel A. Barocas MD, MPH [a], Zhiguo Zhao PhD [b], Li-Ching Huang PhD [b], Tatsuki Koyama PhD [b], Matthew J. Resnick MD, MPH, MMHC [a], Ralph Conwill BS [c], Dan McCollum BS [c], Matthew R. Cooperberg MD, MPH [d], Michael Goodman MD, MPH [e], Sheldon Greenfield MD [f], Ann S. Hamilton PhD [g], Mia Hashibe PhD [h], Sherrie H. Kaplan PhD [i], Lisa E. Paddock MPH, PhD [j], Antoinette M. Stroup PhD [j], Xiao-Cheng Wu MD, MPH [k], David F. Penson MD, MPH, MMHC [l], Karen E. Hoffman MD, MHSc, MPH [m]

**Table 3** Treatment details for radiation treatment by D'Amico risk criteria

| | Low risk | Intermediate risk | High risk | Overall | *P*-value [a, b] |
|---|---|---|---|---|---|
| EBRT (n) | 185 | 294 | 157 | 636 | |
| *Use of ADT* | | | | | |
| % receiving ADT, (n) | | | | | < .001 |
| Yes | 8% (15) | 44% (128) | 81% (127) | 43% (270) | |
| No | 92% (166) | 56% (166) | 19% (30) | 57% (362) | |
| *Dose prescription for EBRT* | | | | | |
| Conventional fractionation | 91% (157) | 95% (251) | 98% (141) | 95% (549) | .006 |
| Median dose (IQR), Gy | 79.2 (76.0, 79.2) | 79.2 (77.4, 79.2) | 79.0 (77.4, 79.2) | 79.2 (76.0, 79.2) | .516 |
| % receiving >75 Gy, (n) | 139 (89%) | 237 (94%) | 134 (95%) | 510 (93%) | .041 |
| Moderate fractionation | 1% (1) | 2% (6) | 1% (1) | 1% (8) | |
| Ultra-hypofractionation | 8% (14) | 3% (7) | 1% (2) | 4% (23) | |
| *Radiation fields for EBRT* | | | | | |
| % receiving pelvic radiation, (n) | | | | | |
| Yes | 4% (7) | 13% (36) | 40% (59) | 17% (102) | < .001 |
| No | 96% (165) | 87% (232) | 60% (87) | 83% (484) | |
| Use of image guidance | | | | | |
| % with IGRT, (n) | | | | | |
| Yes | 85% (132) | 85% (218) | 87% (125) | 85% (475) | .737 |
| No | 15% (24) | 15% (39) | 13% (18) | 15% (81) | |

Practical Radiation Oncology (2018) 8, 307–316

Original Investigation | Oncology

# Long-term Outcomes of Stereotactic Body Radiotherapy for Low-Risk and Intermediate-Risk Prostate Cancer

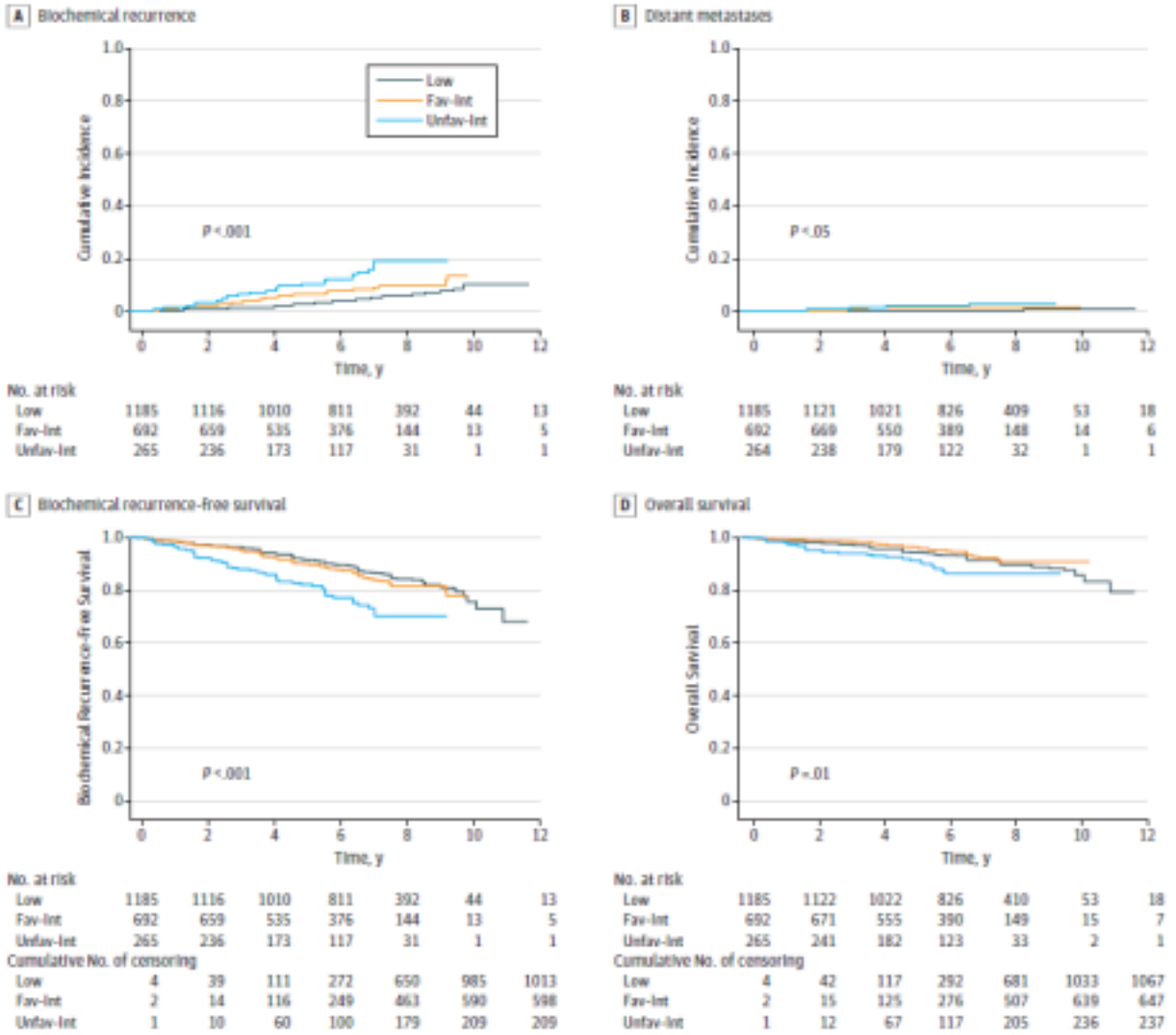
Amar U. Kishan, MD; Audrey Dang, MD; Alan J. Katz, MD, JD; Constantine A. Mantz, MD; Sean P. Collins, MD, PhD; Nima Aghdam, MD; Fang-I Chu, PhD; Irving D. Kaplan, MD; Limor Appelbaum, MD; Donald B. Fuller, MD; Robert M. Meier, MD; D. Andrew Loblaw, MD; Patrick Cheung, MD; Huong T. Pham, MD; Narek Shaverdian, MD; Naomi Jiang, MD; Ye Yuan, MD, PhD; Hilary Bagshaw, MD; Nicolas Prionas, MD, PhD; Mark K. Buyyounouski, MD, MS; Daniel E. Spratt, MD; Patrick W. Linson, MD; Robert L. Hong, MD; Nicholas G. Nickols, MD, PhD; Michael L. Steinberg, MD; Patrick A. Kupelian, MD; Christopher R. King, MD, PhD

Table 2. Patient and Treatment Characteristics

| Characteristic | Value (N = 2142) |
|---|---|
| Age | |
| Mean (SD), y | 67.9 (9.5) |
| Median (range), y | 68 (41-92) |
| Risk grouping, No. (%) | |
| Low risk | 1185 (55.3) |
| Favorable intermediate risk | 692 (32.3) |
| Unfavorable intermediate risk[a] | 265 (12.4) |
| Gleason grade, No. (%) | |
| I | 1355 (63.3) |
| II | 614 (28.7) |
| III | 173 (8.1) |
| Clinical T stage, No. (%) | |
| T1c | 1595 (74.5) |
| T2a | 430 (20.1) |
| T2b | 104 (4.9) |
| T2c | 13 (0.6) |
| Initial prostate-specific antigen level | |
| Mean (SD), ng/mL | 6.4 (3.1) |
| Median (range), ng/mL | 5.7 (0.09-19.9) |
| Equivalent dose in 2-Gy fractions, No. (%) | |
| ≥91 Gy | 797 (37.2) |
| <91 Gy | 1346 (62.8) |
| Treatment platform, No. (%) | |
| Robotic arm-mounted linear accelerator[b] | 1479 (69.0) |
| Gantry-mounted linear accelerator | 664 (31.0) |
| Fractionation, No. (%) | |
| Daily | 1013 (47.3) |
| Every other day | 1015 (47.4) |
| Weekly | 114 (5.3) |
| Androgen deprivation therapy use, No./total No. (%) | |
| Total | 115/2142 (5.4) |
| Low | 43/1185 (3.6) |
| Favorable | 47/692 (6.8) |
| Unfavorable | 25/265 (9.4) |
| Duration of androgen deprivation therapy, mean (SD), mo | 3.6 (4.2) |

*JAMA Network Open*. 2019

Figure 1. Study Outcomes



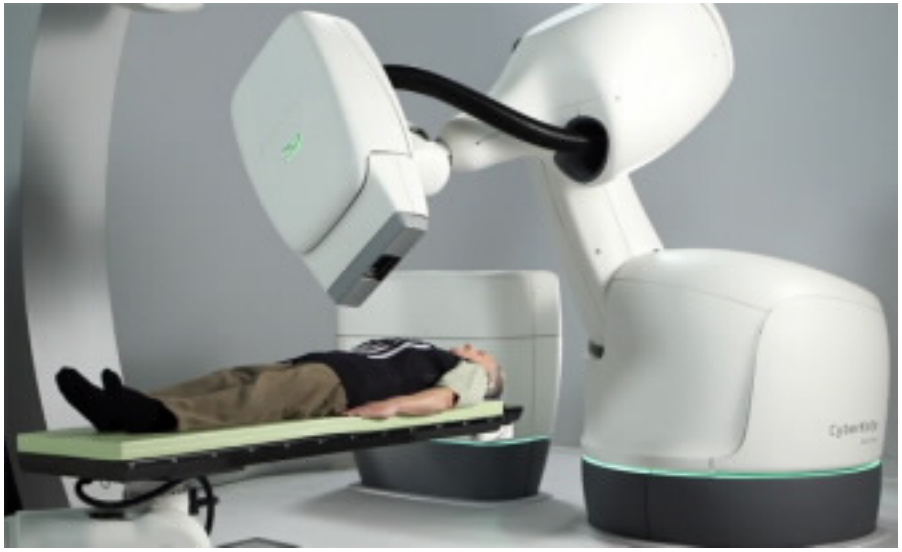

A, Cumulative incidence of biochemical recurrence ($P < .001$). B, Cumulative incidence of distant metastases ($P = .03$). C, Kaplan-Meier curve of biochemical recurrence–free survival ($P < .001$). D, Kaplan-Meier curve of overall survival ($P = .01$). Fav-Int indicates favorable intermediate-risk disease; Low, low-risk disease; and Unfav-Int, unfavorable intermediate-risk disease.

