La Radioterapia palliativa con tecniche speciali della malattia metastatica

Trattamento non chirurgico delle oligometastasi

Polmone: Radioterapia stereotassica

Gianpiero Catalano

UO Radioterapia Oncologica

IRCCS MultiMedica, Sesto S. Giovanni (Mi)

Istituto Clinico MultiMedica, Castellanza (Va)

Gruppo MultiMedica

Genova, 13.9.13

…the relevant question is not whether a benefit exists from local therapy for oligometastases, but which patients are likely to derive such a benefit…

Milano MT, IJROBP 2012

…the Benchmark

5206 casi chirurgici

2yOS: 70%

5yOS: 36%

15yOS: 26%

International Registry of Lung Metastases

VOLUME 31 · NUMBER 11 · APRIL 10 2013

JOURNAL OF CLINICAL ONCOLOGY

COMMENTS AND CONTROVERSIES

Extracranial Oligometastases: A Subset of Metastases Curable With Stereotactic Radiotherapy

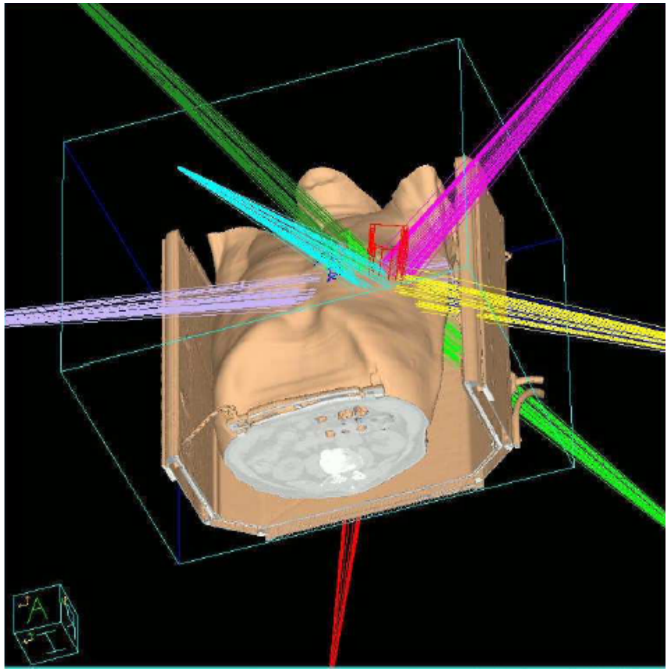
Kimberly S. Corbin, Samuel Hellman, and Ralph R. Weichselbaum, University of Chicago Medical Center, Chicago, IL

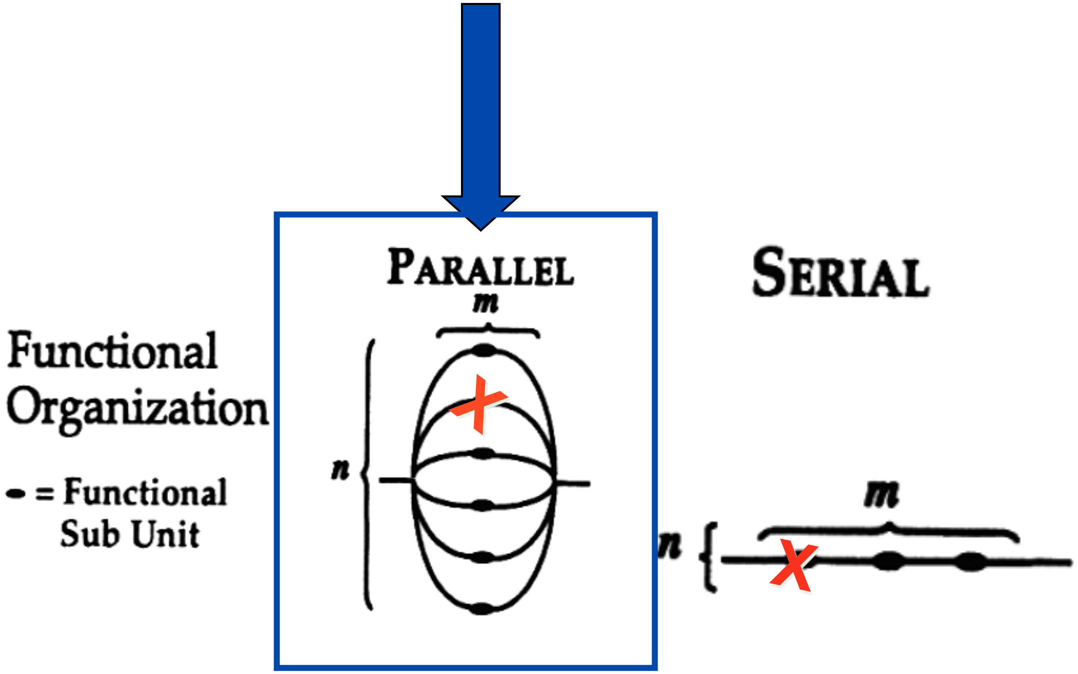
Controllo locale

Tossicità

Irradiazione selettiva di lesioni individuate attraverso principi di localizzazione stereotassici e trattate con schemi ipofrazionati

