



Associazione
Italiana
Radioterapia
Oncologica

LA RADIOTERAPIA
PALLIATIVA CON
TECNICHE SPECIALI
DELLA MALATTIA
METASTATICA

TREVISO
7 giugno 2013



Trattamento non
chirurgico
Delle oligometastasi

Colonna: la radioterapia
stereotassica

Relatore: Rolando Polico
U.O. Radioterapia "Massimo Pieratelli"
Meldola (FC)

**La finalità dei trattamenti radioterapici
(in generale e nei tumori ossei primitivi e secondari)**

- Radicale
- Palliativa
- Sintomatica

In concorso con altre cure specifiche

- chirurgia
- chemio-ormonoterapia
- Embolizzazione
- Altro

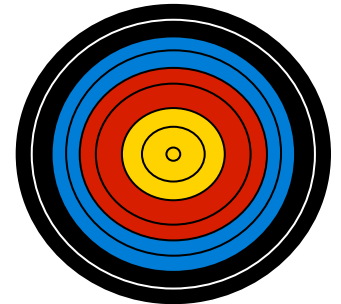
**secondo strategie e tempistiche individuate
e concordate nei gruppi multidisciplinari di
patologia**



Gruppi multidisciplinari
di osteo-oncologia

Nelle metastasi ossee l'azione della radioterapia si esercita in 3 direzioni:

- Effetto antalgico (dolore nei 2/3 dei pazienti)
- Prevenzione e cura delle fratture patologiche
- Prevenzione e cura delle paralisi secondarie a sofferenza midollare





Il ruolo antalgico della radioterapia è stato riconosciuto sin dalla sua nascita. Le prime segnalazioni risalgono agli anni '30 (Leddy), ampiamente confermato da un'abbondante successiva letteratura: il 70-80% dei pazienti risponde favorevolmente alla radioterapia con un 30-40 % di regressione sintomatica completa

Meccanismo d'azione

Effetto citocida sulle cellule neoplastiche

riduzione dei fenomeni meccanici

Induzione apoptosi cellule normali radiosensibili

espressione o inibizione di mediatori chimici

riduzione della stimolazione degli osteoclasti



Il trattamento radiante delle metastasi ossee



La radioterapia delle metastasi ossee prevede l'impiego di

Campi localizzati

Trattamento di singole lesioni

Campi estesi (*hemibody*)

Trattamento contemporaneo di sedi multiple

Isodose Lines

Isodose lines are

Max dose cGy

Add Line(s)...

Remove Line...

Line Details...

Value	Color	2D Display	3D Display
<input type="text" value="880"/>	<input type="text" value="slateblue"/>	<input checked="checked" type="checkbox"/>	<input type="checkbox"/>
<input type="text" value="800"/>	<input type="text" value="red"/>	<input checked="checked" type="checkbox"/>	<input type="checkbox"/>
<input type="text" value="760"/>	<input type="text" value="green"/>	<input checked="checked" type="checkbox"/>	<input type="checkbox"/>
<input type="text" value="720"/>	<input type="text" value="blue"/>	<input checked="checked" type="checkbox"/>	<input type="checkbox"/>
<input type="text" value="640"/>	<input type="text" value="skyblue"/>	<input checked="checked" type="checkbox"/>	<input type="checkbox"/>

Dose Display & Analysis

2D Colorwash Display On Off

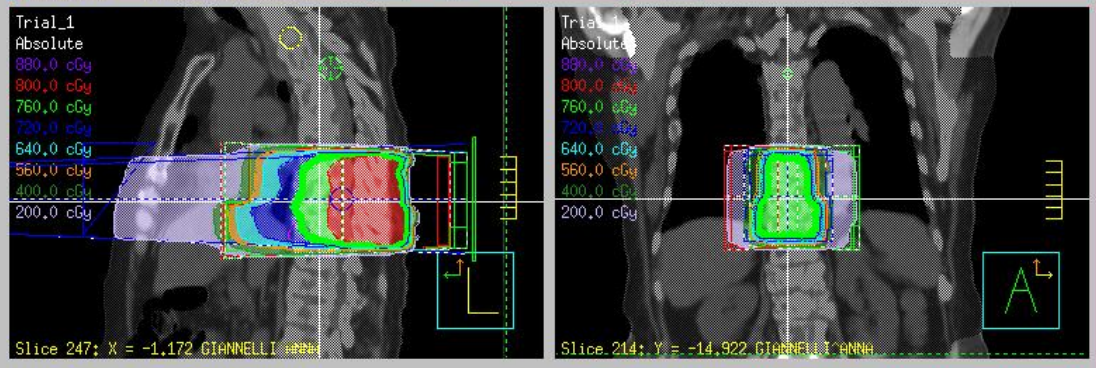
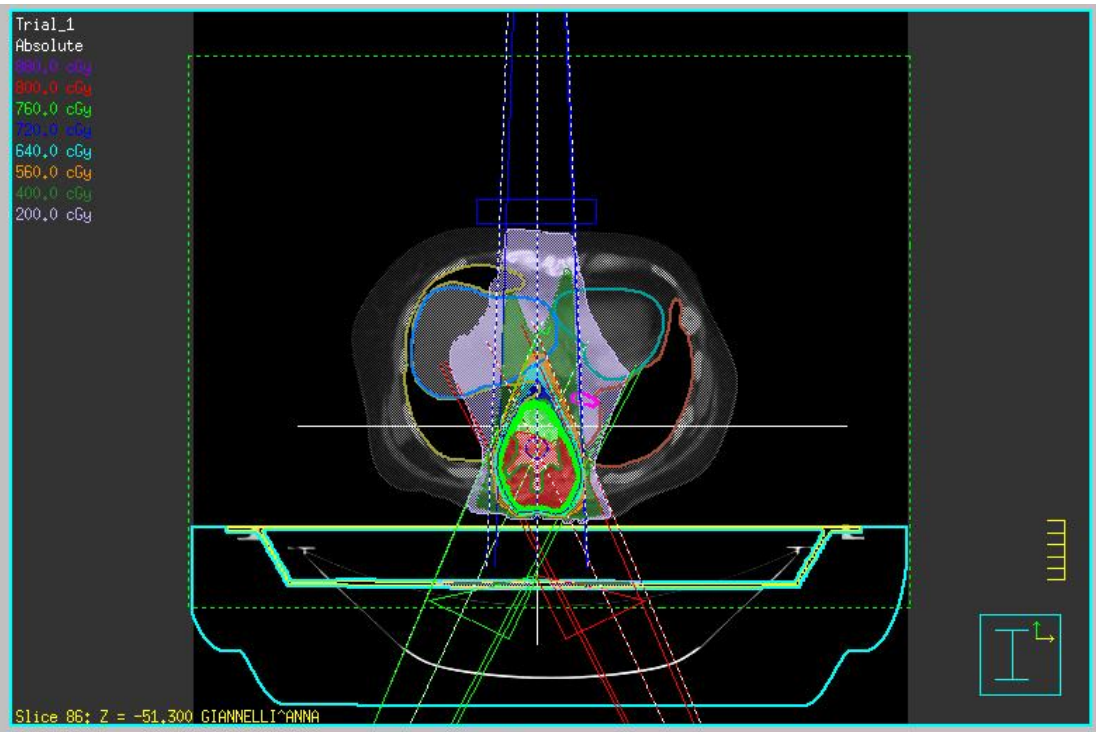
3D Colorwash Display On Off

Max dose point display... On Off

Point of Interest Dose Table...

Dose Volume Histogram...

Beam Weighting...



Primary
 Secondary
 Fusion

 Secondary:

Taskbar showing icons for 'glu 6', 'Nuovo_2', 'Nuovo_3', 'EXIT', 'cpu disk', and system tray icons including a question mark and a power button.

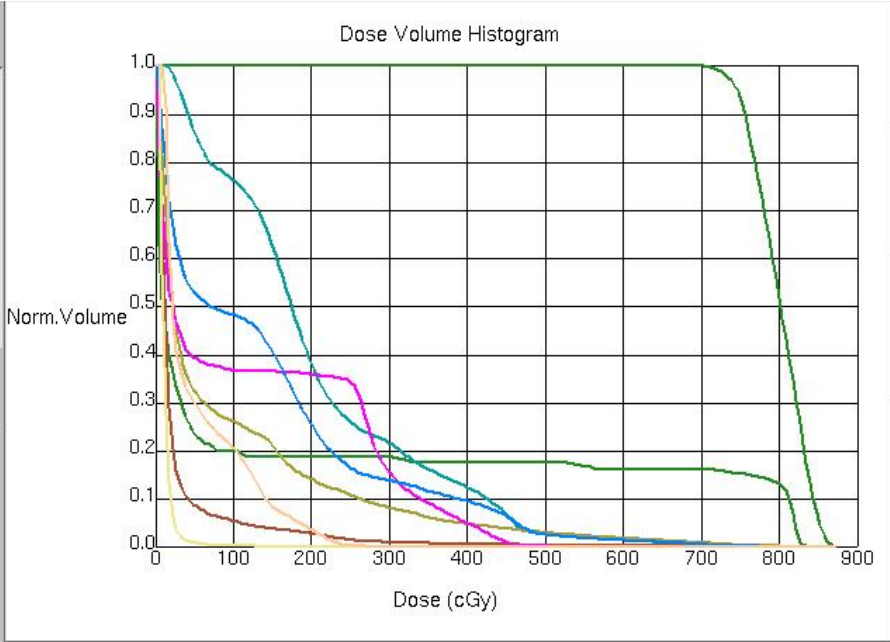
Windows taskbar showing the following applications: Reflection X..., Nuovo, Patient Select, Tools, Viewing Wind..., Pinnacle Mai..., Planning, Immagine - P..., and system clock at 8.10.