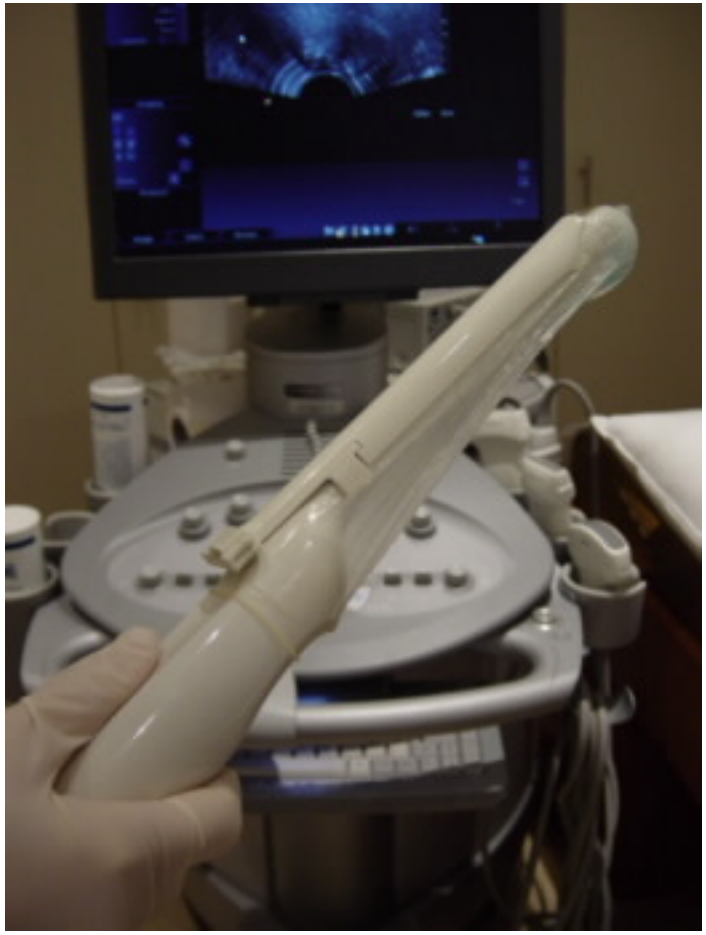
Table 3. Crude Incidence of Acute Composite Radiation Therapy Oncology Group and Common Terminology Criteria for Adverse Events Grade 2 and Grade ≥3 Toxic Events, and Cumulative Incidence of Late Composite Radiation Therapy Oncology Group and Common Terminology Criteria for Adverse Events Grade 2 and Grade ≥3 Toxic Events[a]

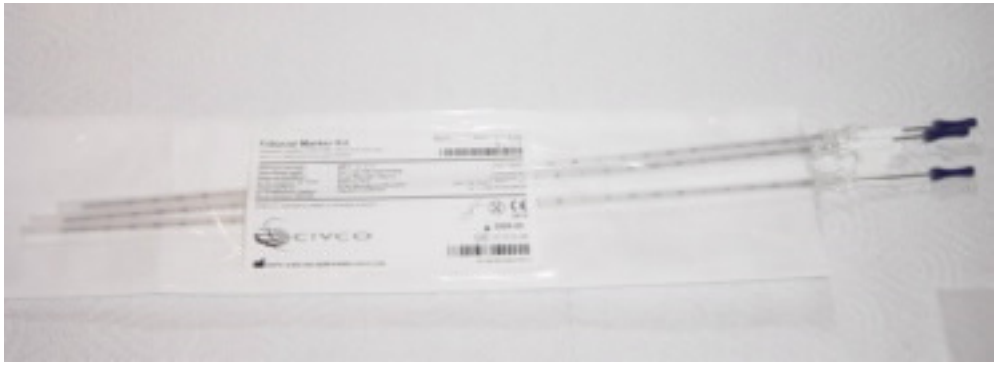
| Toxic Event | Crude Incidence, No. (%)[b] | Cumulative Incidence Estimate (95% CI) | | |
|---|---|---|---|---|
| | | 5 y | 7 y | 10 y |
| Grade 2 | | | | |
| Acute GU | 153 (9.0) | NA | NA | NA |
| Acute GI | 56 (3.3) | NA | NA | NA |
| Late GU | 163 (9.6) | 11.2 (9.7-12.8) | 12.3 (10.8-14.0) | 13.4 (11.6-15.4) |
| Late GI | 67 (3.9) | 4.5 (3.6-5.6) | 4.5 (3.6-5.6) | 4.5 (3.6-5.6) |
| Grade ≥3 | | | | |
| Acute GU | 13 (0.6) | NA | NA | NA |
| Acute GI | 2 (0.09) | NA | NA | NA |
| Late GU | 46 (2.1) | 1.8 (1.3-2.5) | 2.4 (1.8-3.2) | 3.2 (2.2-4.6) |
| Late GI | 7 (0.3) | 0.4 (0.2-0.8) | 0.4 (0.2-0.8) | 0.4 (0.2-0.8) |

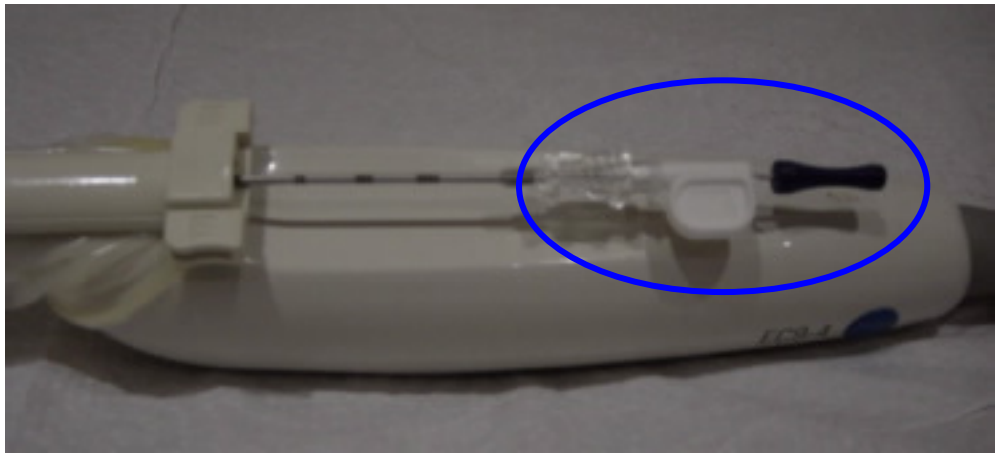
# Teknik

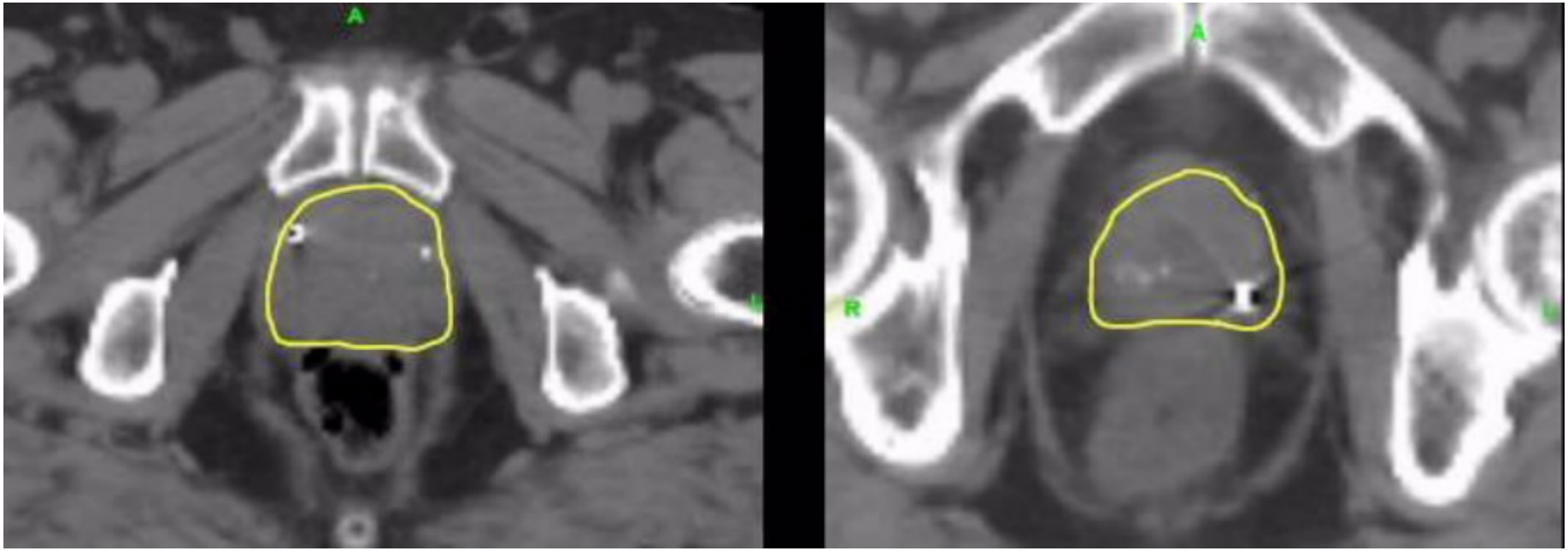
- Gantri veya robotik kol tabanlı
- Multiple non-coplanar alanlar, VMAT





