



XXI

CONGRESSO
DA SOCIEDADE
BRASILEIRA DE
RADIOTERAPIA

Estratégias do Cyberknife no controle intrafração

VILA NOVA STAR
REDE D'OR



GABRIELA REIS S DE JESUS

GRUPO ONCOLOGIA D'OR –
HOSPITAL VILA NOVA STAR

REALIZAÇÃO



SBRT
SOCIEDADE BRASILEIRA
DE RADIOTERAPIA

GERENCIAMENTO



CCM
CONGRESSES

AGÊNCIA OFICIAL



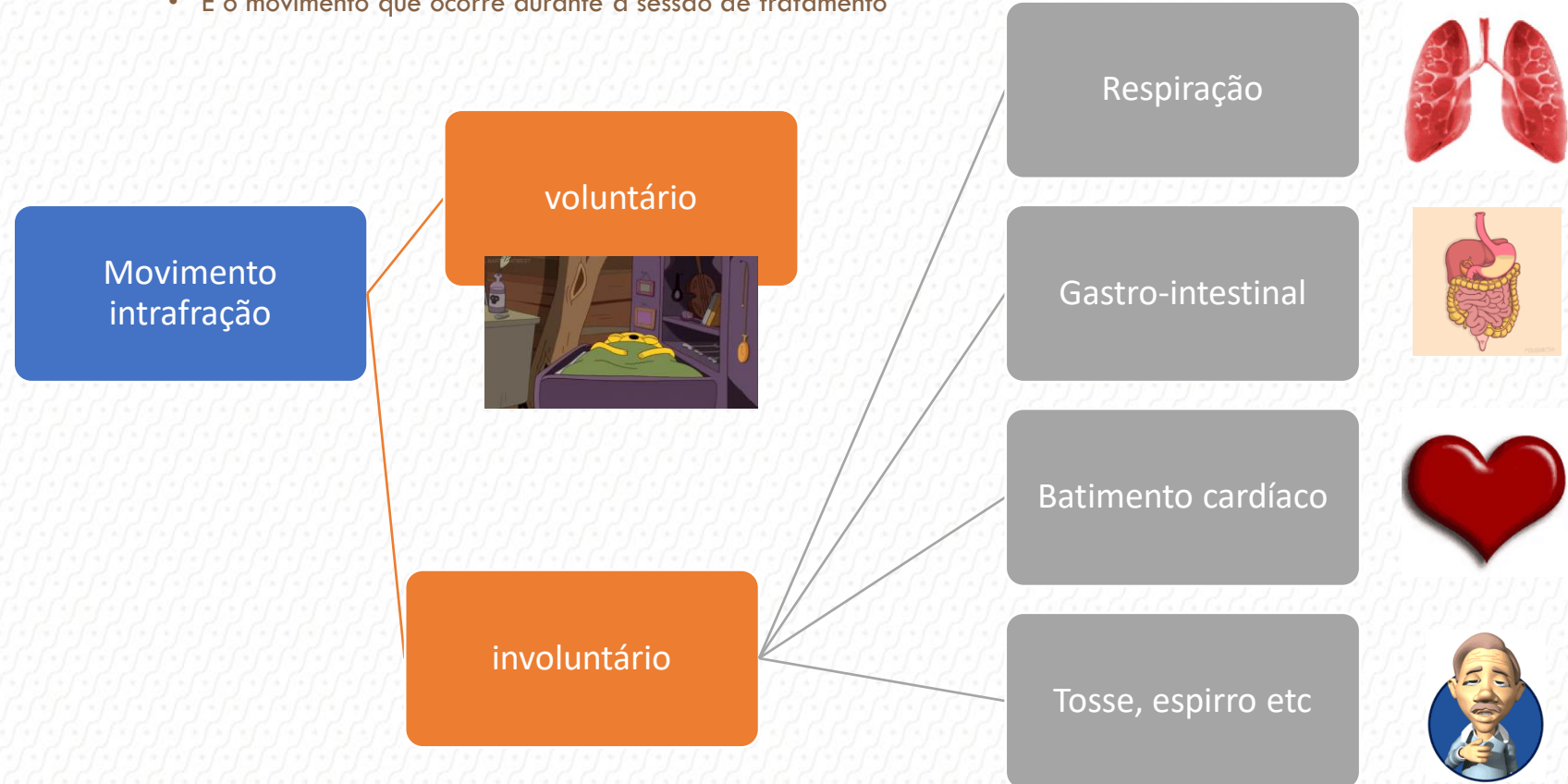
MADE FOR MEETINGS

Declaração de conflito de interesse

- Afirmando NÃO haver conflito de interesse a declarar.