Trials

Display	Trial	Line Type
<input type="checkbox"/>	appr RP	Medium Solid
<input checked="" type="checkbox"/>	Trial_1	Medium Solid

ROIs

Display	ROI	a
<input type="checkbox"/>	D2-D6 8 GY 1 FR	1
<input checked="" type="checkbox"/>	D8-D10 8 GY 1 FR	1
<input type="checkbox"/>	L1-L3 8 GY 1 FR	1
<input checked="" type="checkbox"/>	Lung_L1	1
<input checked="" type="checkbox"/>	Lung_R1	1
<input checked="" type="checkbox"/>	esofago	1
<input checked="" type="checkbox"/>	Heart	1
<input type="checkbox"/>	Kidney_L	1
<input type="checkbox"/>	Kidney_R	1
<input type="checkbox"/>	intestino	1
<input checked="" type="checkbox"/>	fegato	1
<input checked="" type="checkbox"/>	milza	1
<input checked="" type="checkbox"/>	stomaco	1



DVH Calculation

- Cumulative
- Differential

Dose Axis Display

- Normalized Dose
- Absolute Dose
- Auto-Compute Max
- Specify Max Dose

Volume Axis Display

- Normalized Volume
- Absolute Volume

Tabular DVH...

ROI Statistics Compute

Line Type	ROI	Trial	Min.	Max.	Mean	Std. Dev.	% Outside Grid	% > Max	Generalized EUD
<input checked="" type="checkbox"/>	Cord4	Trial_1	0.0	835.2	121.2	270.7	19.95 %	0.00 %	--
<input type="checkbox"/>	D8-D10 8 GY 1 FR	Trial_1	658.5	869.8	800.0	33.6	0.00 %	0.00 %	--
<input type="checkbox"/>	Heart	Trial_1	14.0	743.5	200.7	137.0	0.00 %	0.00 %	--
<input type="checkbox"/>	Lung_L1	Trial_1	2.1	753.4	26.0	54.7	0.00 %	0.00 %	--
<input type="checkbox"/>	Lung_R1	Trial_1	2.3	802.8	86.3	136.6	0.00 %	0.00 %	--
<input type="checkbox"/>	esofago	Trial_1	2.1	506.7	122.6	147.8	0.00 %	0.00 %	--
<input type="checkbox"/>	fegato	Trial_1	1.6	773.6	135.6	151.0	0.20 %	0.00 %	--
<input type="checkbox"/>	milza	Trial_1	4.9	130.0	11.8	7.8	0.00 %	0.00 %	--

Beams

- D8_180-130
- D8_130-180
- D8_50-310
- D8_310-50

Add Beam

Delete Beam...

Control Point 1

Setup

Geometry

Modifiers

Isocenter Iso D8-D10

Angles

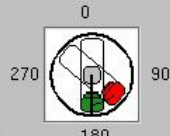
Couch

0



Gantry

Start 180



Stop 130

Gantry Rotation Direction

Collimator (from above)

0.0



Jaws

	X2	X1	Symmetric
cross-plane	4.47	4.32	No
in-plane	5.00	4.50	No

Units: cm Y1 Y2

Apply To All Beams

- appr RP
- Absolute
- 880,0 cGy
- 800,0 cGy
- 760,0 cGy
- 720,0 cGy
- 640,0 cGy
- 560,0 cGy
- 400,0 cGy
- 200,0 cGy

Slice 86; Z = -51,300 GIANNELLI ANNA

- appr RP
- Absolute
- 880,0 cGy
- 800,0 cGy
- 760,0 cGy
- 720,0 cGy
- 640,0 cGy
- 560,0 cGy
- 400,0 cGy
- 200,0 cGy

Slice 247; X = -1,172 GIANNELLI ANNA

- appr RP
- Absolute
- 880,0 cGy
- 800,0 cGy
- 760,0 cGy
- 720,0 cGy
- 640,0 cGy
- 560,0 cGy
- 400,0 cGy
- 200,0 cGy

Slice 214; Y = -14,922 GIANNELLI ANNA

Primary Secondary Fusion Reset to T/S/C Secondary:

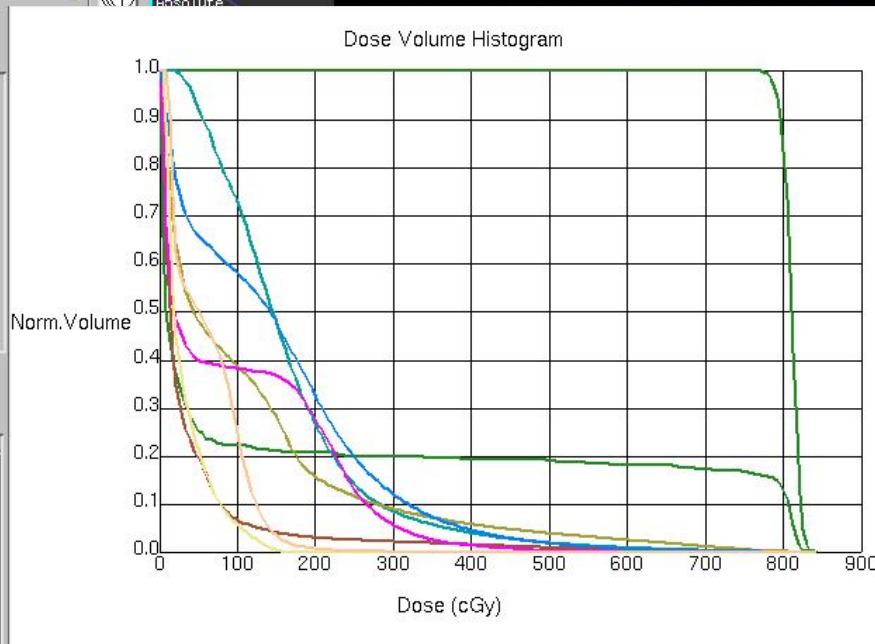
Beams

Trials

Display	Trial	Line Type
<input checked="" type="checkbox"/>	appr RP	Medium Solid
<input type="checkbox"/>	Trial_1	Thin Solid

ROIs

Display	ROI	a
<input type="checkbox"/>	D2-D6 8 GY 1 FR	1
<input checked="" type="checkbox"/>	D8-D10 8 GY 1 FR	1
<input type="checkbox"/>	L1-L3 8 GY 1 FR	1
<input checked="" type="checkbox"/>	Lung_L1	1
<input checked="" type="checkbox"/>	Lung_R1	1
<input checked="" type="checkbox"/>	esofago	1
<input checked="" type="checkbox"/>	Heart	1
<input type="checkbox"/>	Kidney_L	1
<input type="checkbox"/>	Kidney_R	1
<input type="checkbox"/>	intestino	1
<input checked="" type="checkbox"/>	fegato	1
<input checked="" type="checkbox"/>	milza	1
<input checked="" type="checkbox"/>	stomaco	1



DVH Calculation

- Cumulative
 - Differential
- Dose Axis Display
- Normalized Dose
 - Absolute Dose
 - Auto-Compute Max
 - Specify Max Dose

Volume Axis Display

- Normalized Volume
- Absolute Volume

Tabular DVH...

ROI Statistics

Line Type	ROI	Trial	Min.	Max.	Mean	Std. Dev.	% Outside Grid	% > Max	Generalized EUD
<input checked="" type="checkbox"/>	Cord4	appr RP	0.1	832.8	131.9	280.2	19.95 %	0.00 %	--
<input type="checkbox"/>	D8-D10 8 GY 1 FR	appr RP	746.0	841.4	810.2	10.5	0.00 %	0.00 %	--
<input type="checkbox"/>	Heart	appr RP	19.4	785.2	163.9	105.4	0.00 %	0.00 %	--
<input type="checkbox"/>	Lung_L1	appr RP	2.1	771.1	36.8	75.2	0.00 %	0.00 %	--
<input type="checkbox"/>	Lung_R1	appr RP	3.9	807.7	110.5	145.7	0.00 %	0.00 %	--
<input type="checkbox"/>	esofago	appr RP	2.8	587.1	99.3	118.0	0.00 %	0.00 %	--
<input type="checkbox"/>	fegato	appr RP	2.5	773.5	148.5	130.2	0.20 %	0.00 %	--
<input type="checkbox"/>	milza	appr RP	5.5	160.9	32.3	31.1	0.00 %	0.00 %	--

Status

NUOVO_2

NUOVO_3

cpu disk

Reflection X Man...

Nuovo

Patient Select

Tools

Viewing Window...

Pinnacle Main M...

Planning

8.06

Trials

Display Trial Line Type

appr RP Medium Solid

Trial_1 Medium Dashed

ROIs

Display ROI a

D2-D6 8 GY 1 FR 1

D8-D10 8 GY 1 FR 1

L1-L3 8 GY 1 FR 1

Lung_L1 1

Lung_R1 1

esofago 1

Heart 1

Kidney_L 1

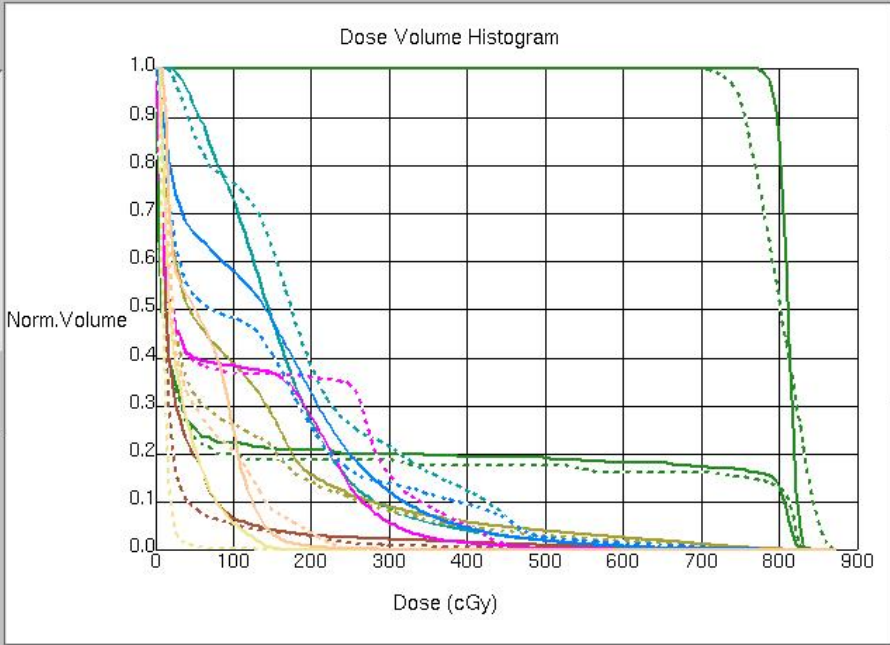
Kidney_R 1

intestino 1

fegato 1

milza 1

stomaco 1



DVH Calculation

Cumulative

Differential

Dose Axis Display

Normalized Dose

Absolute Dose

Auto-Compute Max

Specify Max Dose

Volume Axis Display

Normalized Volume

Absolute Volume

Tabular DVH...