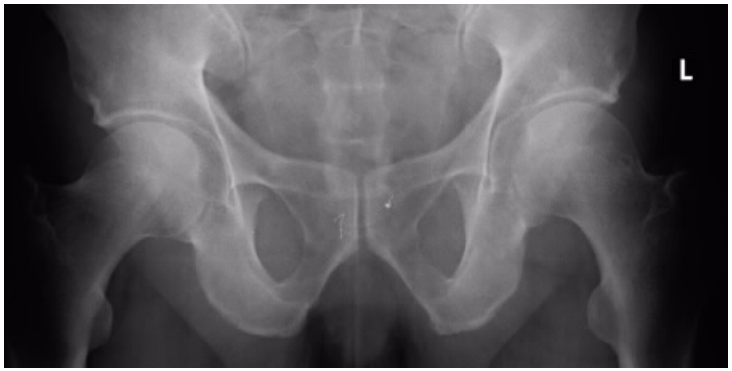


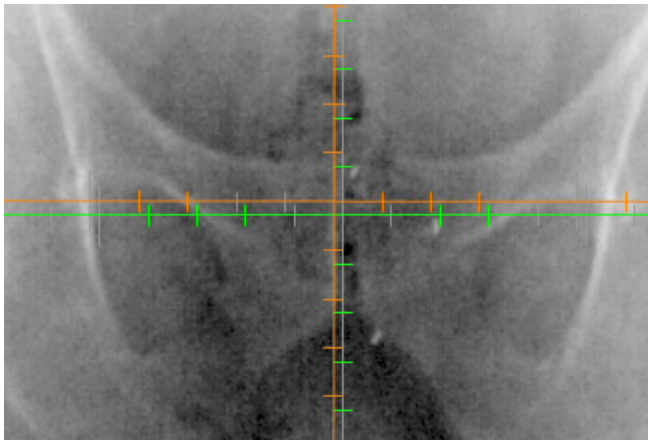


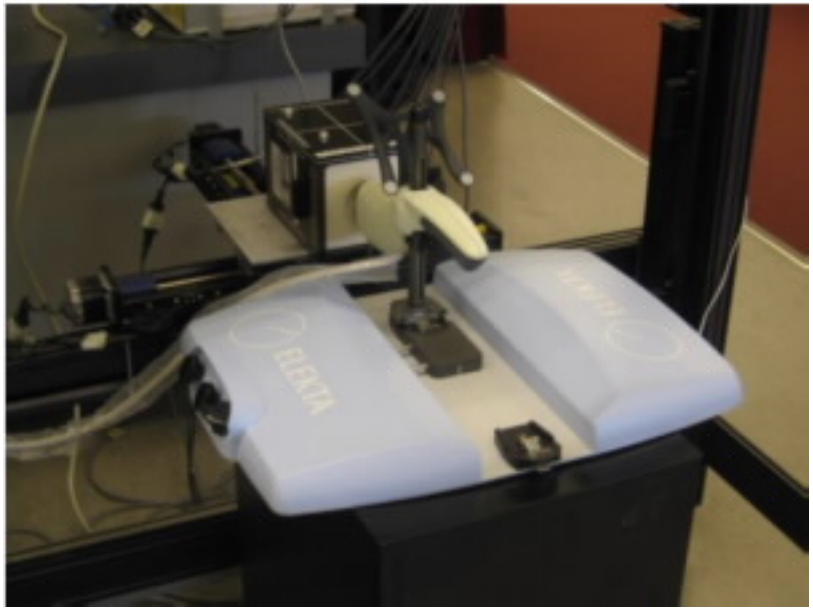



- Antibiotik profilaksi
- Rektum hazırlığı
- TRUS rehberliği

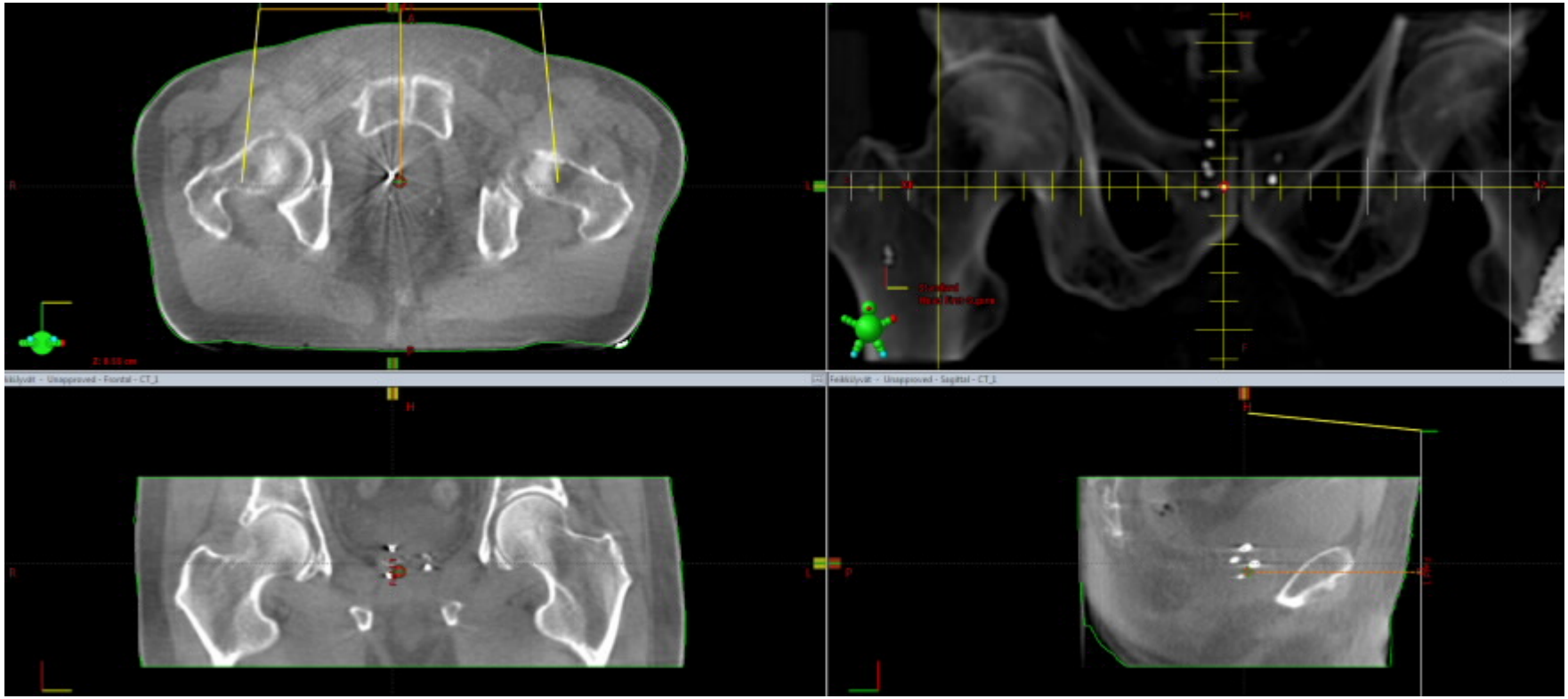
# Görüntü Rehberliği



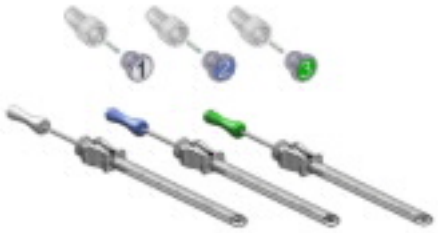


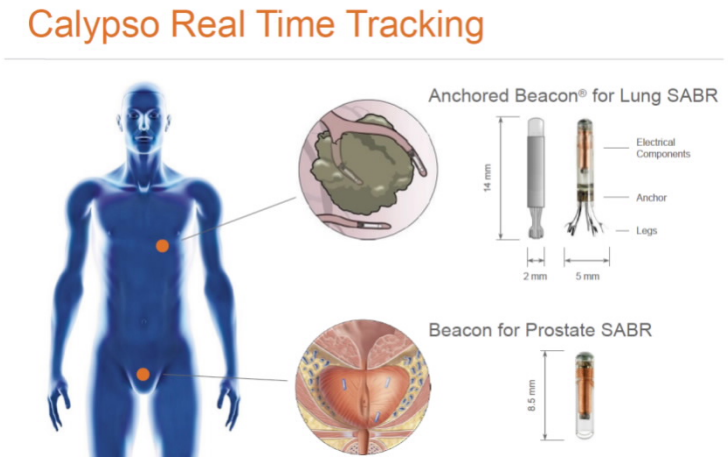
# Setup sırasında hareket



# Calypso


0 1 CM
Calypso System




Calypso Real Time Tracking
Anchored Beacon® for Lung SABR
Electrical Components
Anchor
Legs
14 mm
2 mm
5 mm
Beacon for Prostate SABR
8.5 mm

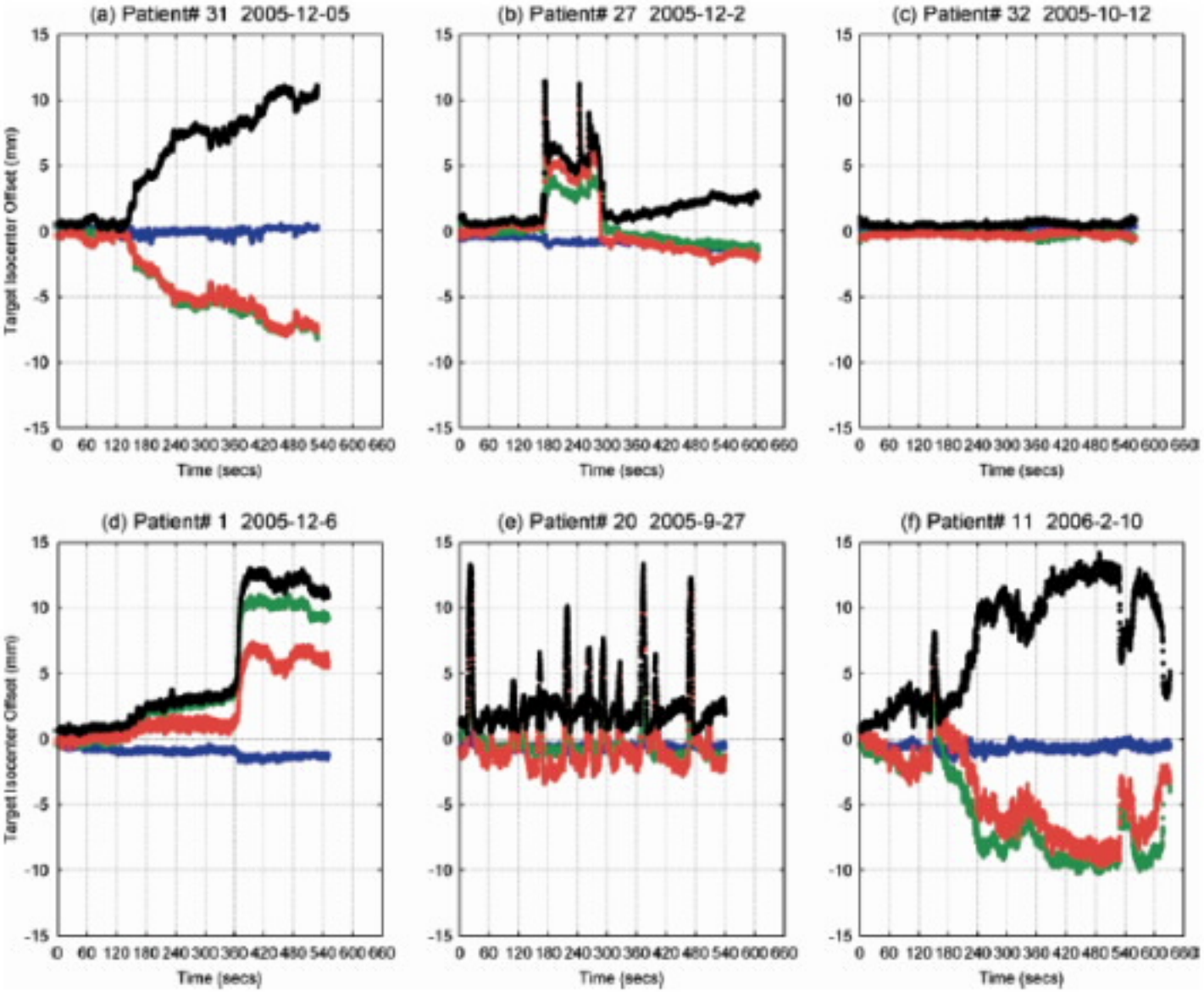
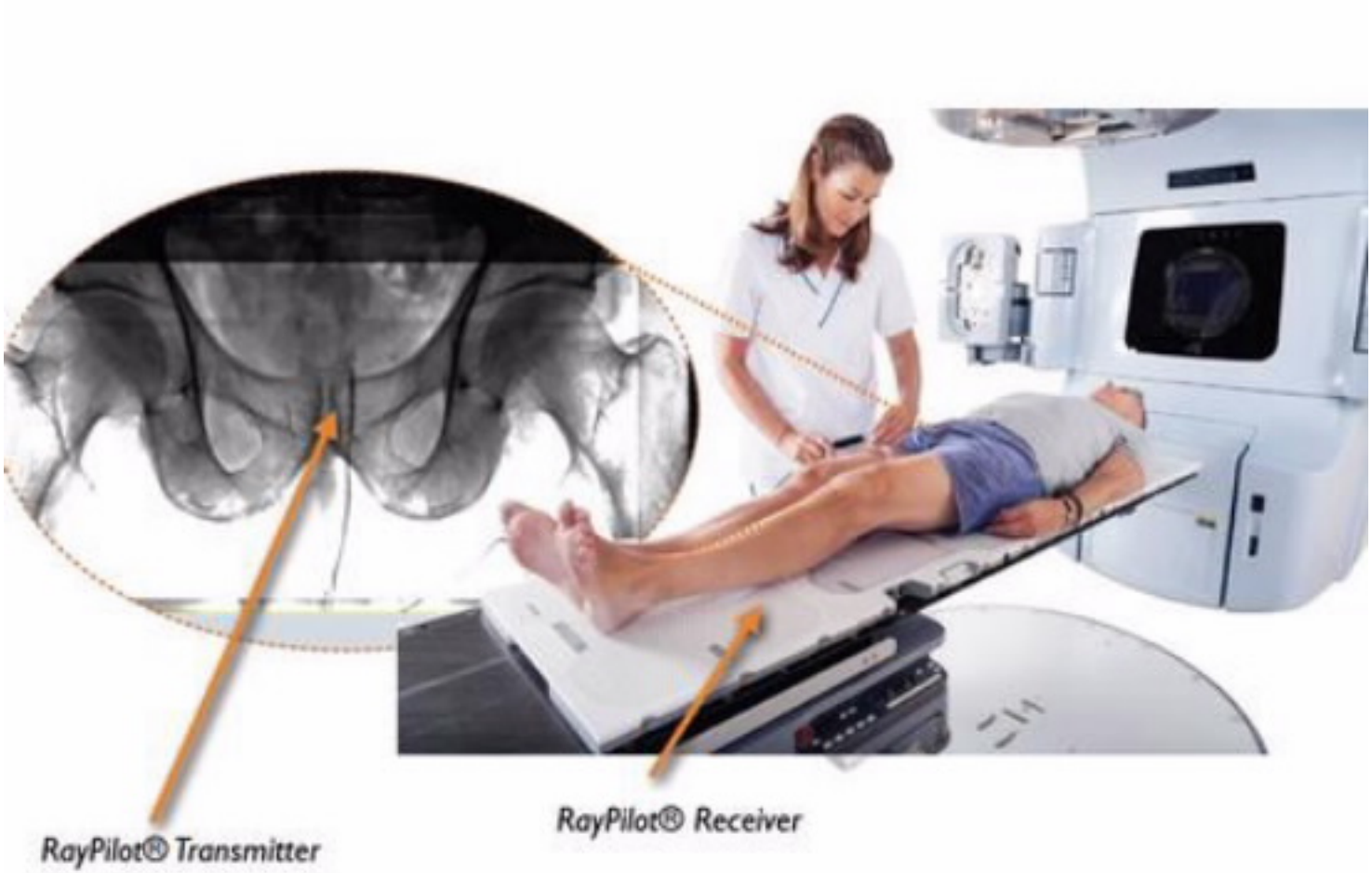