Movimento intrafração: definição e exemplos

- É o movimento que ocorre durante a sessão de tratamento



Movimento intrafração: é relevante?

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ELSEVIER

Original article

Intrafraction motion quantification and planning target volume margin determination of head-and-neck tumors using cine magnetic resonance imaging

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ABSTRACT

Purpose: To quantify intrafractional motion to determine population-based margins for head-and-neck tumors.

Methods: Cine MR imaging was performed in 100 patients with head-and-neck a radiotherapy treatment setup. MR images were analyzed using deformable image registration (DIPY) and changes in tumor contour position were used to calculate intrafractional motion.



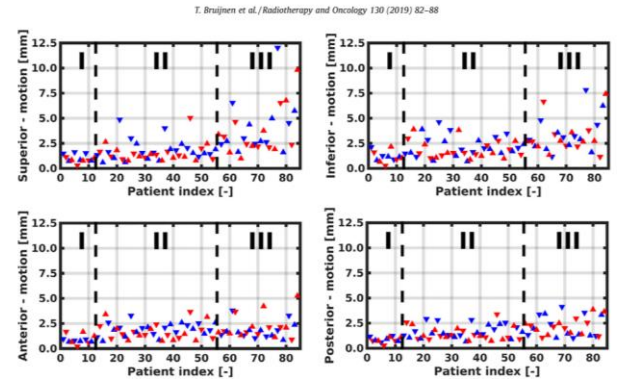


Fig. 2. Maximum (95th percentile) tumor motion (swallowing excluded) over the cine MR scans. Patients are arranged according to the anatomical position of the tumor, with I denoting the nasopharyngeal tumors, II the oropharyngeal tumors and III the laryngeal tumors. The different colors and shapes are used to distinguish neighboring points.

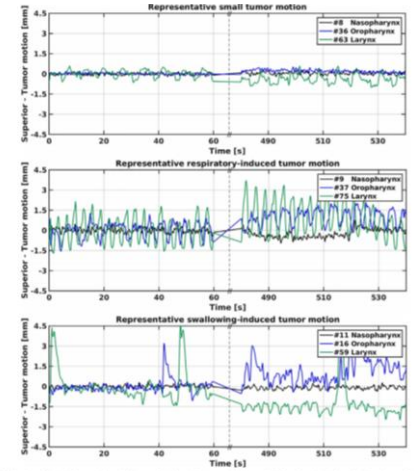


Fig. 3. Examples of motion in the superior direction for tumors that showed almost no motion, for tumors that showed respiratory induced motion and tumors that showed swallowing induced motion. The graphs have a break on the horizontal axis to differentiate the data from the two different cine MR scans.

HEAD AND NECK

Movimento intrafração: é relevante?

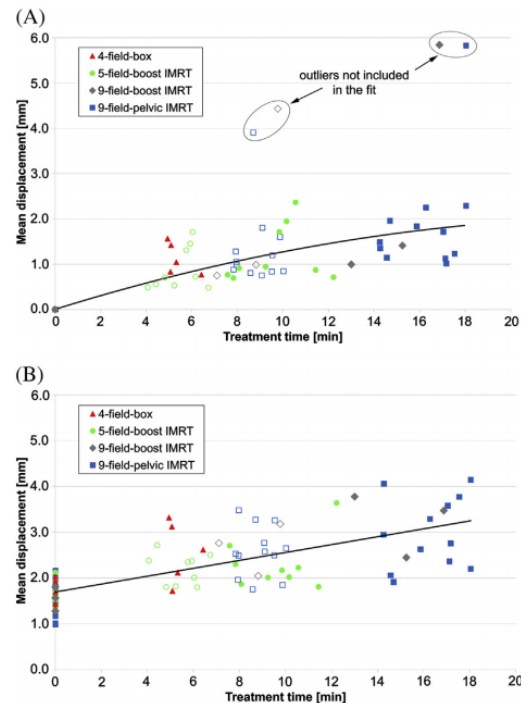


Fig. 1. Three-dimensional mean displacements of patient/bony anatomy (A) and prostate positions (B) for each patient before ($t = 0$ min), during (empty symbols) and after (filled symbols) treatment fractions with interpolated trend line. IMRT = intensity modulated radiation therapy.