L'elevato gradiente di dose e la possibilità di ricorrere a schemi Ipofrazionati, consente di trattare la neoplasia con dosi biologicamente "ablative", esasperando il risparmio dei tessuti sani

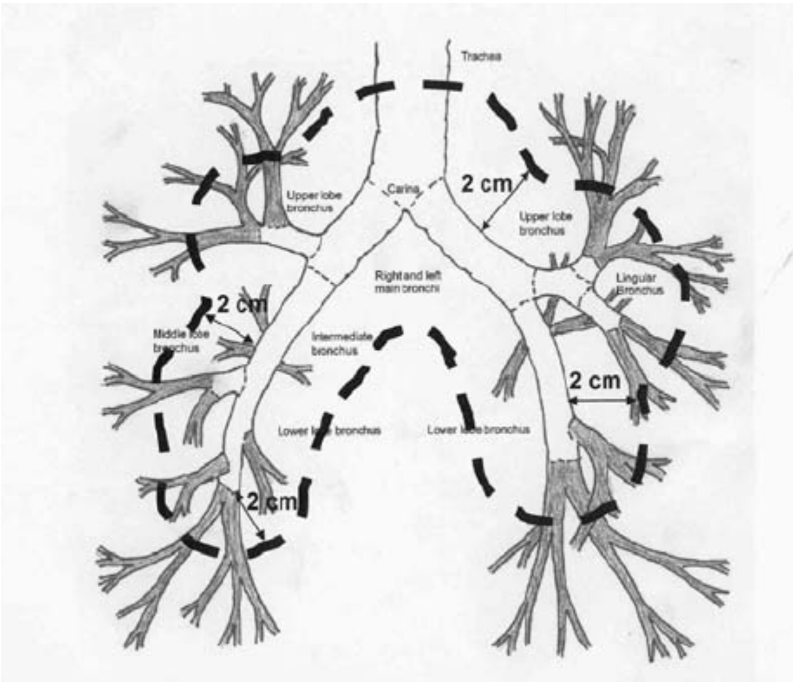


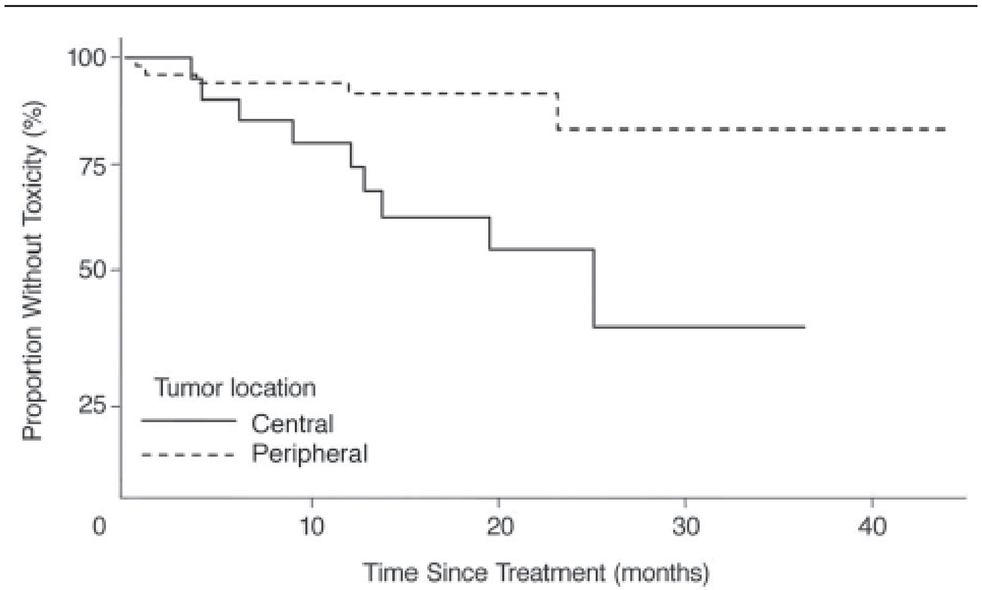


▪ **Anche se spesso pretrattati con chemioterapia, i pazienti metastatici hanno generalmente una migliore funzionalità respiratoria rispetto ai primitivi**

▪ **"*A LITTLE TO A LOT*" è peggio per il polmone**

▪ **La sede della irradiazione impatta sul rischio di tossicità**





Timmerman, JCO 2007

Mancanza di studi randomizzati

Pochi studi con metastasi solo polmonari

Disomogeneità di dosi e frazionamenti

Outcome complessivo difficile da analizzare (competing risk)

Valutazione della risposta secondo criteri "ad hoc" (o comunque non necessariamente convenzionali)

E' molto difficile fornire risposte definitive!!