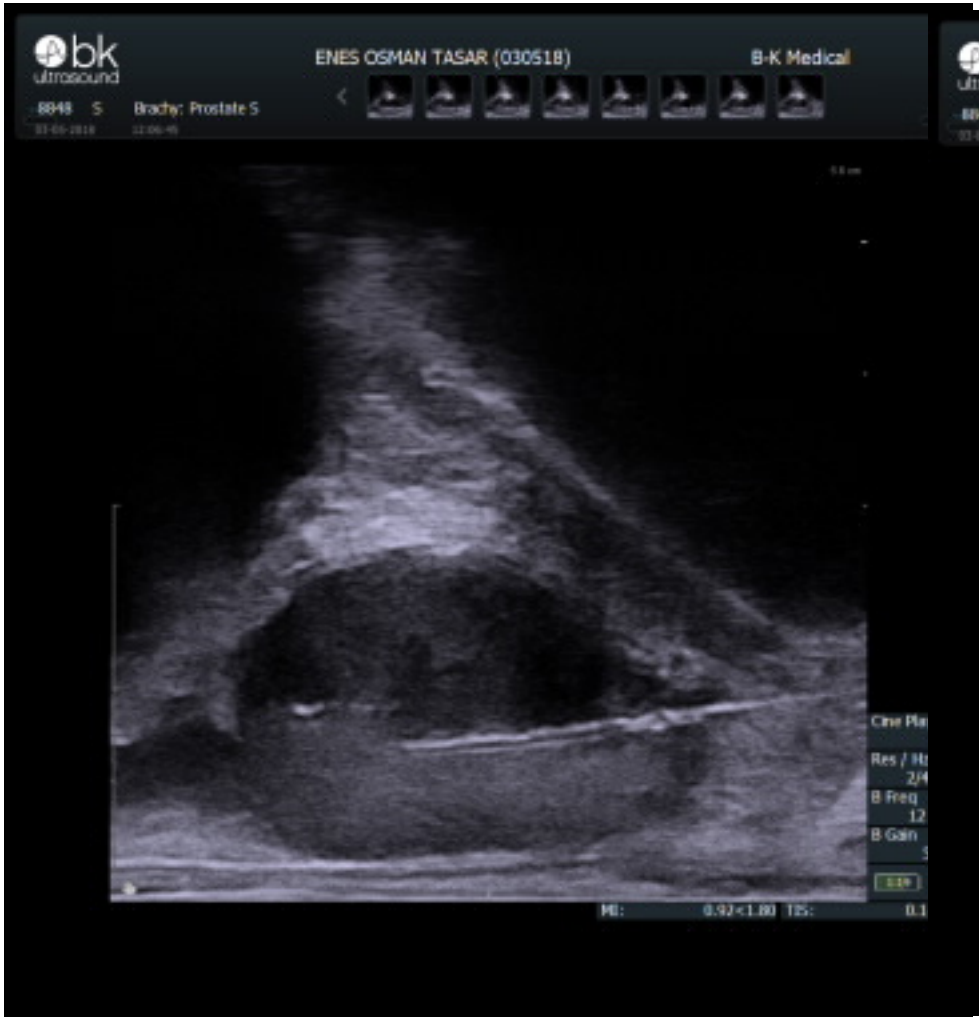

Fig. 6. Examples of behaviors observed in the continuous tracking data: (a) continuous target drift; (b) transient excursion; (c) stable target at baseline; (d) persistent excursion; (e) high-frequency excursions; (f) erratic behavior. Red: vertical, green: longitudinal, blue: lateral, black: vector length.