Physics Contribution

Prostate and Patient Intrafraction Motion: Impact on Treatment Time-Dependent Planning Margins for Patients With Endorectal Balloon

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PROSTATE

Movimento intrafração: é relevante?

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practical radiation oncology
pro
www.practicalradonc.org

Original Report

Required target margins for image-guided lung SBRT: Assessment of target position intrafraction and correction residuals

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doi:10.1016/j.ijrobp.2010.09.035

PHYSICS CONTRIBUTION

EFFECT OF IMMOBILIZATION AND PERFORMANCE STATUS ON INTRAFRACTION MOTION FOR STEREOTACTIC LUNG RADIOTHERAPY: ANALYSIS OF 133 PATIENTS

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Table 1 Analysis of fractions with intrafraction variation greater than or less than 2 mm

Variables	IFV < 2 mm	IFV ≥ 2 mm	t test P value
Continuous variables (mean values)			
Age (y)	74.1	73.5	.48
ECOG performance status	0.94	1.01	.29
Weight (kg)	68.0	71.5	.009
GTV max dimension (cm)	2.8	2.8	.49
Excursion vector (cm)	0.54	0.67	<.001
FEV ₁ (L)	1.46	1.52	<.001
FEV ₁ % predicted	65.1%	65.8%	<.001
DLCO (mL CO/min/mm Hg)	10.93	11.52	.15
DLCO % predicted	51.0%	55.1%	<.001
Pre-correction to post-correction time (min)	7:51	8:43	<.001
Post-correction to post-treatment time (min)	23:06	25:12	<.001
Total time (min)	31:09	33:35	<.001
Categoric variables (percentage of fractions)			
Male	33%	68%	.15
Female	35%	65%	
No local recurrence	34%	66%	.68
Local recurrence	26%	74%	
Immobilization device			
α-cradle	28%	72%	
Body frame	51%	49%	
BodyFIX	40%	60%	
None	33%	67%	
Hybrid	36%	65%	
Wing board	27%	73%	

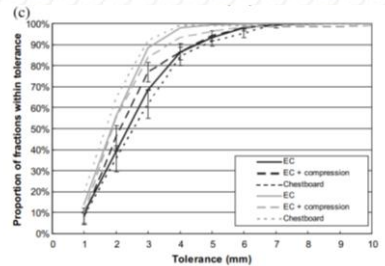
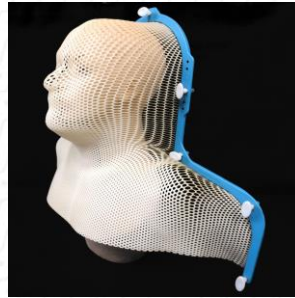


Fig. 3. Proportion of treatment fractions within tolerance (in all directions) stratified by immobilization type. (a) Comparison between localization (black) and verification (gray) CBCT scans. (b) Comparison between verification (gray) and intrafraction (black) CBCT scans. (c) Comparison between verification (gray) and post-treatment (black) CBCT scans. EC = evacuated cushion.