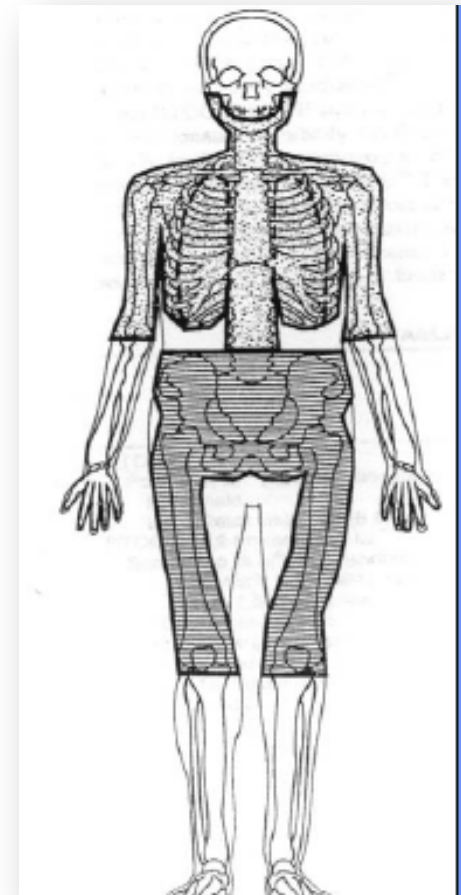
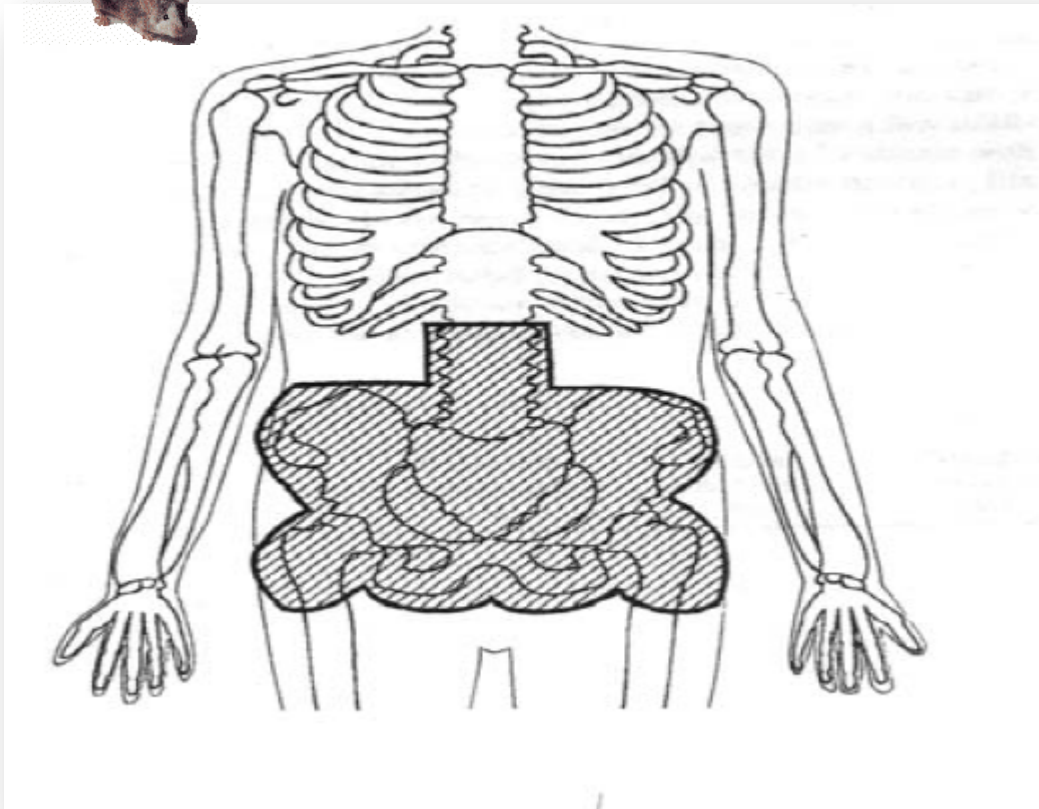
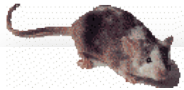
ROI Statistics Compute

Line Type	ROI	Trial	Min.	Max.	Mean	Std. Dev.	% Outside Grid	% > Max	Generalized EUD
<input type="checkbox"/>	Cord4	Trial_1	0.0	835.2	121.2	270.7	19.95 %	0.00 %	--
<input checked="" type="checkbox"/>	Cord4	appr RP	0.1	832.8	131.9	280.2	19.95 %	0.00 %	--
<input type="checkbox"/>	D8-D10 8 GY 1 FR	Trial_1	658.5	869.8	800.0	33.6	0.00 %	0.00 %	--
<input checked="" type="checkbox"/>	D8-D10 8 GY 1 FR	appr RP	746.0	841.4	810.2	10.5	0.00 %	0.00 %	--
<input type="checkbox"/>	Heart	Trial_1	14.0	743.5	200.7	137.0	0.00 %	0.00 %	--
<input checked="" type="checkbox"/>	Heart	appr RP	19.4	785.2	163.9	105.4	0.00 %	0.00 %	--
<input type="checkbox"/>	Lung_L1	Trial_1	2.1	753.4	26.0	54.7	0.00 %	0.00 %	--
<input checked="" type="checkbox"/>	Lung_L1	appr RP	2.1	771.1	36.8	75.2	0.00 %	0.00 %	--

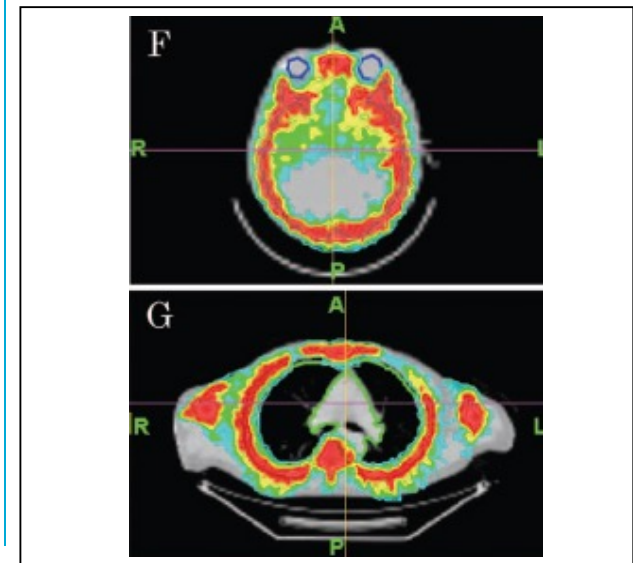
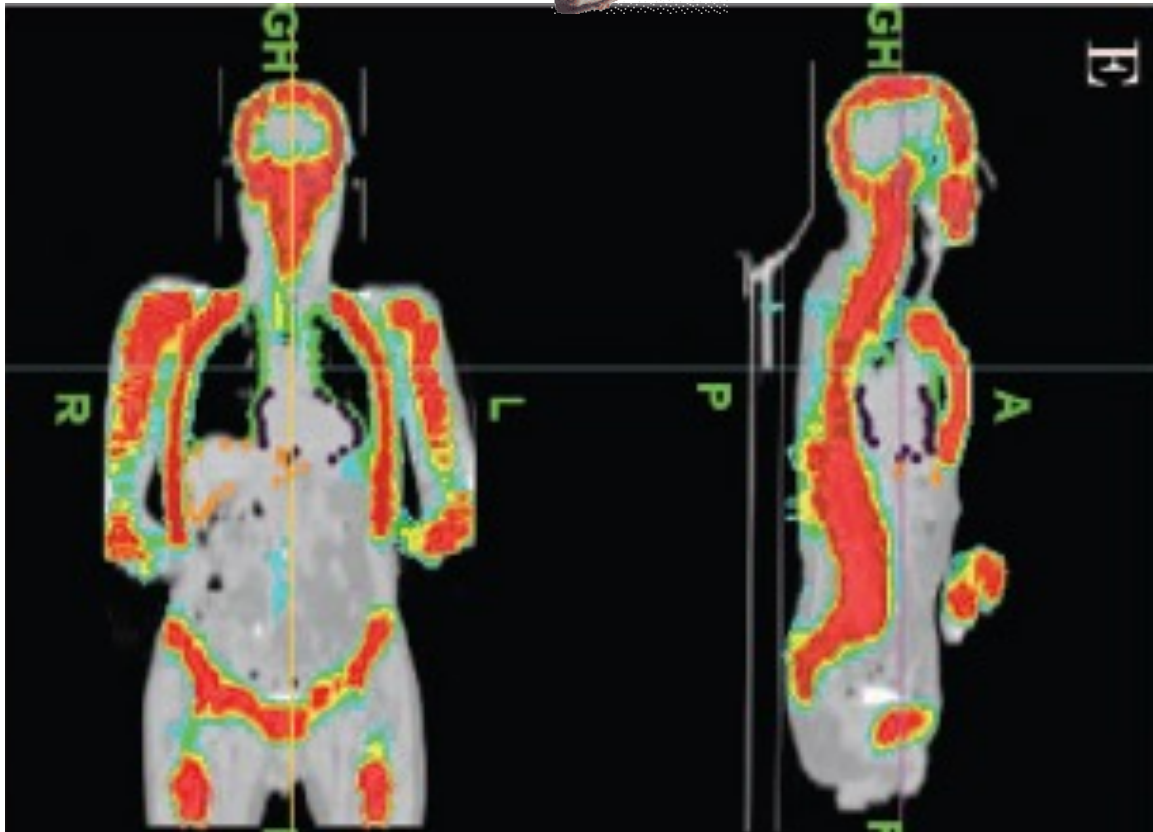
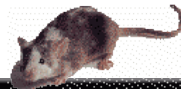
Windows taskbar showing system tray icons (clock, volume, network, etc.) and open applications: giu 6, Nuovo, Patient Sel..., Tools, Viewing Wi..., Pinnacle M..., Planning, Plan Evalu..., Immagine ...