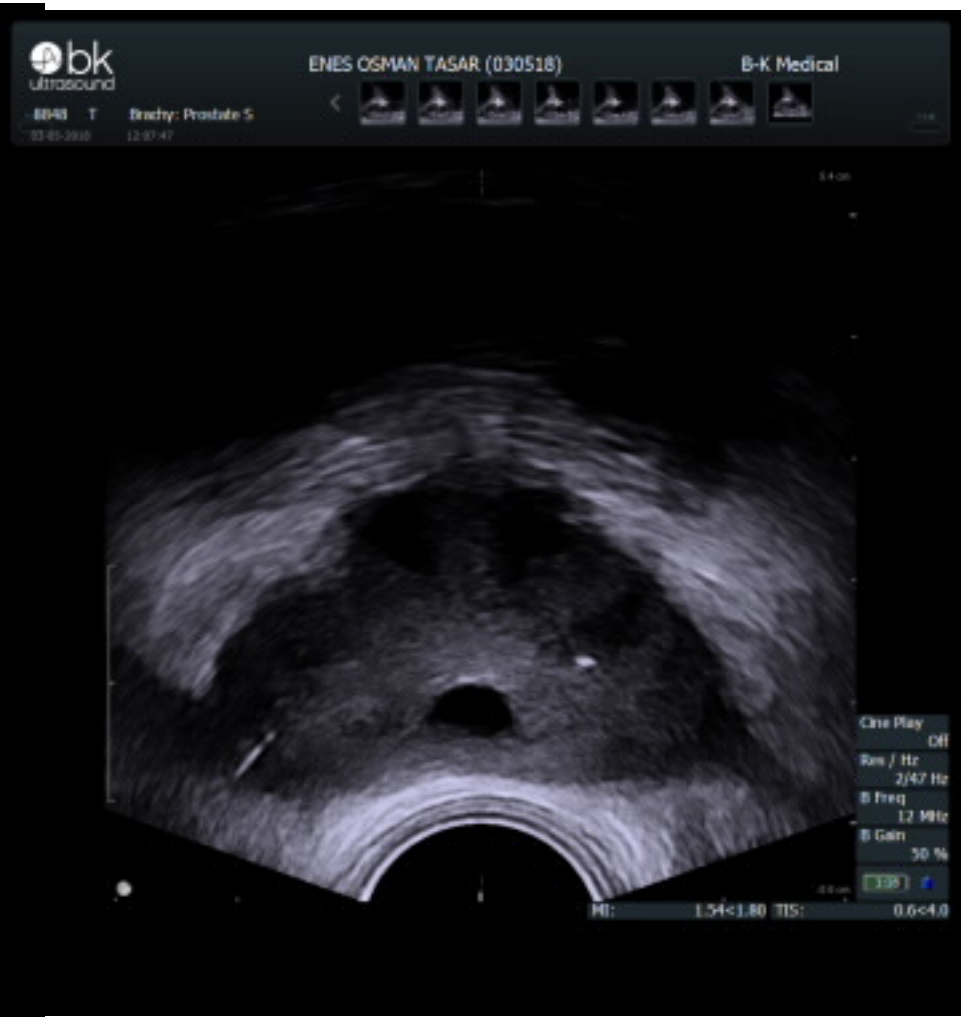
Red Journal, 2007

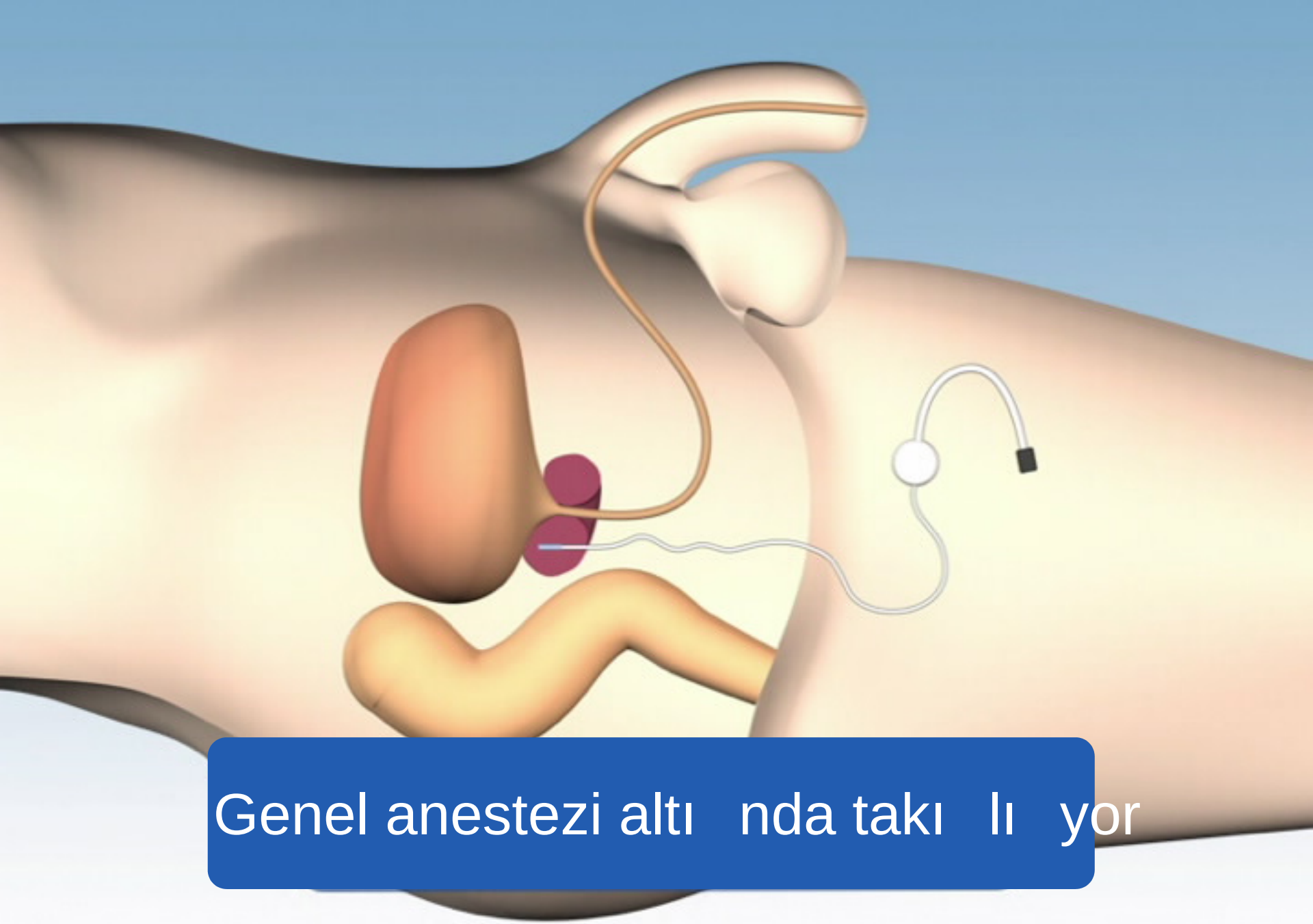
# RayPilot



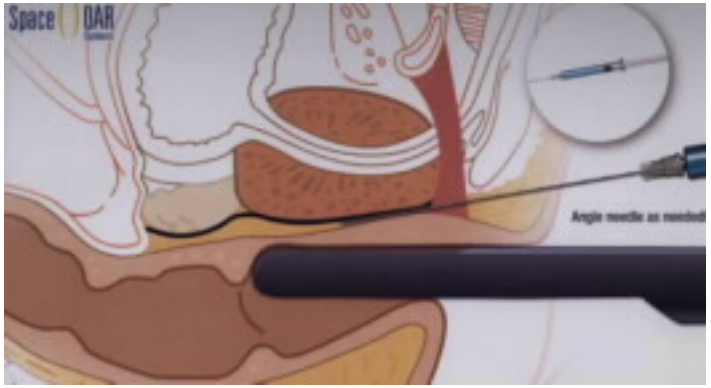
# TRUS Kılavuzluğu

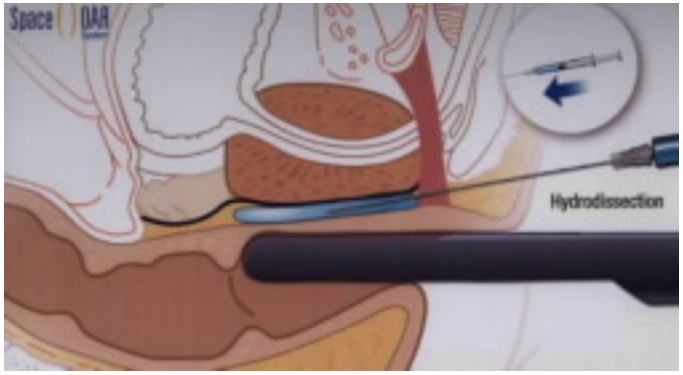


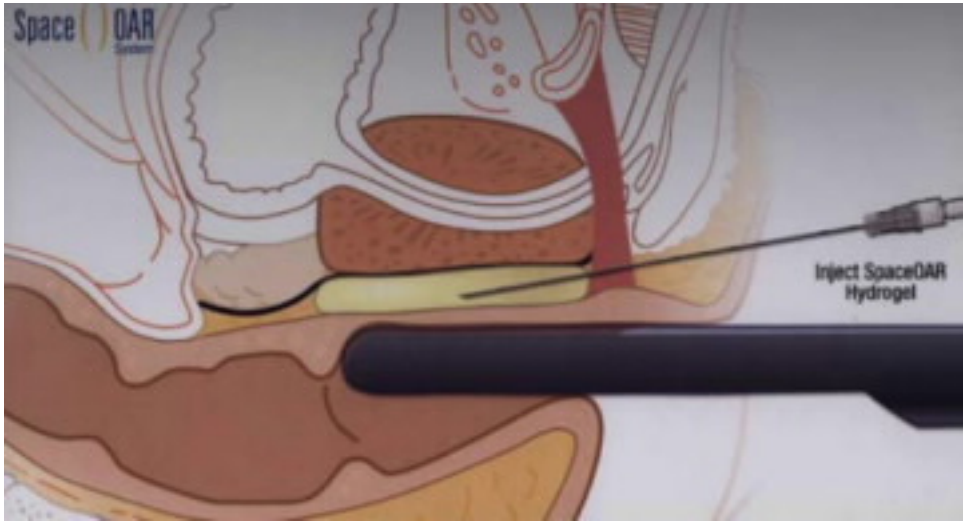




Genel anestezi altı nda takı lı yor

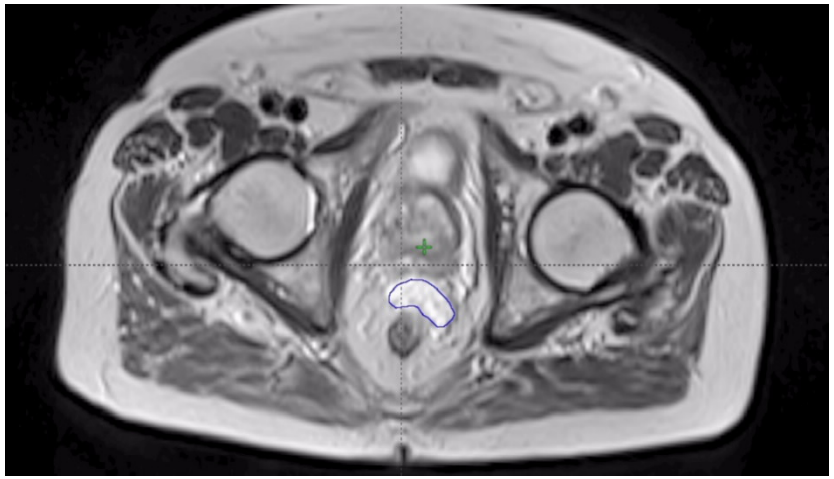
# SpaceOAR

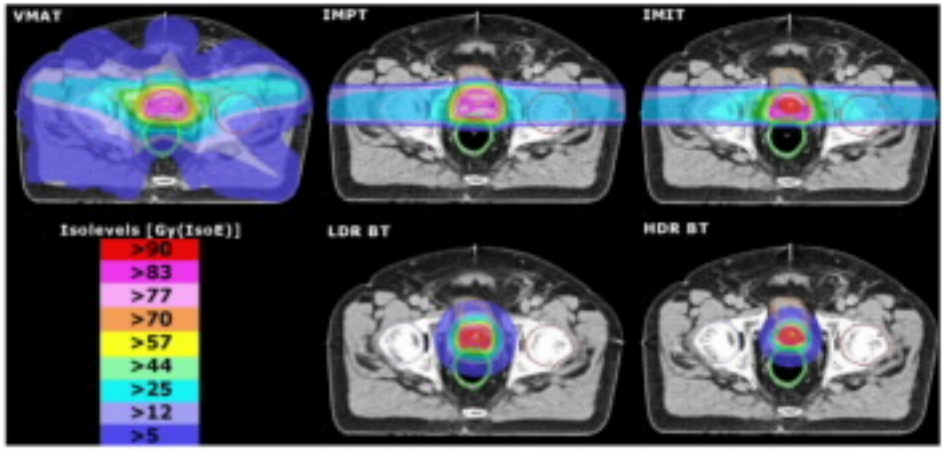

Space OAR


Space OAR
Hydrodissection


Space OAR
Inject SpaceOAR Hydrogel

# SpaceOAR vs ERB






| Spacer | Endorectal balloon |
|---|---|
| Needs invasive procedures (with local and/or general anesthesia) | Not invasive procedures needed |
| It is a one-step procedure. Once placed, it remains stable for several weeks (up to 1 year) | The balloon need to be placed before each fraction of irradiation, and its position should be verified before the delivery of the treatment. Also the shape of the balloon should be checked as it could change |
| If the positioning of the spacer is not correct, it is not possible to modify or adapt it | The position of the balloon is verified and corrected before each fraction of irradiation |
| It keeps the anterior wall of the rectum away from the prostate (at least 1 cm) | The lateral and posterior walls of the rectum are kept far from the higher isodoses, while the anterior wall is closer to them (compared to treatments without balloons) |
| No impact on the rectal filling during the treatment | The rectum is filled always in the same way (better reproducibility?) |
| Potential risk of procedure related side effects (infection, allergic reactions, injection site reactions such as bleeding and pain, urinary retention, rectal pressure, embolization of spacers and incorrect injection into the prostate or rectum) | No risk of side effects |

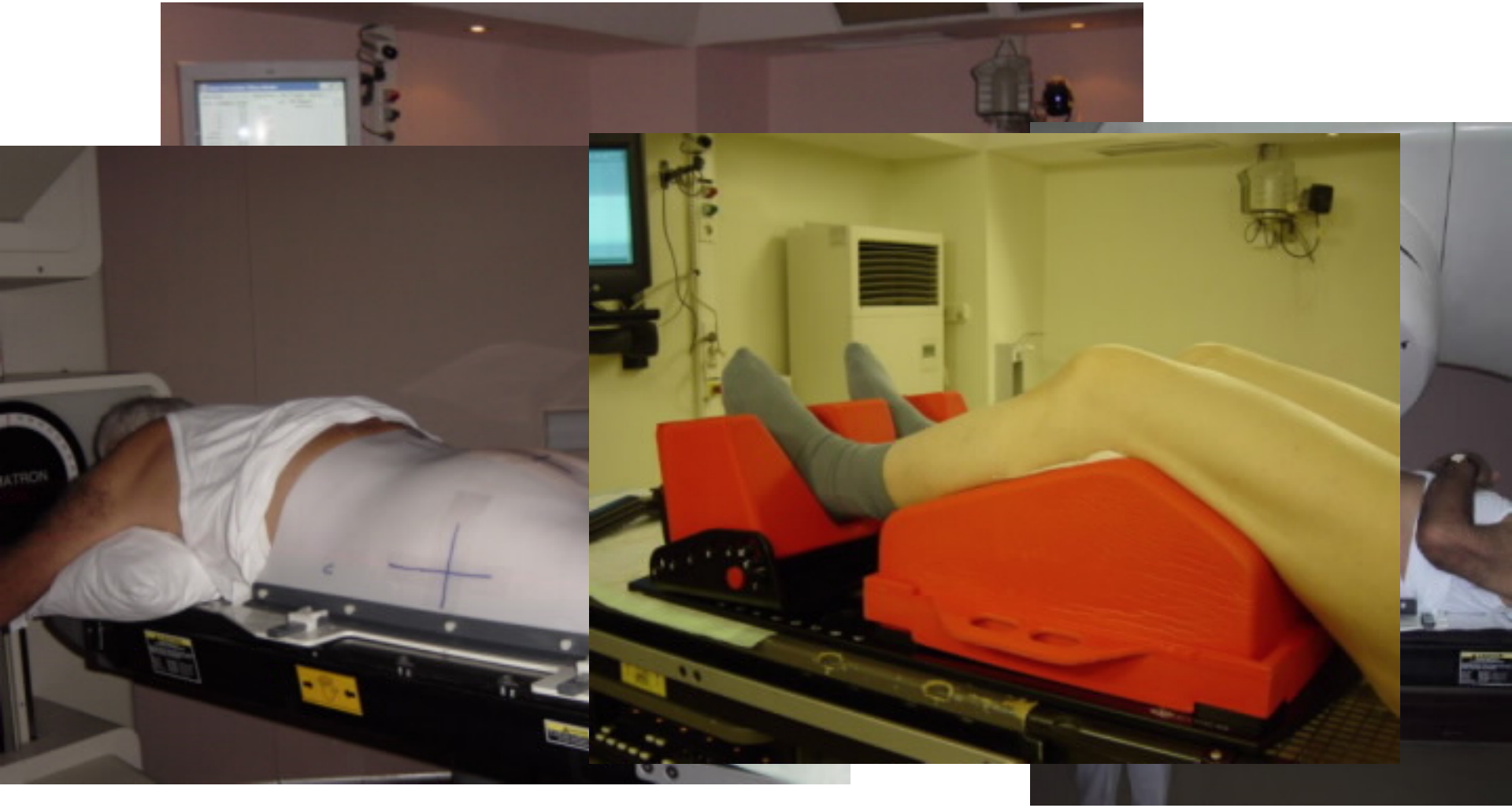
De Bari, et al. Cancer Treatment Reviews, 2016

# Biz nasıl yapıyoruz?

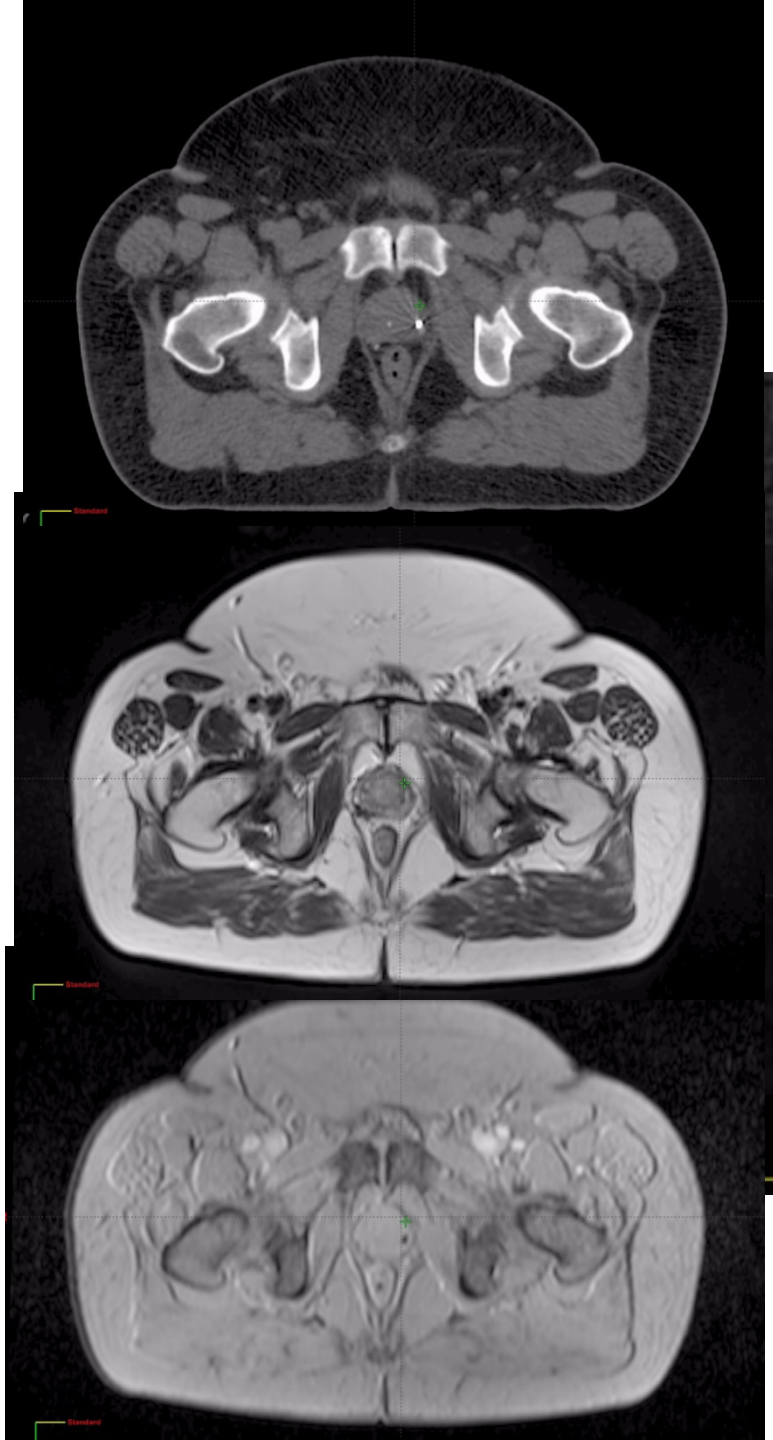
- Transmitter günü
  - Ameliyathane, GA
  - TRUS eşliğinde transperineal üç altın marker yerleştiriliyor
  - Transmitter implantasyonu
  - Öğleden sonra taburcu