LUNG SBRT

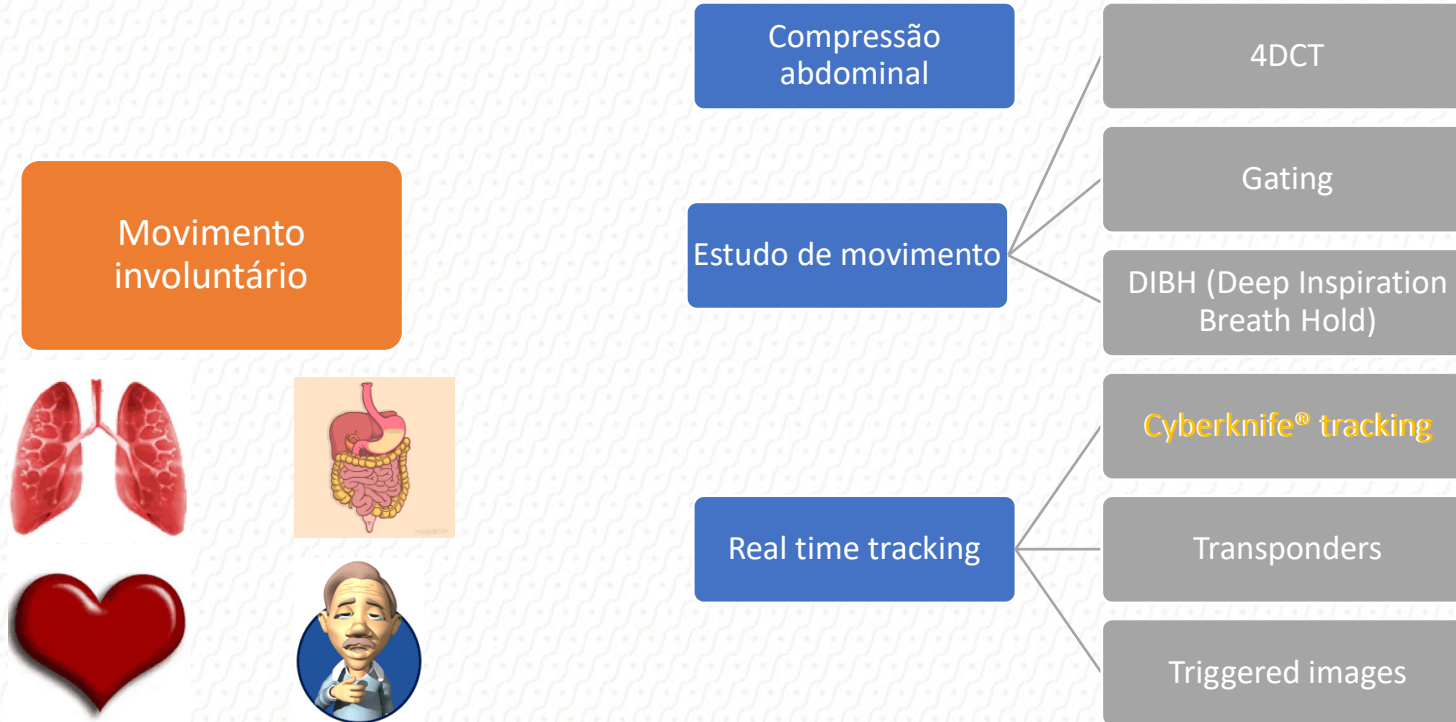
Movimento voluntário: como lidar?