1. campi estesi all'emicorpo

1. esempi di tecniche con fasci a fluenza continua, contrapposti AP-PA, schermati, con calcolo della dose all'emispessore o tridimensionale e pianificazione diretta



2.2 esempi di tecniche a fasci modulati: le favorevoli distribuzione di dose osservabili nelle procedure di irradiazione midollare (BMI) sono trasferibili all'hemibody irradiation





Frazionamento della dose

Clinical Oncology (2003) 15: 345–352
doi:10.1016/S0936-6555(03)00113-4

Overview

Palliation of Metastatic Bone Pain: Single Fraction versus Multifraction Radiotherapy – A Systematic Review of Randomised Trials

W. M. Sze*, M. D. Shelley†, I. Held§, T. J. Wilt¶, M. D. Mason‡

*Department of Clinical Oncology, Pamela Youde Nethersole Eastern Hospital, Hong Kong, PR China; †Cochrane Unit, Velindre NHS Trust, Cardiff, U.K.; ‡Section of Oncology and Palliative Medicine, Velindre NHS Trust, Cardiff, U.K.; §Department of Oncology, Wrexham Maelor Hospital, Wrexham, U.K.; ¶Minneapolis VA Center for Chronic Disease Outcomes Research, Minneapolis, MN, U.S.A.

CLINICAL INVESTIGATION

Bone

META-ANALYSIS OF DOSE-FRACTIONATION RADIOTHERAPY TRIALS FOR THE PALLIATION OF PAINFUL BONE METASTASES

JACKSON SAI-YIU WU, M.D., F.R.C.P.C.,* REBECCA WONG, M.B.Ch.B., M.Sc., F.R.C.P.C.,†
MARY JOHNSTON, B.Sc.,‡ ANDREA BEZIAK, M.D.C.M., M.Sc., F.R.C.P.C.,†
AND TIMOTHY WHELAN, B.M.B.Ch., F.R.C.P.C.,*

ON BEHALF OF THE CANCER CARE ONTARIO PRACTICE GUIDELINES INITIATIVE SUPPORTIVE CARE GROUP§

*Division of Radiation Oncology, Hamilton Regional Cancer Centre, and Department of Medicine, McMaster University, Hamilton, Ontario, Canada; †Department of Radiation Oncology, Princess Margaret Hospital, University of Toronto, Toronto, Ontario, Canada; ‡Department of Clinical Epidemiology and Biostatistics, McMaster University, Hamilton, Ontario, Canada; §Program in Evidence-Based Care, Cancer Care Ontario, Ontario, Canada

Definizione delle procedure chirurgiche oncologiche

Intralesionale

Rimozione a pezzi o escissione in blocco con margine di taglio dentro il tumore

Marginale

Escissione in blocco lungo la pseudocapsula

Ampio

Escissione in blocco fuori la pseudocapsula

Radicale

Escissione in blocco dell'intero compartimento

Palliativo

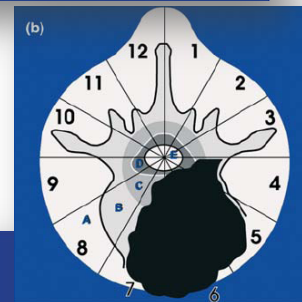
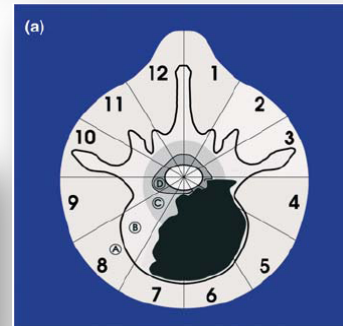
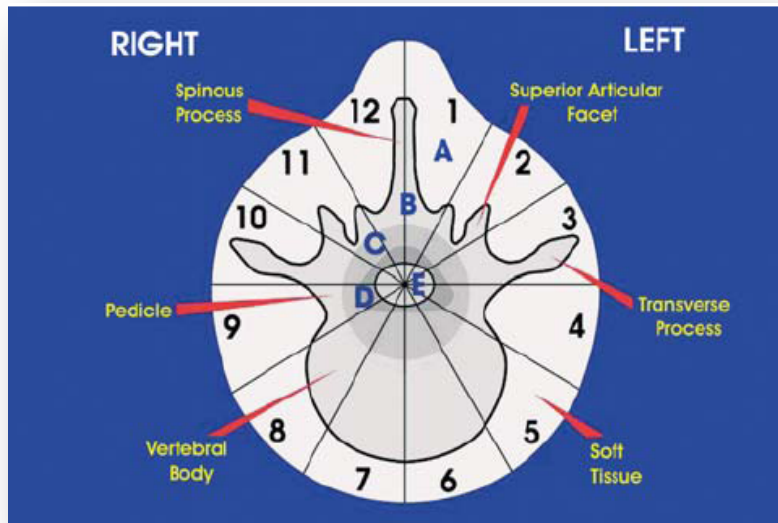
Qualsiasi procedura con scopo solo funzionale



Tumors of the osseous spine

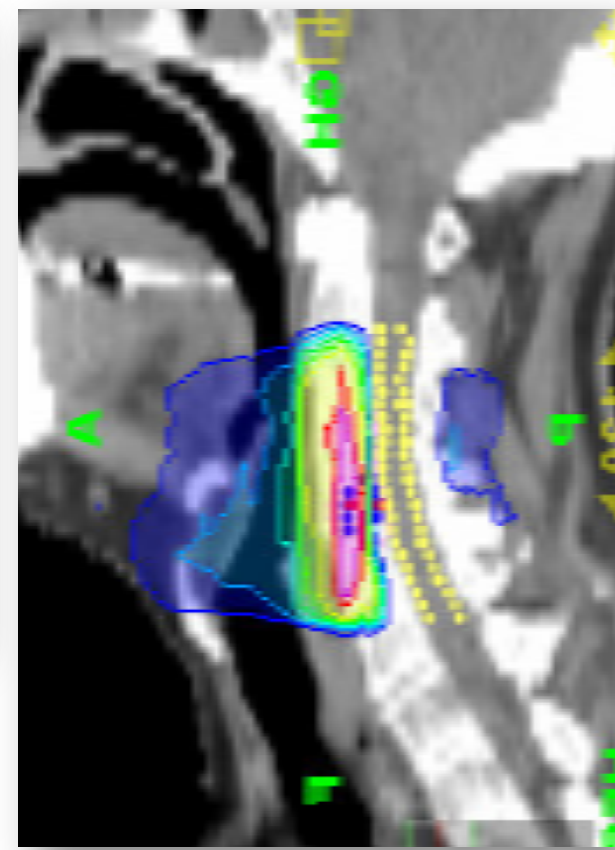
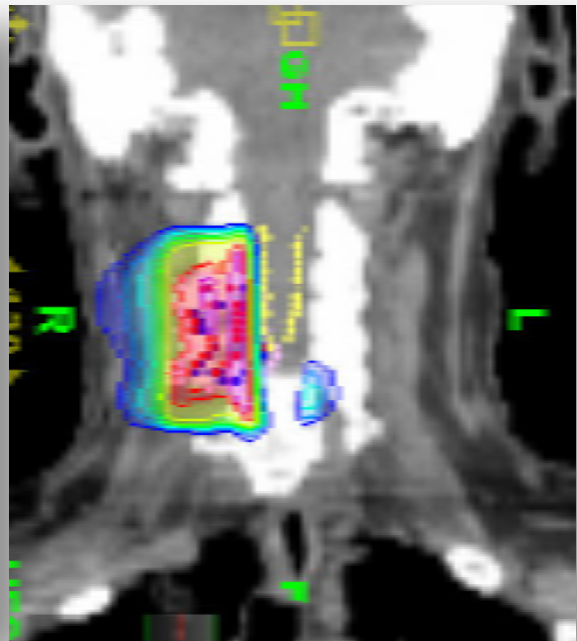
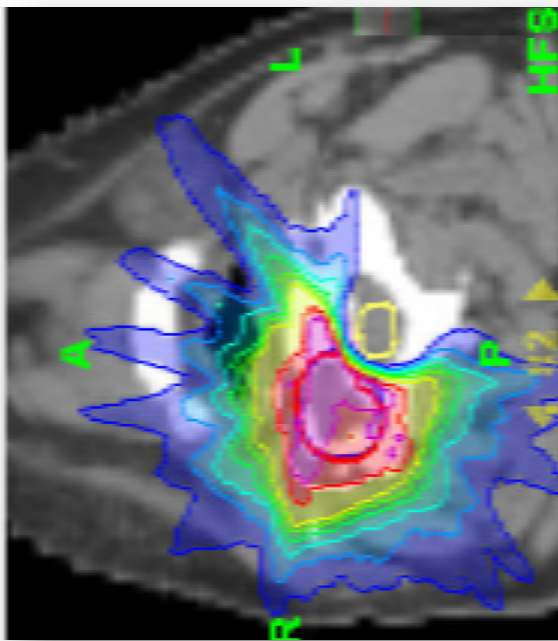
Narayan Sundaesan^{1,2}, Stephano Boriani³, Allen Rothman¹ and Robert Holtzman⁴