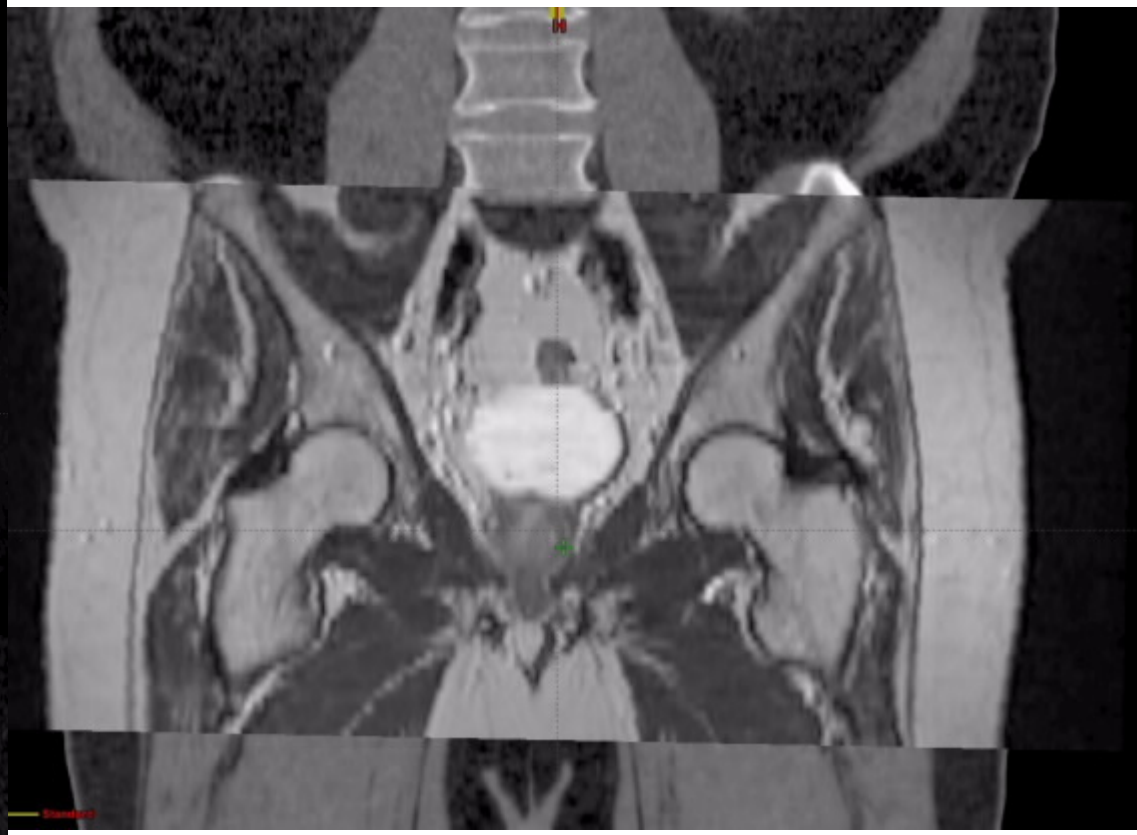
- Simülasyon günü
  - 1-2 saat önce lavman
  - Dolu mesane
  - Diz ve ayak fiksasyonu
  - CT (ve hemen sonrasında MR)

# İmmobilizasyon



# BT-MR füzyon



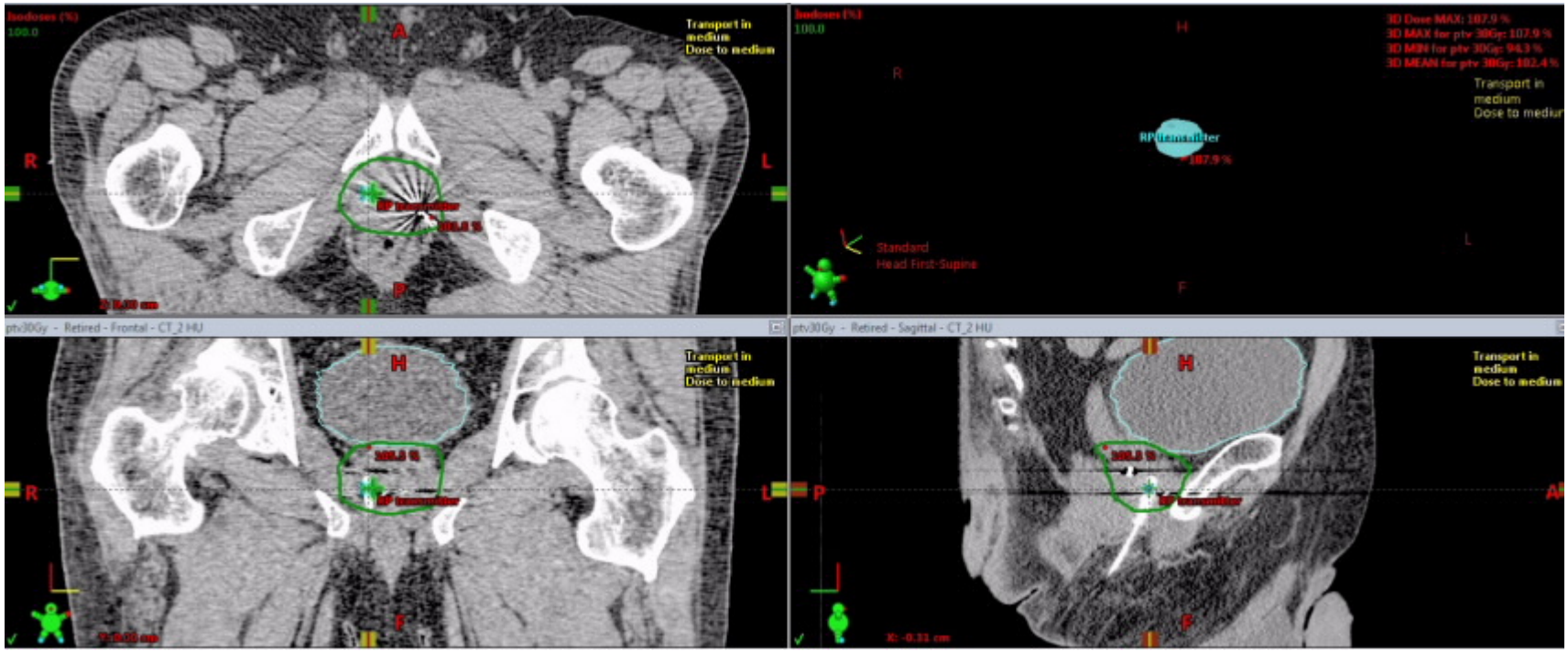


- Hedef Volümler ve Doz
  - Düşük risk: prostat
  - Orta risk: prostat+proksimal sv
  - 10MV FFF, iki full ark
  - 36.25Gy #5, günaşırı tedavi

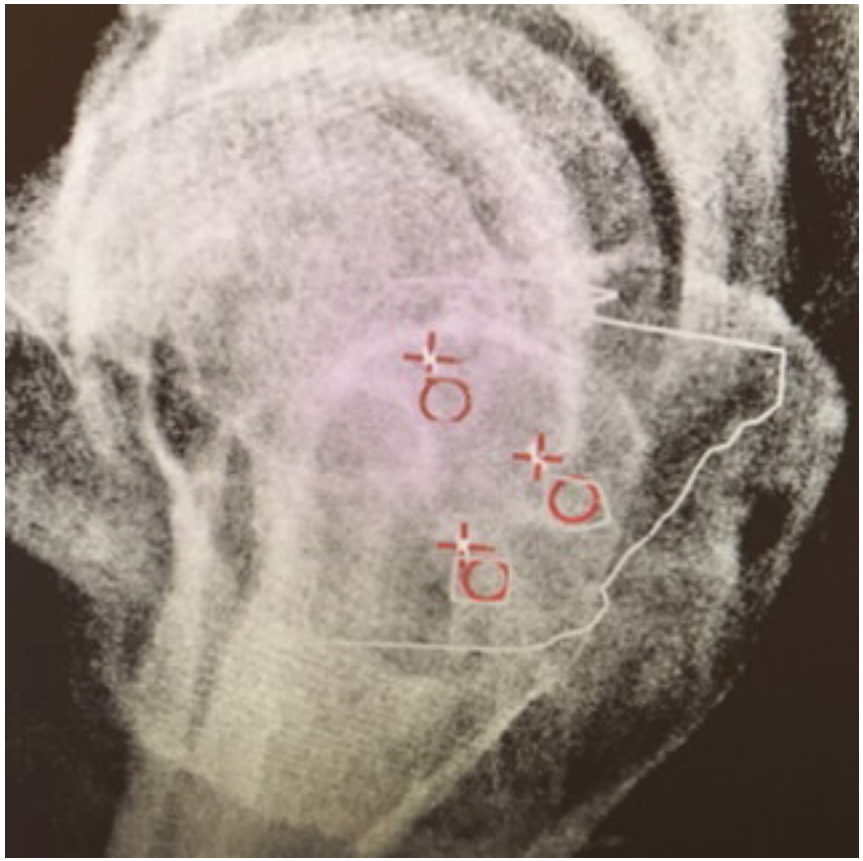
# Doz kısıtlamaları:
# RTOG 9308

| Organ | Hedef |
|---|---|
| Prostat (PTV) min kabul edilebilir | ≥93% - ≤95% |
| max kabul edilebilir | ≥107% - ≤110% |
| 0.03cc | <38.78Gy(<%107 PD) |
| D%95 | ≥36.25Gy (%100 PD) |
| PTV min doz | ≥34.43Gy(%95 PD) |
| | |
| Rektum mak nokta doz 0.03cc | ≤38.06Gy(%105 PD) |
| ≤3cc | ≤34.40Gy(%95 PD) |
| V100% (36.25Gy) | <5% |
| V90% (32.625Gy) | <10% |
| V80% (29.00Gy) | <20% |
| V50% (18.125Gy) | <50% |
| | |
| Mesane mak nokta doz 0.03cc | ≤38.06Gy(%105 PD) |
| V90% (32.625Gy) | <10% |
| V%50 (18.125Gy | <40% |
| | |
| Penile bulb mak nokta doz 0.03cc | ≤%100 PD |
| <3cc | 19.57Gy (%54 PD) |
| | |
| Femur başları (bilateral) | |
| Maksimum nokta doz | 29.36Gy (%81PD) |
| <10cc | 19.57Gy(%54 PD) |
| V%40 (14.5Gy) | <5% |
| Uretra 0.03cc | ≤38.78Gy(%107 PD) |