Movimento voluntário

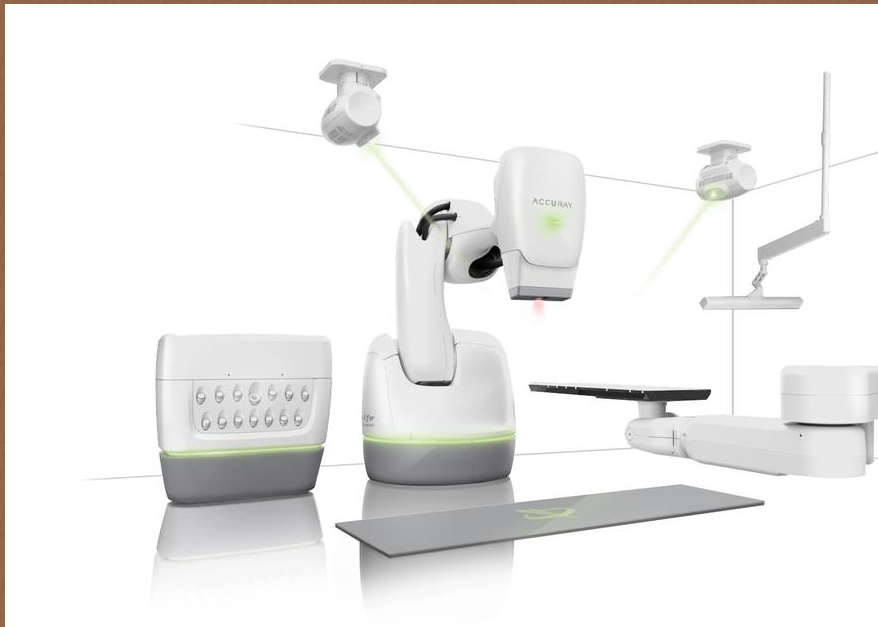


Imobilização

Movimento involuntário: como lidar?

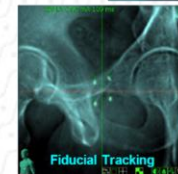
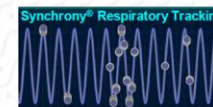
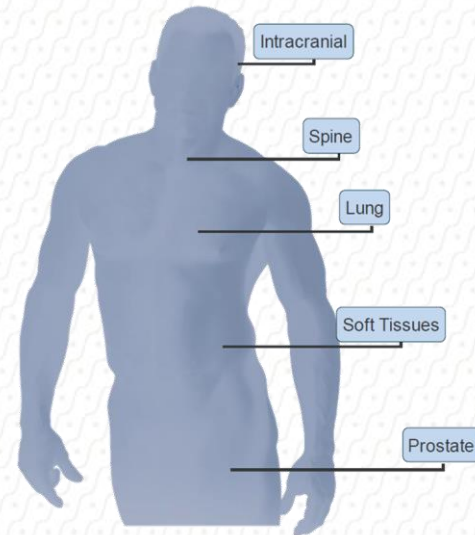


Real time tracking: Cyberknife®



- Durante a sessão de tratamento, através de imagens frequentes, os erros residuais, movimentos voluntários e involuntários são corrigidos pelo reposicionamento do robô.