¹Department of Neurosurgery, Mount Sinai Medical Center, New York, NY; ²Medtronic Sofamor Danek, Memphis, TN, USA; ³Ospedale Maggiore, Institute Rizzoli, Bologna, Italy; ⁴Department of Neurosurgery, Lenox Hill Hospital, New York, NY, USA

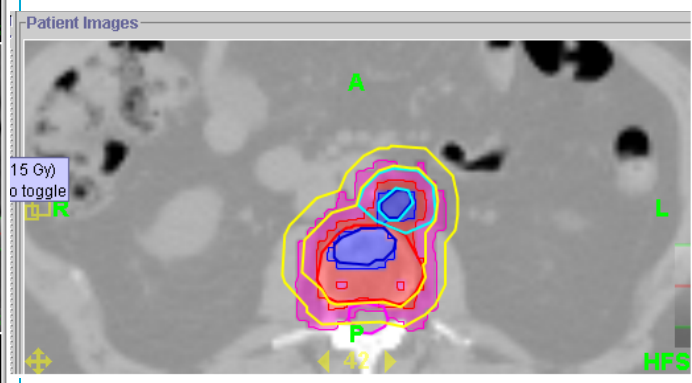
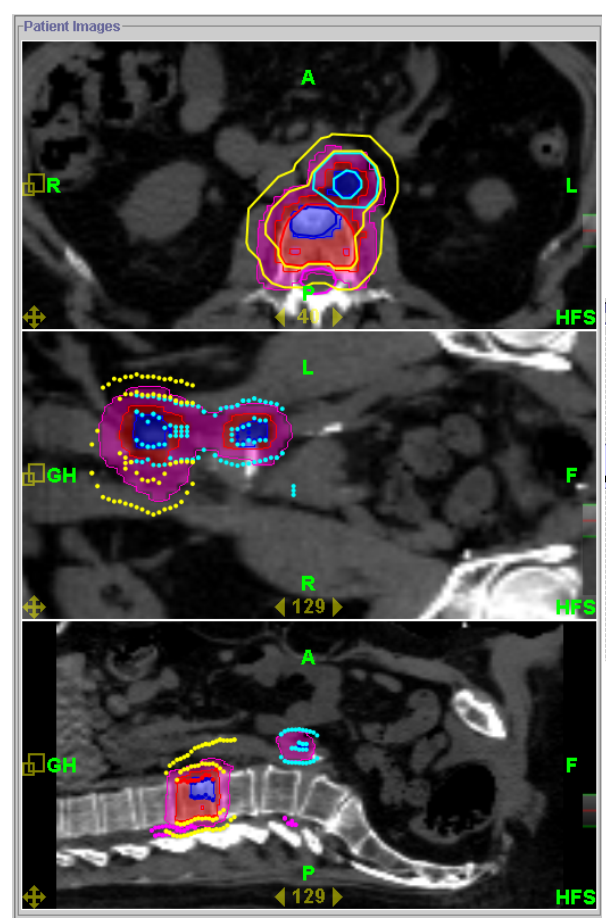
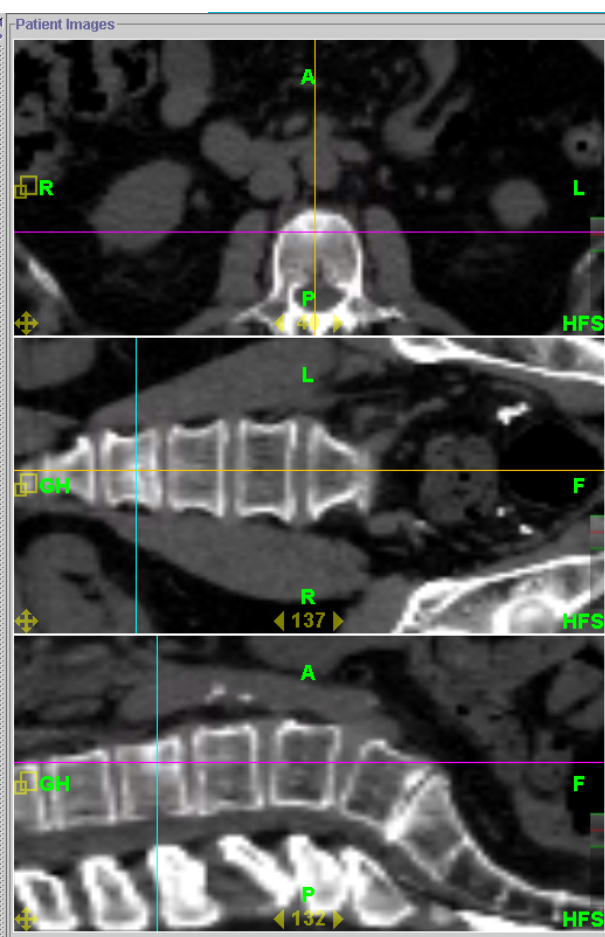


In the transverse plane, the vertebra is divided into 12 radiating zones (numbered 1–12 in a clockwise order) and into five layers (A to E, from the paravertebral extraosseous region to the dural involvement). The longitudinal extent of the tumor is deduced by recording the spine segment(s) involved

Tecnica radioterapica 1



Tecnica radioterapica 2



Tecnica radioterapica 2



The plan has 3 fractions defined for a planned delivery of 15.0 Gy.
95.0% of the 75 Gy-volume receives at least 15.0 Gy for the current plan.
Modulation factor for this tomotherapy IMRT plan is 2.778

Fraction	Locked	Fraction Date	Fraction	Locked	Fraction Date
1	<input type="checkbox"/>	October 06, 2008			
2	<input type="checkbox"/>	October 07, 2008			
3	<input type="checkbox"/>	October 08, 2008			

Finalize
Final Dose
Final Accept
Plan Report

Tumor Settings

Name	Display	Color
18.GY.3.FR2	<input checked="" type="checkbox"/>	Blue
15.GY	<input checked="" type="checkbox"/>	Red

Sensitive Structure Settings

Name	Display	Color
MENO DI 17	<input checked="" type="checkbox"/>	Magenta
Bpdy	<input checked="" type="checkbox"/>	Green
rimo 18Gy	<input type="checkbox"/>	Cyan
rimo 15 Gy	<input type="checkbox"/>	Yellow

Dose Display

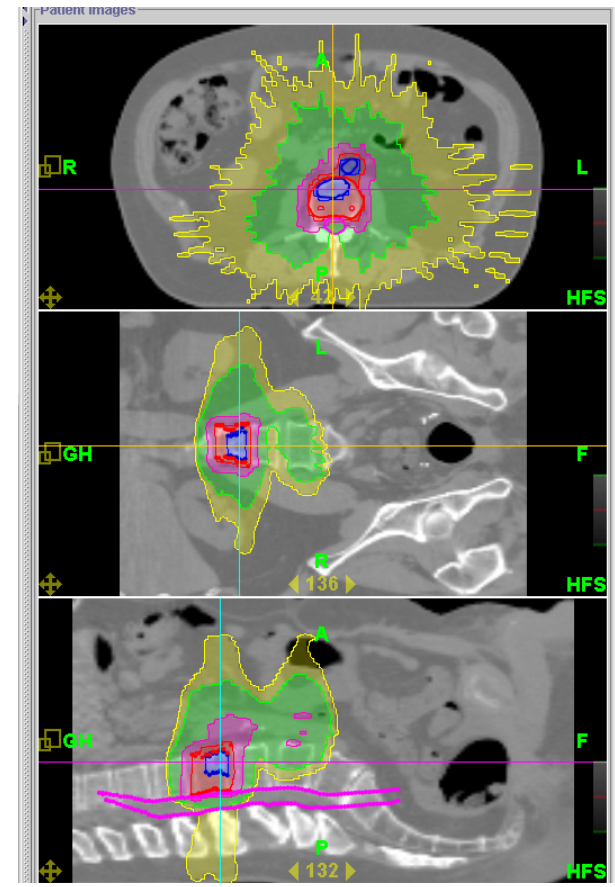
Isodose

17.8
15
10

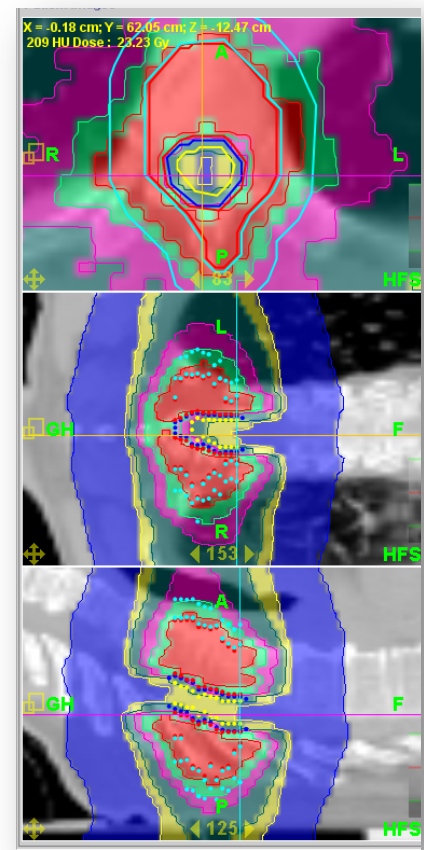
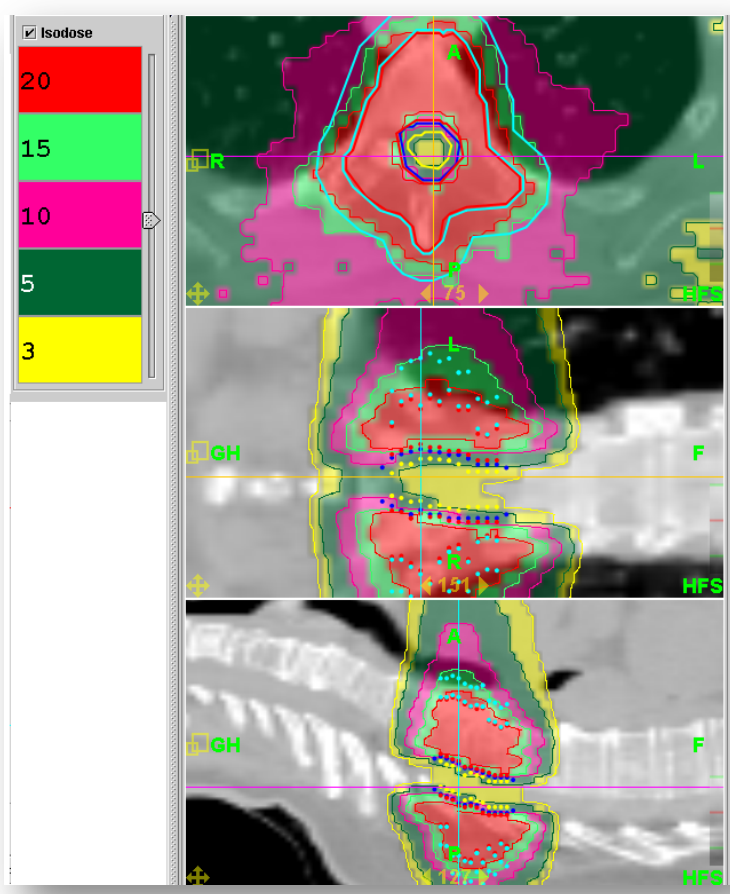
Dose-Volume Histogram - Cumulative Mode Relative