# Doz dağılımı

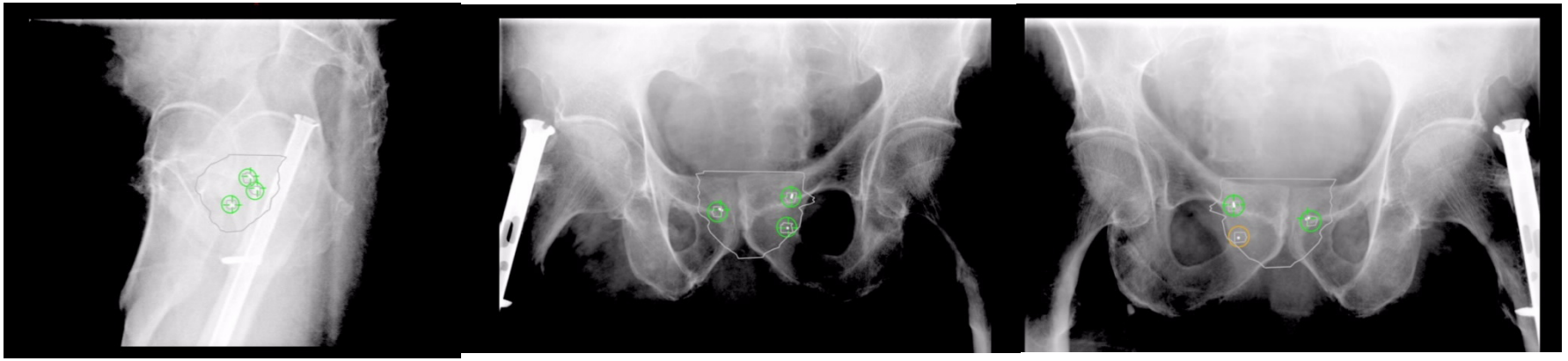


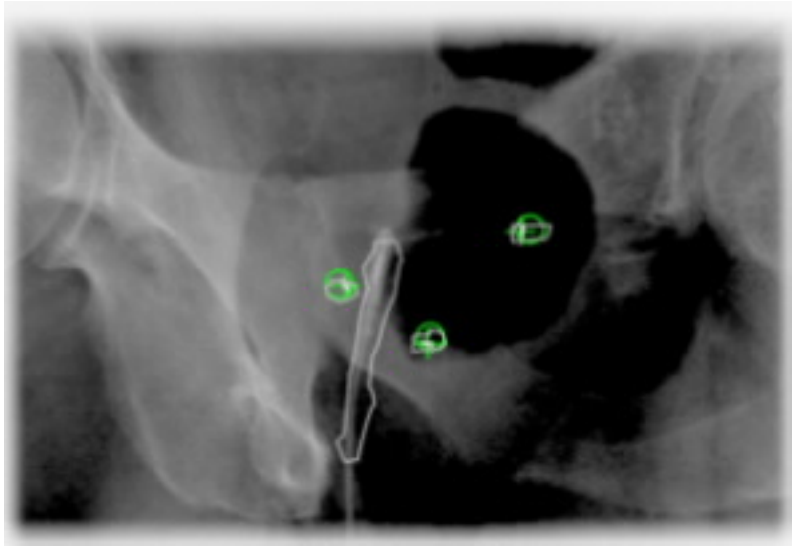
# Auto Beam Hold

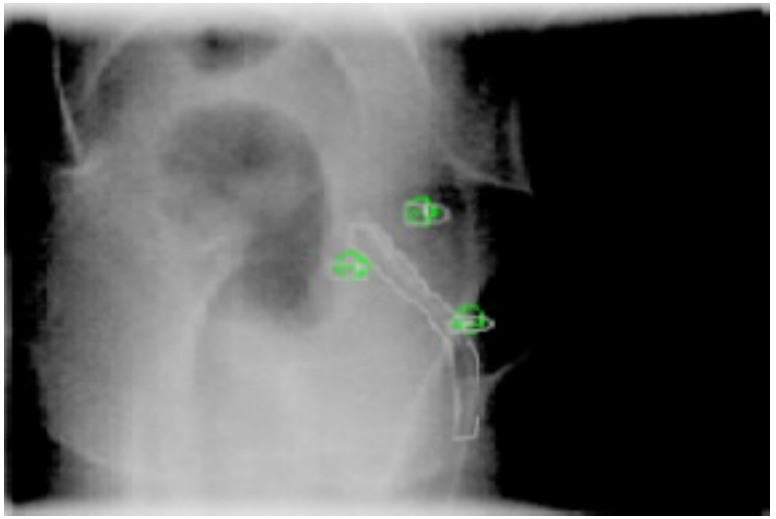


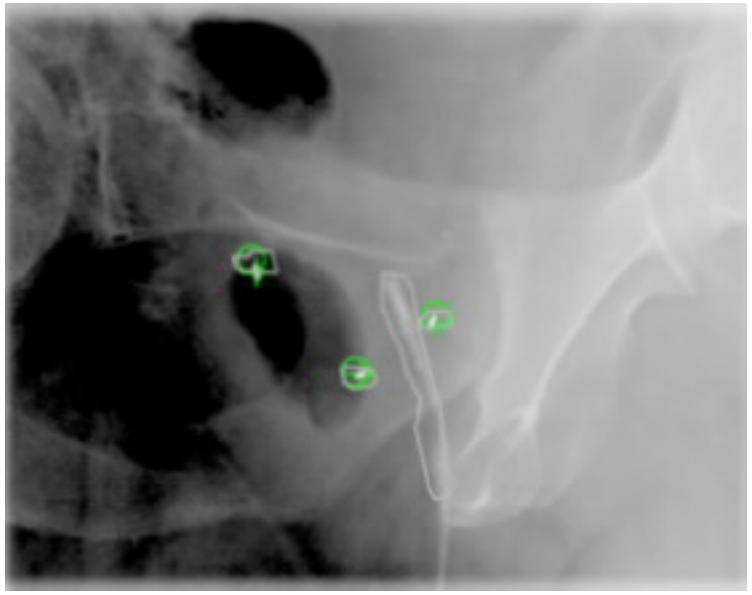
# Triggered Imaging

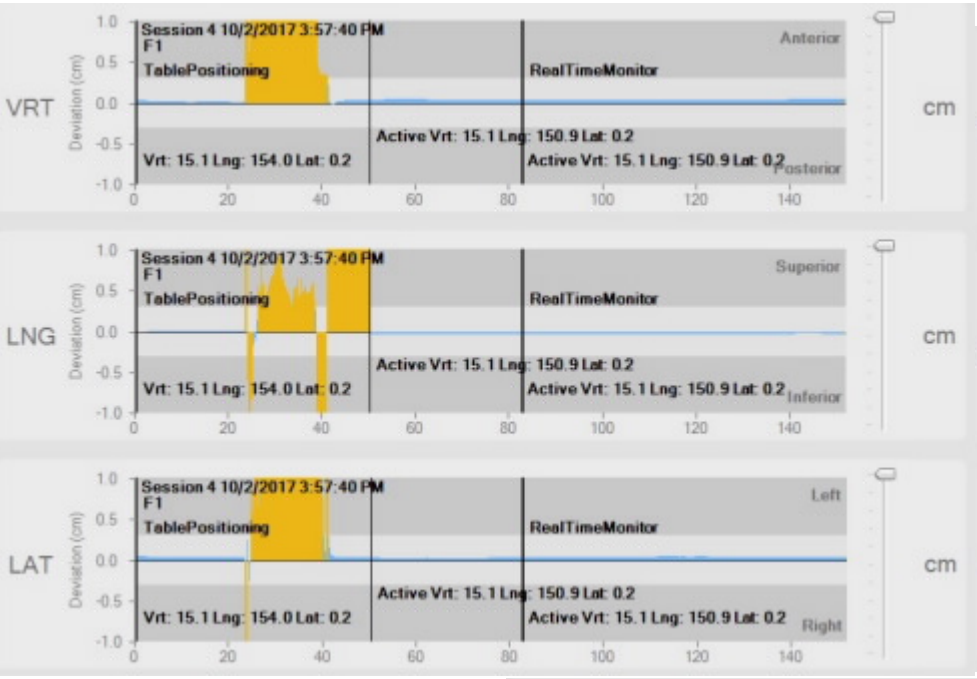
- 25 prostat kanserli olguda 125 fraksiyon
- fraksiyon süresi: medyan 7.6 dakika (3.4-29 dakika)
- 24 adet kV görüntüleme
- medyan 3 (0-25) kez düzeltme
- medyan 1 (1-9) tanesinde düzeltme 2mm ve 1°'den daha fazla
- yapılan kV görüntülemelerde olgulara her fraksiyonda medyan 62.2mGy (54.2-78mGy) ek doz verildiği gözlenmiştir.

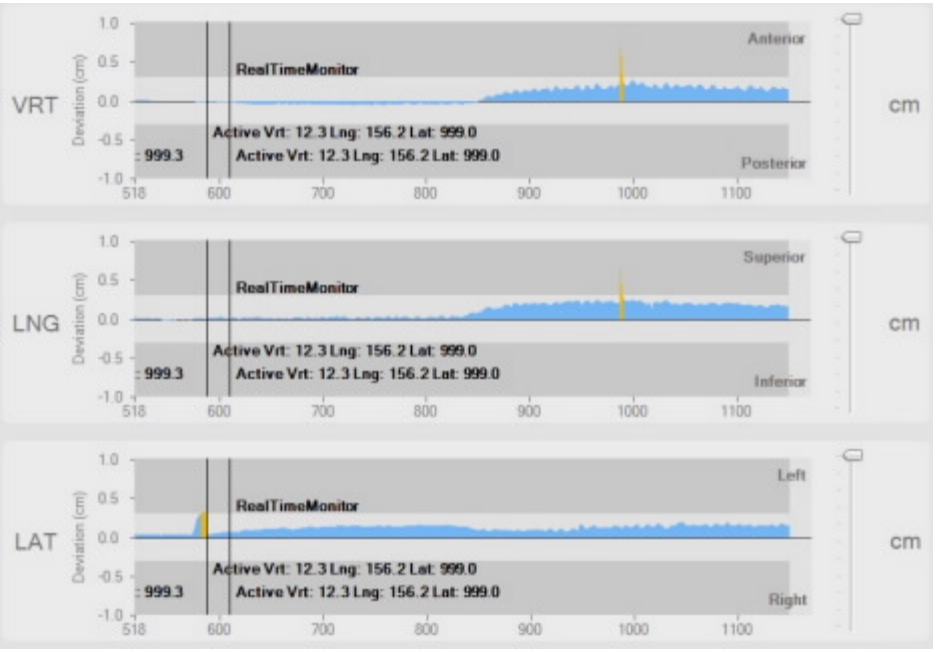


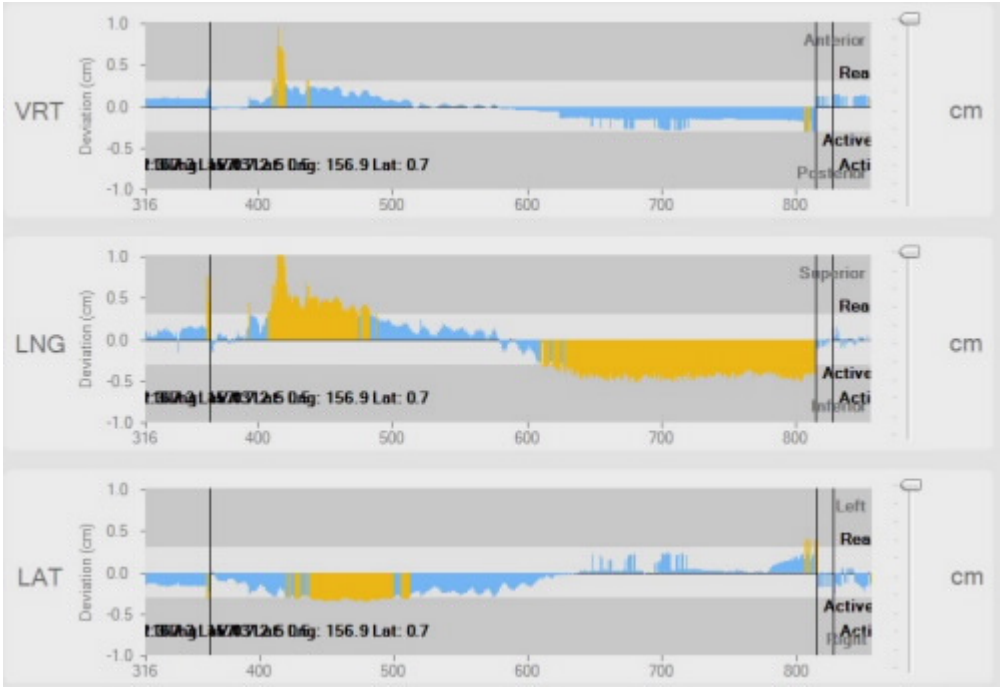







VRT
Session 4 10/2/2017 3:57:40 PM
F1
TablePositioning
RealTimeMonitor
Anterior
Posterior
Vrt: 15.1 Lng: 154.0 Lat: 0.2
Active Vrt: 15.1 Lng: 150.9 Lat: 0.2
Active Vrt: 15.1 Lng: 150.9 Lat: 0.2
Deviation (cm)
cm
LNG
Superior
Inferior
LAT
Left
Right