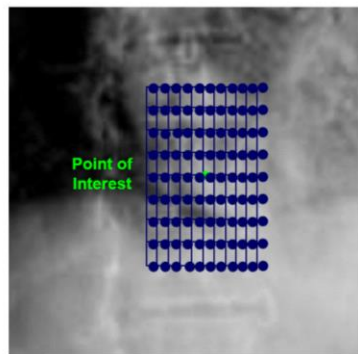
Full Body Radiosurgery



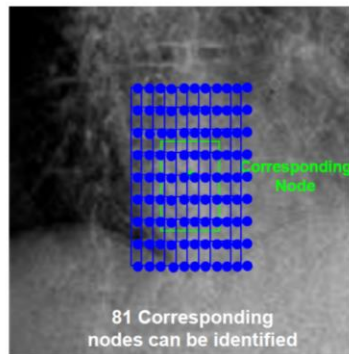
Cyberknife tracking: 6D Skull



Cyberknife tracking: Xsight Spine



DRR Image



Acquired Image

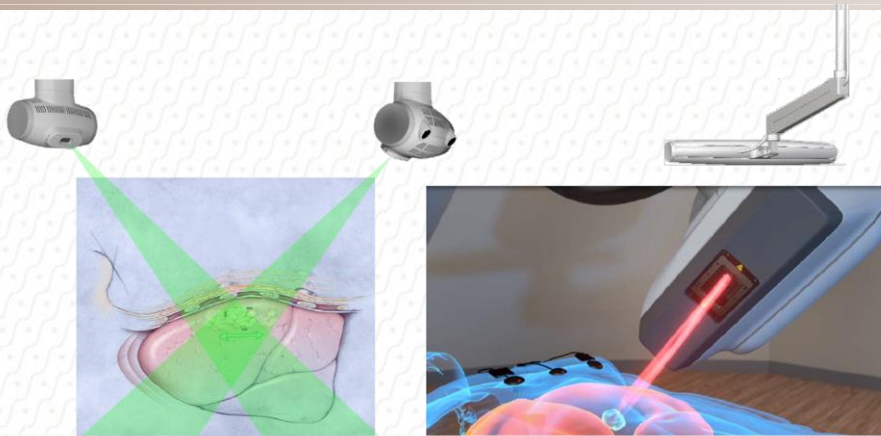


Cyberknife tracking: Fiducial



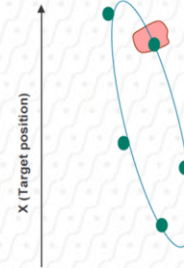
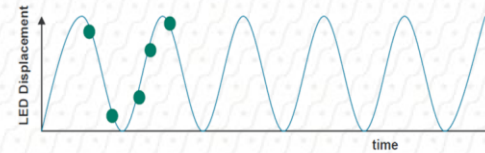
- Fiducial tracking é utilizado para lesões de tecido mole;
- Próstata, Fígado, Pâncreas, alguns tumores pulmonares, sarcomas etc;
- Mínimo de 3 fiduciais para compensar movimentos translacionais e rotacionais;
- Geralmente, os clips cirúrgicos não são visualizados pelas imagens de raios-X produzidas pelo CK

Cyberknife tracking: Synchrony®

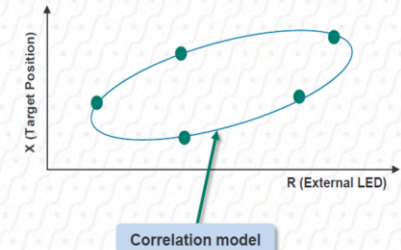


Imaging system captures target at discrete points in respiratory cycle

Optical markers are monitored in real time by the Synchrony camera system



Model creation



- O Sistema utiliza a posição dos marcadores externos (LEDs) para prever a posição do alvo interno;
- Se o padrão respiratório se altera, o modelo de correlação é atualizado;
- Se a posição do alvo detectada na imagem, não condiz com o modelo, o modelo é atualizado após a aquisição de um novo par de imagem