Vol Min < 0.0 Gy Min < 0.0 Gy Max < 20.0

Wednesday, October 8, 2008 18:41:10



Tecnica radioterapica 3



Tecnica radioterapica 3



0.1% of the 20Gy in5fr volume receives at least 30.0 Gy for the current plan.
Modulation factor for this tomotherapy IMRT plan is 2.908

Fraction	Locked	Fraction Date	Fraction	Locked	Fraction Date
1	<input type="checkbox"/>	September 22, 2008			
2	<input type="checkbox"/>	September 23, 2008			
3	<input type="checkbox"/>	September 24, 2008			
4	<input type="checkbox"/>	September 25, 2008			
5	<input type="checkbox"/>	September 26, 2008			
6	<input type="checkbox"/>	September 29, 2008			
7	<input type="checkbox"/>	September 30, 2008			
8	<input type="checkbox"/>	October 01, 2008			
9	<input type="checkbox"/>	October 02, 2008			
10	<input type="checkbox"/>	October 03, 2008			

Isodose

- 20
- 15
- 10
- 5
- 3

Finalize

Final Dose
Final Accept
Plan Report

Tumor Settings

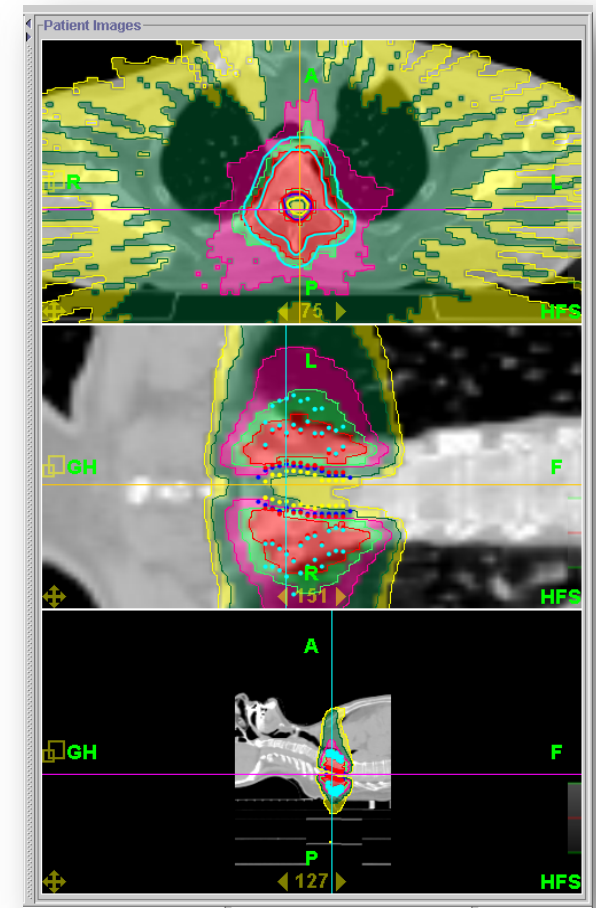
Name	Display	Color
MIDOLLO SF	<input checked="" type="checkbox"/>	Yellow
MIDOLLO E	<input checked="" type="checkbox"/>	Blue
20Gy in5fr	<input checked="" type="checkbox"/>	Red

Sensitive Structure Settings

Name	Display	Color
VERT DOR	<input type="checkbox"/>	Dark Green
BODY	<input type="checkbox"/>	Magenta
COUCH	<input type="checkbox"/>	Light Green
RING 1cm	<input checked="" type="checkbox"/>	Cyan

Dose-Volume Histogram - Cumulative Mode Relative

Vol Min < 0.0 > Gy Min < 0.0 > Gy Max < 30.0 >



Spinal re-irradiation

A second episode of MSCC occurs in 7–14% of the patients.

$BED = D \times [1 + (d/a/b)]$, as derived from the linear-quadratic model; D = total dose, d = dose per fraction, a = linear (first-order dose-dependent) component of cell killing, b = quadratic (second-order dose dependent) component of cell killing, a/b-ratio = the dose at which both components of cell killing are equal [58]. The a/b-ratio suggested for radiation myelopathy is 2 Gy.



Short-course

Re-RT appears safe if the cumulative BED (primary RT plus re-RT) is 100 Gy² or less. If two series of short course RT are delivered, radiation myelopathy appears unlikely. The cumulative BED is 80 Gy² for 1×8Gy plus 1×8 Gy, 97.5 Gy² for 5×4 Gy plus 5×3 Gy, and 100 Gy² for 5×4 Gy plus 1×8 Gy, respectively.

Long course

If long course RT with a higher BED (BED = 75 Gy² for 10×3 and BED = 80 Gy² for 20×2 Gy) was the primary treatment, the risk of radiation myelopathy appears small for a cumulative BED of 135.5 Gy² or less, if the interval between primary RT and re-RT is 6 months and the BED of each RT course is 98 Gy².

Re-RT with 1×8Gy, 5×3 Gy, or 5×4 Gy is effective. Improvement of motor function occurred in 40% of the re-irradiated patients with no further progression of motor dysfunction in another 45%. After primary long-course RT, new radiation techniques such as IMRT, stereotactic radiosurgery, tomotherapy, and proton therapy can be used to reduce the cumulative BED delivered to the spinal cord, in particular if the cumulative BED exceeds 135.5 Gy².

Review

Cancer Response Criteria and Bone Metastases: RECIST 1.1, MDA and PERCISTColleen M. Costelloe¹✉, Hubert H. Chuang², John E. Madewell¹, Naoto T. Ueno³

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RECIST

Response Evaluation Criteria in Solid Tumors

..... updated to **RECIST 1.1** in 2009

One of the differences between RECIST and RECIST 1.1 is that bone metastases with soft tissue masses measuring ≥ 10 mm are now accepted as target lesions. The soft tissue component is to be measured in an identical manner to that used for other target lesions

RECIST 1.1 specifies contrast administration for both MRI and CT scans.

RECIST 1.1



One of the differences between

Table I Response Evaluation Criteria in Solid Tumors (RECIST 1.1)*

Response category	Criteria
Complete response	Disappearance of all target lesions Reduction in short axis of target lymph nodes to < 10 mm
Partial response	Decrease in target lesion diameter sum $\geq 30\%$ †
Progressive disease	Increase in target lesion diameter sum $\geq 20\%$ ‡ ≥ 5 mm increase in target lesion diameter sum New, malignant FDG uptake in the absence of other indications of progressive disease or an anatomically stable lesion, and confirmed on contemporaneous or follow-up CT Unequivocal progression of nontarget lesions
Stable disease	Does not meet other criteria‡

*Measurements are based on the sum of the unidimensional measurement of the greatest diameter of a maximum 5 lesions.

†Reference standard: baseline sum.

‡Reference standard: smallest recorded sum.

Table modified from Eisenhauer et al. (11).

RECIST 1.1

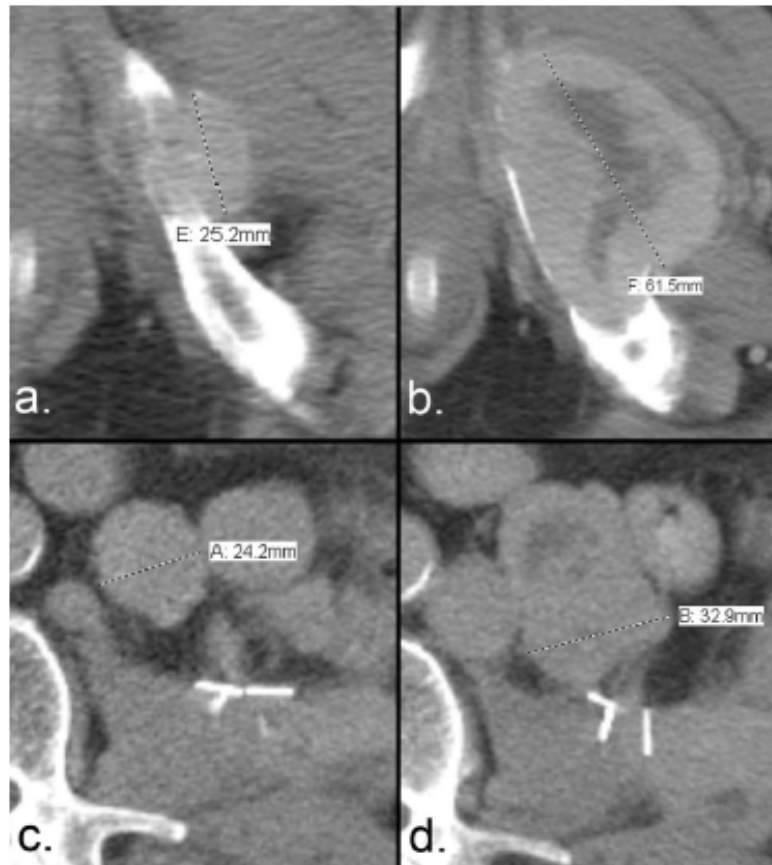


Figure 1. Measurement of disease progression using the RECIST 1.1 criteria. (a) Axial CT of the pelvis and abdomen of a patient with renal cell carcinoma demonstrates a bone metastasis in the left inferior pubic ramus. The soft tissue component is > 10 mm, and (b) the short-axis diameter of the left retroperitoneal lymph node metastasis is >15 mm; both are considered measurable according to RECIST 1.1. The sum of the longest diameters is used to assess tumor response. (c) The bone metastasis has increased from 25.2 mm to 61.5 mm, and (d) the nodal metastasis has increased from 24.2 mm to 32.9 mm. The sum of the 2 lesions at the first time point is 49.4 mm, and the sum at the second time point is 94.4 mm. This increase of 91% exceeds the required > 20% increase that is necessary to qualify for the progressive disease category.