VRT
RealTimeMonitor
Anterior
Posterior
Active Vrt: 12.3 Lng: 156.2 Lat: 999.0
: 999.3
Active Vrt: 12.3 Lng: 156.2 Lat: 999.0
Deviation (cm)
cm
LNG
Superior
Inferior
LAT
Left
Right


VRT
Anterior
Active
Deviation (cm)
cm
LNG
Superior
Active
LAT
Left
Active

# PROSTAT KANSERİ RADYOTERAPİSİNDE İNTRAFRAKSİYON HAREKETİ İZLEMEK AMACIYLA ELEKTROMANYETİK TRANSMİTTER KULLANIMI: UYGULAMA, STABİLİTE, TEDAVİ SÜRESİ

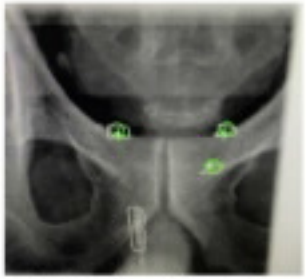
Ş. İğdem, M. Barlan, T. Ercan, G. Alço, D. Çelik, S. Okkan
İstanbul Bilim Üniversitesi, Florence Nightingale Gayrettepe Hastanesi

## AMAÇ

Prostat kanseri radyoterapisinde intrafraksiyonel organ hareketinin gerçek zamanlı takibi özellikle hipofraksiyone şemalarda önem kazanmaktadır. Bu çalışmada RayPilot elektromanyetik pozisyonlama sistemi kullanılan olgularda hasta toleransı, sistemin pozisyonel stabilitesi, tedavi süresine etkisi ve organ hareket bilgileri irdelenmiştir.

## MATERYAL ve METOD

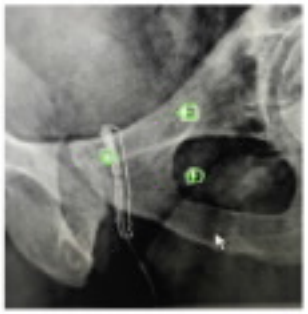
09/17-11/18 tarihleri arasında 6 olguya genel anestezi altında transperineal yolla transrektal US eşliğinde üç adet gold marker ve elektromanyetik transmitter yerleştirildi. Uygulamaya bağlı toksisite bir anket formuyla değerlendirildi. Olguların beşine ultrahipofraksiyone, birine de ılımlı hipofraksiyone şema uygulandı. Her fraksiyon öncesi ortogonal kV görüntüleme yapılarak markerların ve transmitterin pozisyonu değerlendirildi. Tedavi sırasında prostat hareketleri üç düzlemde kaydedildi. Uzun süreli 0.3 cm'yi aşan hareketlerde tedavi durdurularak hareketin geçmesi beklendi.



Resim 1: Olgu #3, transmitter suboptimal pozisyonda, stabil

## BULGULAR

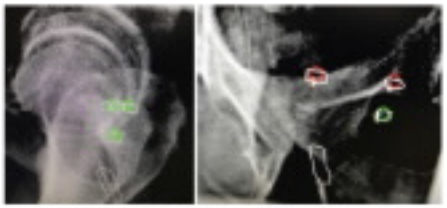
Tüm olgularda transmitter başarıyla implante edildi. Transmitter pozisyonu 4 olguda optimal, iki olguda suboptimal (gland içinde fakat apekse yakın) olarak değerlendirildi. Genel olarak olguların hepsi transmittere bağlı az/orta derecede rahatsızlık belirtti. Özellikle iki olgu perine bölgesinde oturma sırasında tolere edilebilen ağrının olduğunu bildirdi. Bir olguda perinede transmitterin çıkış bölgesinde enfeksiyon gelişti. Toplam 53 fraksiyonun 40'ında (%75) transmitter planlama pozisyonundaydı. Kalan 13 fraksiyonda transmitterin orijinal pozisyonundan medyan 0.52 cm (0.36-1.31 cm) kaydığı gözlendi. Özellikle bir olguda her fraksiyonda transmitterin orijinal pozisyonundan kayma tesbit edildi ve transmitter çıkartıldıktan sonra incelenmek üzere üretici firmaya gönderildi. Gerçek zamanlı yapılan ölçümlerde tedavi sırasında medyan 0.01 cm (-1.79-2.37cm) lateral, -0.06 cm (-4.19-1.85) longitudinal, -0.05 cm (-5.9-1.68 cm) vertikal hareket kaydedildi. Lateral yönde ölçümlerin %2.65 ve %1.5'i, longitudinal yönde %6 ve %3'ü, vertikalde %6.7 ve %5'i 3 ve 5 mm'nin üzerindeydi. Fraksiyonlar medyan 12 dakikada (4.14-46.42 dakika) tamamlandı.



Resim 2: Olgu #6, transmitter optimal pozisyonda, stabil

## SONUÇLAR

Transmitter yerleştirilmesi olgular tarafından iyi tolere edilmiştir. Transmitterin takılması ve çıkartılması sırasında büyük bir problem yaşanmamıştır. Tedavi öncesi alınan ortogonal graflerde transmitter pozisyonunun stabil olmadığı gözlenmiştir. Bu yüzden lokalizasyon amaçlı marker veya CBCT ile beraber kullanılması önerilmektedir. Zaman zaman tedavi sürelerinde uzamalara neden olsa da genellikle 15 dakikalık randevu süreleri içinde tedavi tamamlanabilmektedir.

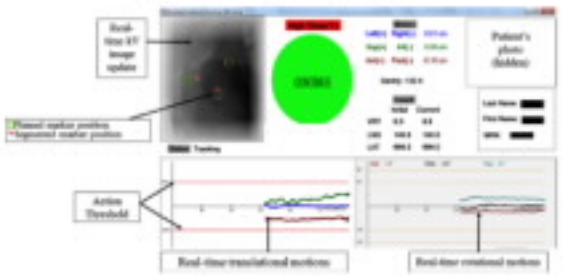


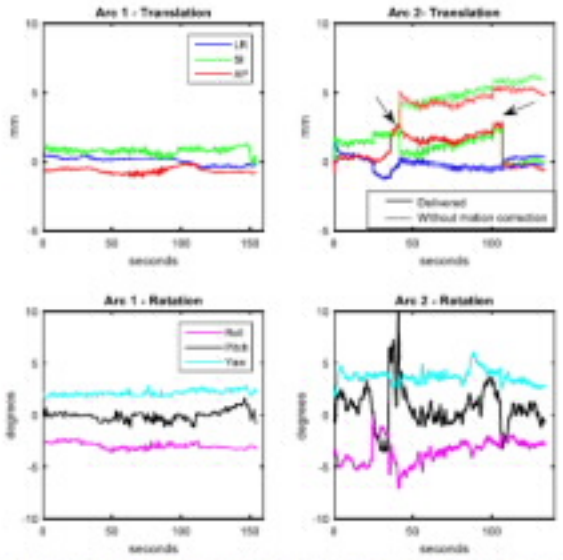
Resim 3: Olgu #4, transmitter pozisyonu suboptimal, fraksiyonlar arası kayma

Original article

# The first clinical implementation of a real-time six degree of freedom target tracking system during radiation therapy based on Kilovoltage Intrafraction Monitoring (KIM)

Doan Trang Nguyen [a], Ricky O'Brien [a], Jung-Ha Kim [a], Chen-Yu Huang [a], Lee Wilton [b], Peter Greer [b,c], Kimberley Legge [c], Jeremy T. Booth [d], Per Rugaard Poulsen [e], Jarad Martin [c], Paul J. Keall [a,*]






Yeşil Dergi, 2018

# Magnetic Resonance Imaging-Guided Adaptive Radiation Therapy: A "Game Changer" for Prostate Treatment?

Angela U. Pathmanathan, MA,[*,†] Nicholas J. van As, MD,[*,†] Linda G.W. Kerkmeijer, PhD,[‡] John Christodouleas, MD,[§] Colleen A.F. Lawton, MD,[‖] Danny Vesprini, MD,[¶] Uulke A. van der Heide, PhD,[#] Steven J. Frank, MD,[**] Simeon Nill, PhD,[*,†] Uwe Oelfke, PhD,[*,†] Marcel van Herk, PhD,[††,‡‡] X. Allen Li, PhD,[‖] Kathryn Mittauer, PhD,[§§] Mark Ritter, PhD,[§§] Ananya Choudhury, PhD,[††,‡‡] and Alison C. Tree, MD[*,†]

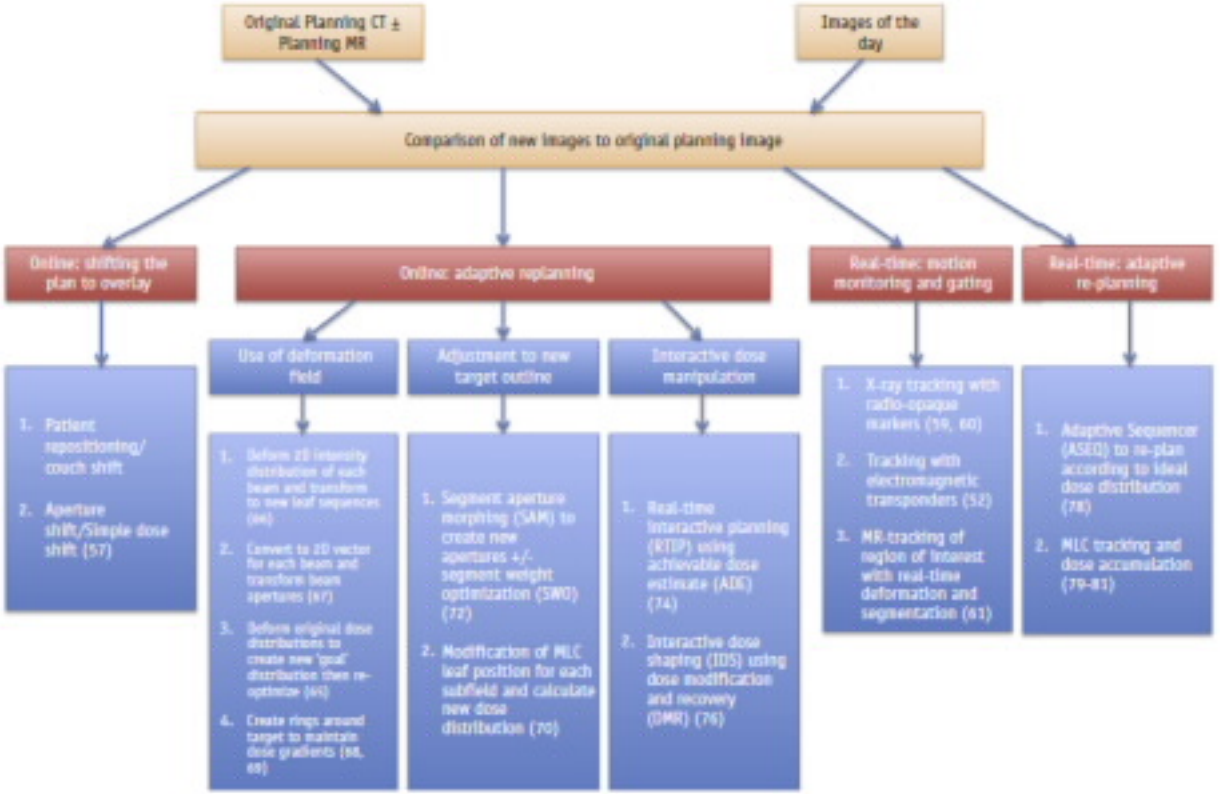



**Fig. 4.** Flow chart summarizing the spectrum of adaptive radiation therapy (ART). *Abbreviations:* CT = computed tomography; MLC = multileaf collimator; MR = magnetic resonance.

# SONUÇLAR

- PROSTAT HAREKET EDİYOR
- ÖNLEM ALINMALI
- HER KLİNİĞİN KENDİ STRATEJİSİ OLMALI