Cyberknife tracking: Synchrony®



Posição dos LEDs em cada par de imagem produzido

Representação do ciclo respiratório em relação ao tempo

Posição do alvo vs posição prevista

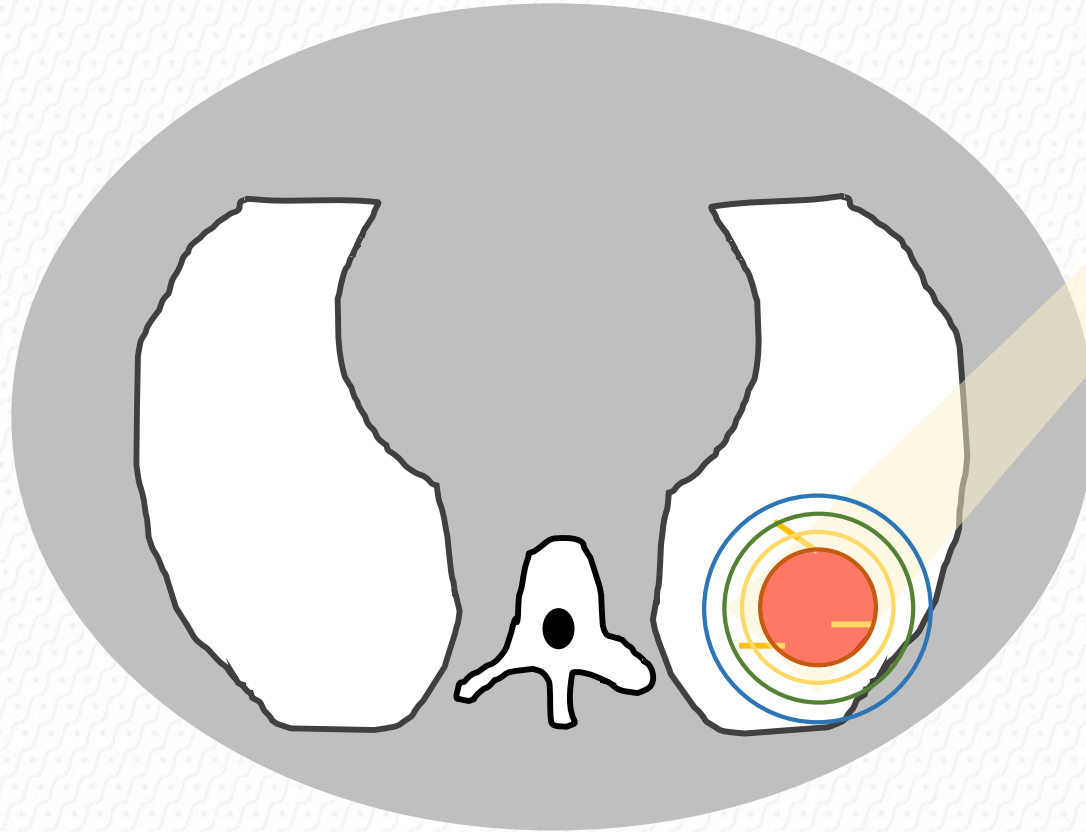


Cyberknife tracking: Synchrony®



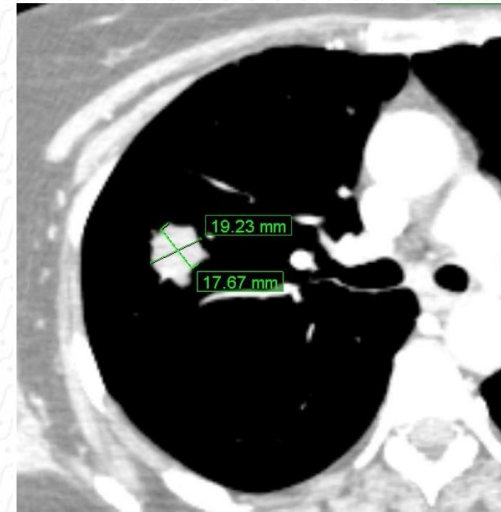
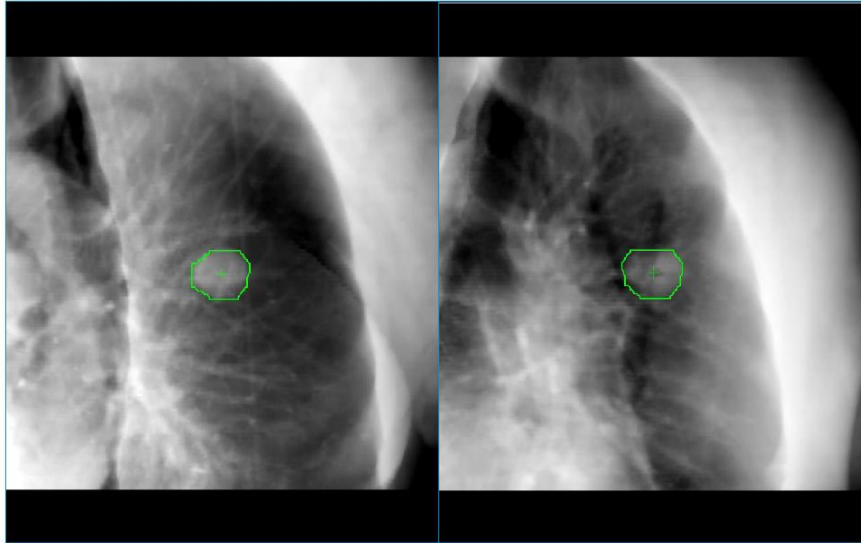
Cyberknife tracking: Synchrony fiducial®

NOVA STAR
RIO



Cyberknife tracking: Synchrony Xsight Lung®

- Permite o tratamento de lesões pulmonares SEM necessidade de fiduciais
- Uma simulação com o paciente na sala de tratamento é realizada ANTES da etapa do planejamento, a fim de verificar que parte da lesão pode ser visualizada pelas fontes de kV.



- O modelo Synchrony® é construído através da posição do TTV (Target Tracking Volume)

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RADIATION ONCOLOGY PHYSICS

WILEY

Influence of respiratory motion management technique on radiation pneumonitis risk with robotic stereotactic body radiation therapy

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Abstract

Purpose/Objectives: For lung stereotactic body radiation therapy (SBRT), real-time tumor tracking (RTT) allows for less radiation to normal lung compared to the internal target volume (ITV) method of respiratory motion management. To quantify the advantage of RTT, we examined the difference in radiation pneumonitis risk between these two techniques using a normal tissue complication probability (NTCP) model.