Table 1 Response

Response category

Complete response

Partial response

Progressive disease

Stable disease

*Measurements are

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Review

Cancer Response Criteria and Bone Metastases: RECIST 1.1, MDA and PERCIST

Colleen M. Costelloe^{1✉}, Hubert H. Chuang², John E. Madewell¹, Naoto T. Ueno³

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MDA Criteria

..... bone-specific response criteria at The University of Texas MD Anderson Cancer Center in 2004.

The MDA criteria updated the UICC and WHO bone response criteria by expanding radiographic assessment and incorporating both CT and MRI.

Review

Cancer Response Criteria and Bone Metastases: RECIST 1.1, MDA and PERCISTColleen M. Costelloe¹, Hubert H. Chuang², John E. Madewell¹, Naoto T. Ueno³**Table 2 MD Anderson (MDA) criteria***

Response category	Criteria
Complete response	Complete sclerotic fill-in of lytic lesions on XR or CT Normalization of bone density on XR or CT Normalization of signal intensity on MRI Normalization of tracer uptake on SS
Partial response	Development of a sclerotic rim or partial sclerotic fill-in of lytic lesions on XR or CT. Osteoblastic flare - Interval visualization of lesions with sclerotic rims or new sclerotic lesions in the setting of other signs of PR and absence of progressive bony disease ≥ 50% decrease in measurable lesions on XR, CT, or MRI ≥ 50% subjective decrease in the size of ill-defined lesions on XR, CT, or MRI ≥ 50% subjective decrease in tracer uptake on SS
Progressive disease	≥ 25% increase in size of measurable lesions on XR, CT, or MRI ≥ 25% subjective increase in the size of ill-defined lesions on XR, CT, or MRI ≥ 25% subjective increase in tracer uptake on SS New bone metastases
Stable disease	No change < 25% increase or < 50% decrease in size of measurable lesions < 25% subjective increase or < 50% subjective decrease in size of ill-defined lesions No new bone metastases

*Measurements are based on the sum of a perpendicular, bidimensional measurement of the greatest diameters of each individual lesion.

Abbreviations: XR, radiography; CT, computed tomography; SS, skeletal scintigraphy; MRI, magnetic resonance imaging.

Table modified from Hamaoka et al. (18).

MRI.

Review

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Table 2. MD Anderson (MDA) criteria*
 within the first 3 months after therapy.
 Scintigraphic flare occurs when heal-

Figure 4. Complete response on MRI using the MDA criteria. (a) T1-weighted sagittal MRI of the thoracic spine of a patient with breast cancer demonstrates a lesion in the T11 vertebral body with abnormally low T1 signal intensity. (b) Eight years later, the lesion has been replaced by normal fat signal (arrow). The upper thoracic spine is slightly tilted in position on the follow-up examination. The response is complete according to the MDA criteria.



MRI.

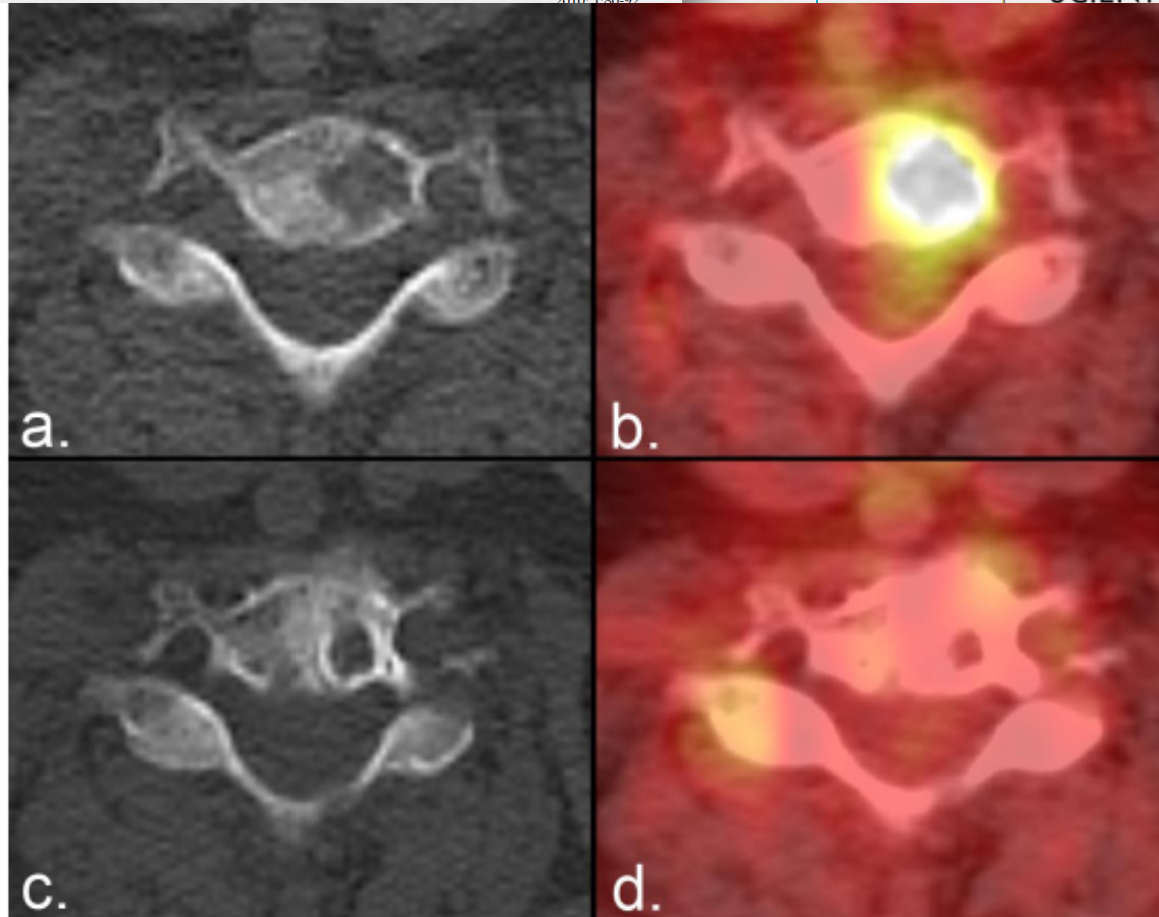
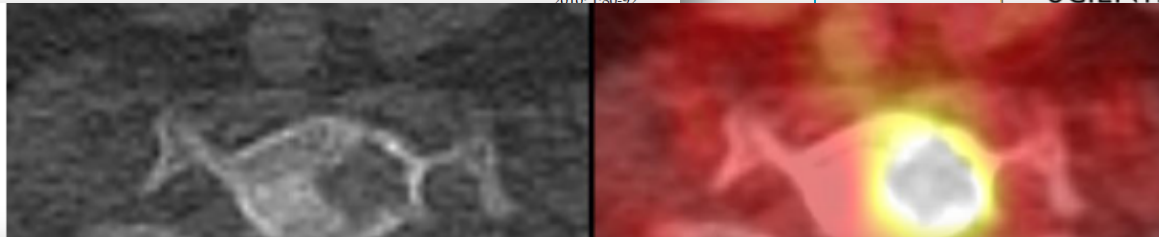


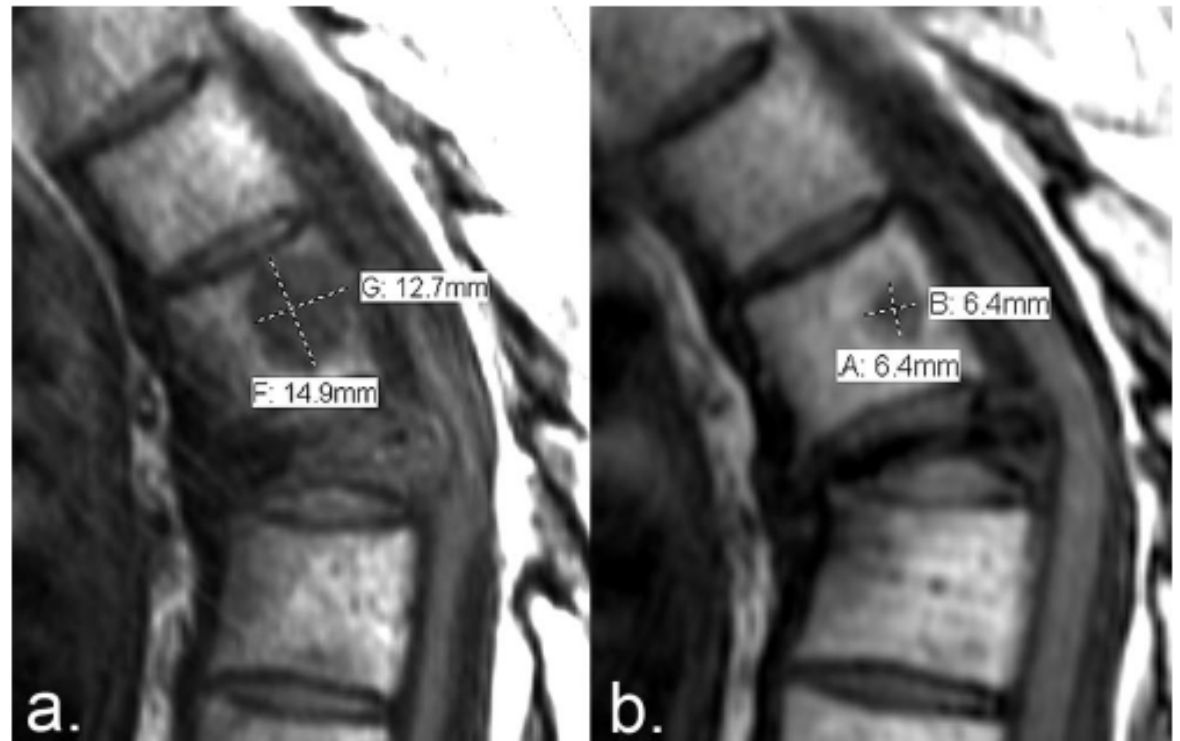
Figure 5. Partial response on radiographs according to the MDA criteria. (a) A lytic metastasis is seen in the C7 vertebral body on CT in a patient with breast cancer. (b) Fused PET/CT image from the same examination demonstrates FDG uptake representing active tumor. (c) Five weeks later, the lesion developed a sclerotic rim that resulted in a reduction in the size of the lytic area. (d) Fused PET/CT image from the same examination as (c) shows resolution of FDG activity, confirming the positive anatomic response.



within

Scientific

Figure 6. Quantitative measurement of PR using the MDA criteria. (a) T1-weighted sagittal MRI of the thoracic spine of a patient with multiple myeloma demonstrates a lesion with abnormally low T1 signal intensity in the T5 vertebral body. (b) Seven months later, fat reconstitution occurred around the periphery of the lesion, resulting in a decrease in the size of the metastasis. The sum of the perpendicular dimensions of the lesion has decreased from 27.6 mm to 12.8 mm (a 52% reduction in size), qualifying as partial response according to the MDA criteria ($\geq 50\%$ reduction required). The metastasis to the severely compressed T6 vertebral body is an example of a lesion that remains unmeasurable with anatomic response criteria.



positive anatomic response.

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Review

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PERCIST

Pet Emission Tomography Response Criteria In Solid Tumors

PET has the potential to revolutionize the definition of measurable tumors because it introduces imaging criteria based on function. The regular, well-defined tumor margins that are necessary for reproducible anatomic measurements are of lesser importance in functional imaging.

Review

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Table 3 Positron Emission Tomography Response Criteria in Solid Tumors (PERCIST)

Response category	Criteria
Complete metabolic response	Normalization of all lesions (target and nontarget) to SUL less than mean liver SUL and equal to normal surrounding tissue SUL Verification with follow-up study in 1 month if anatomic criteria indicate disease progression
Partial metabolic response	> 30% decrease in SUL peak; minimum 0.8 unit decrease* Verification with follow-up study if anatomic criteria indicate disease progression
Progressive metabolic disease	> 30% increase in SUL peak; minimum 0.8 unit increase in SUL peak* > 75% increase in TLG of the 5 most active lesions Visible increase in extent of FDG uptake New lesions Verification with follow-up study if anatomic criteria indicate complete or partial response
Stable metabolic disease	Does not meet other criteria

*Primary outcome determination is measured on the single most active lesion on each scan (not necessarily the same lesion). Secondary outcome determination is the summed activity of up to 5 most intense lesions (no more than 2 lesions per organ).

Abbreviations: SUL, standardized uptake value using lean body mass; TLG, total lesion glycolysis.

Table modified from Wahl et al. (27).

measurements are of lesser importance in functional imaging.

Table 3 Positron

Response category

Complete metabolic

Partial metabolic

Progressive meta

Stable metabolic

*Primary outcome
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Abbreviations: ST

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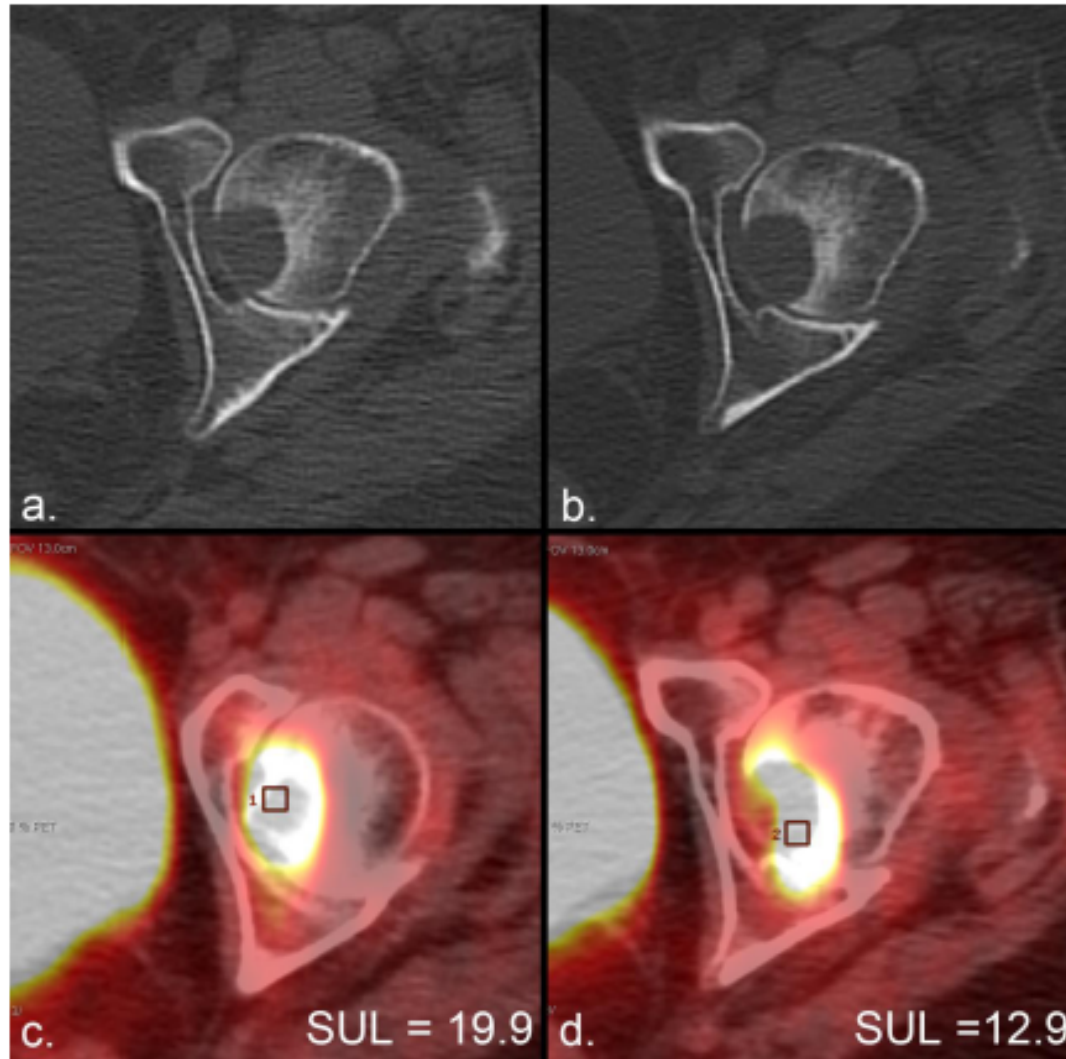


Figure 10. Metabolic response according to the PERCIST criteria in the absence of anatomic response. (a) The CT portion of an FDG PET/CT scan in a patient with lung cancer demonstrates a lytic metastasis in the left femoral head. (b) The CT from a PET/CT scan 2 months later demonstrates no anatomic change. (c, d) The standardized uptake value corrected for lean body mass (SUL) peak (average SUL in a 1-cm³ region of interest centered at the most active part of each tumor) changes from (c) 19.8 to (d) 12.9, representing a 35% decrease that satisfies the minimal requirements for partial response (> 30%) according to PERCIST. Assessment of tumor metabolism allowed therapeutic response to be measured in the absence of any other indication of change.



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Table 4. Comparison of RECIST, MDA and PERCIST

	RECIST	MDA criteria	PERCIST
Characteristics	Anatomic response criteria for soft tissue metastases	Anatomic response criteria for bone metastases	Functional response criteria reflecting tumor metabolism
Advantages	Common use allows direct comparison of the results of different studies	- Allows the response of the majority of bone metastases to be factored into therapeutic response - Provides response criteria for patients with bone-only disease	Allows response determination regardless of the location of the metastasis
Disadvantages	- Limited to "measurable" soft tissue metastases or unequivocal progression of unmeasurable disease	Limited to bone metastases	Limited to FDG avid metastases

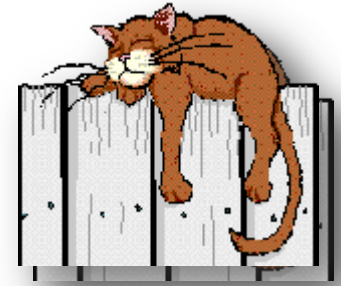
All criteria are subject to minimum lesion size limitations and PERCIST is also subject to minimum FDG uptake limitations.



Lettera d'Intenti per Progetto IRST

(da compilare in italiano)

Titolo del progetto:	CDO 21: Valutazione della risposta morfologico-funzionale delle metastasi ossee da tumori solidi radiotrattate con tre diversi frazionamenti di dose
Linea di Ricerca:	3 osteoncologia
Ricercatore Principale:	Simona Micheletti
E-mail:	s.micheletti@irst.emr.it
Altri Ricercatori coinvolti:	Elena Amadori, Paola Caroli, Toni Ibrahim, Laura Fabbri, Devil Oboldi
U.O. IRST partecipanti:	Radioterapia, Radiologia, Medicina Nucleare, Centro di Osteoncologia e Tumori Rari, Hospice
Altri enti coinvolti oltre IRST:	-
Razionale:	



Grazie dell'attenzione

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