Materials/Method: 20 lung SBRT treatment plans using RTT were replanned with the ITV method using respiratory motion information from a 4D-CT image acquired at the original simulation. Risk of symptomatic radiation pneumonitis was calculated for both plans using a previously derived NTCP model. Features available before treatment planning that identified significant increase in NTCP with ITV versus RTT plans were identified.

Results: Prescription dose to the planning target volume (PTV) ranged from 22 to 60 Gy in 1–5 fractions. The median tumor diameter was 3.5 cm (range 2.1–5.5 cm) with a median volume of 14.5 mL (range 3.6–59.9 mL). The median increase in PTV volume from RTT to ITV plans was 17.1 mL (range 3.5–72.4 mL), and the median increase in PTV/lung volume ratio was 0.46% (range 0.13–1.98%). Mean lung dose and percentage dose–volumes were significantly higher in ITV plans at all levels tested.

The median NTCP was 5.1% for RTT plans and 8.9% for ITV plans, with a median difference of 1.9% (range 0.4–25.5%, pairwise $P < 0.001$). Increases in NTCP between plans were best predicted by increases in PTV volume and PTV/lung volume ratio.

Conclusions: The use of RTT decreased the risk of radiation pneumonitis in all plans. However, for most patients the risk reduction was minimal. Differences in plan PTV volume and PTV/lung volume ratio may identify patients who would benefit from RTT technique before completing treatment planning.

PACS
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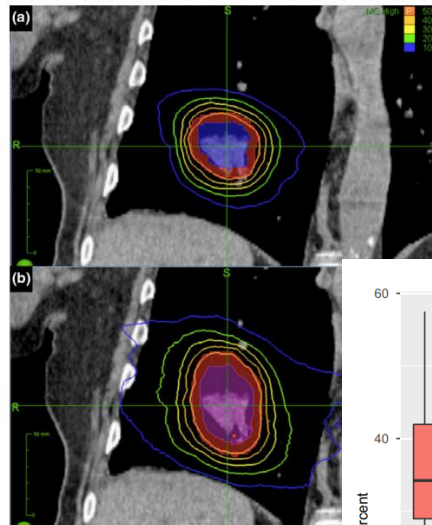
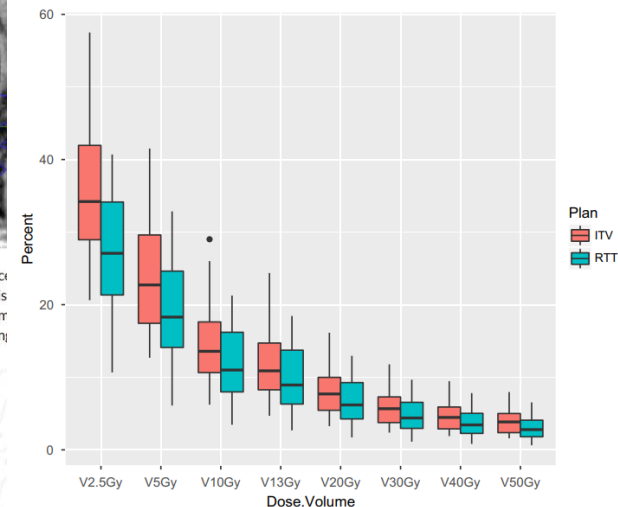


FIG. 1. Example plan comparison with coronal slice planning CT for RTT plan (a) and ITV plan (b). GTV is ITV is shaded purple, and PTVs are shaded red. From based-plan, PTV volume increased 36.4 mL, PTV/lung increased 0.69%, and NTCP increased 4.1%.



- O movimento intrafração pode ser relevante, mesmo para alvos que não se movimentam com a respiração;
- A correção de erros intrafração aumenta a segurança nos tratamentos e, em muitos casos, possibilita redução de margens, reduzindo toxicidade
- O Cyberknife® possui algoritmos de localização específicos para cada sítio anatômico e executa a correção de movimentos interfração com acurácia inferior a 0,5 mm;



OBRIGADA!

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