JTO 2010

Stereotactic Radiotherapy for Pulmonary Oligometastases

A Systematic Review

Shankar Siva, MBBS, Michael MacManus, MD, MRCP, FRCR, FRANZCR, and David Ball, MD, MBBS, FRANZCR

TABLE 2. Lengths of Follow-Up, Outcomes, Toxicities Dose, Organ Constraints, Toxicities, and BED

Group	F/U Period (mo) Median (Range)	Outcomes	Single Fraction Dose	Constraints for Critical Organs	Toxicity	BED at Isocenter
Nakagawa	Median 10 (2–82)	95% crude LC, median survival 9.4 mo estimated 2-yr o/s 35%, estimated 2-yr	Median 20 Gy (range, 15–25 Gy) prescribed to covering isodose	Not specified	No grade 3+ or above	Not reported
Fritz	Median 22 mo (6.8–83 mo)	87% crude LC, 73% 2-yr o/s	30 Gy prescribed to isocenter	Mediastinal organs	73% radiological pneumonitis	120 Gy
Hof	Median 14 (1.5–82)	65.1% 2-yr o/s, 47.8% 3-yr o/s, 73.7% 2-yr LC, 63.1% 3-yr LC	24 Gy (n = 28), 26 Gy (n = 20), other doses (n = 23) all prescribed to isocenter	Mediastinal organs and lungs	5% grade 3 pneumonitis	Variable

FRAZIONE SINGOLA (15-30 Gy)

148 pts con 175 lesioni (4-40 cc), 1-2 les.

FU: 9 - 22 mesi

2yLC: 78.6%(48-91%); 2yOS: 50.3%(33-73%)

Pneumo G3: 5-9%

Study Group	F/U Period Median (Range)	Outcomes	Toxicity	BED at Isocenter	BED at Margin
Lax, Blomgren	Median 8.2 mo (3.5–25)	94% crude control. Crude o/s 46%, mean survival 11.3 mo, estimated 2-yr LC = 83%	Not reported	Median 183 Gy	Median 112.5 Gy
Uematsu	Median 11 mo (3–31)	97% LC at 11 mo (data pooled with NSCLC cohort). Estimated 2-yr LC = 93.6%	Not reported	Range, 144–188 Gy	Not reported
Nagata	Median 19 mo (pooled with NSCLC)	67% crude local control	Pooled with NSCLC: only mild grade 1. No grade 3 or 4	105.6 Gy	Not reported
Onimaru	Median 18 mo (2–44)	48% 2-yr o/s, 69.6% 3-yr pooled LC for 48 Gy (n = 39), 100% 3-yr pooled LC for 60 Gy (n = 19)	One grade 5 esophageal necrosis in one patient, one other grade 2 chest pain, nil else	48 Gy/8 = 76.8 Gy early 60 Gy/8 = 105 Gy early	Not reported
Song	Median 14 mo (9–49), mean F/U 22.6 mo	90% crude local control, estimated [illegible]	29% grade 1–2 toxicities (4 [illegible] 14 patients), nil grade 3	Not reported	Not reported
Aoki	Median 17.7 mo (9.4–39.5)	93% crude LC (pooled with NSCLC), o/s at 2 yr 89.5%, estimated 2-yr LC = 93%	Nil grade 3 or 4 toxicities	86.4 Gy	Not reported
Milano, Okunieff	Median 18.7 mo (3.7–60.9)	3-yr actuarial LC 91.0 ± 13.2%, crude LC = 94%, estimated 2-yr LC = 92%, 2-yr o/s 50%	3/49 (6%) grade 2, 1/49 (2%) grade 3 pericardial effusion	Not reported	Minimum 56 Gy at PTV margin
Norihisa	Median 27 mo (10–80)	2-yr LC 90%. 2-yr o/s 84%	1/34 grade 3 toxicity, 6% (2/34) musculoskeletal, grade 2 pneumonitis in 12% (4/34)	132 Gy	Not reported
Brown	Median 18 mo (2–41)	77% crude o/s. Estimated 2-yr o/s = 72.5%, LC not reported, 84% response rate	One patient with grade 4 pneumonitis	6–110 Gy using α/β ratio of 20	Variable
Salazar	Median 44 mo (2–84)	86% crude LC, median o/s = 19 mo, 3-yr o/s 29%	Pooled toxicity with NSCLC: 19% overall, 7% grade 2, no grade 3 or 4	119.6 Gy	Not reported
Rusthoven	Median 15.4 mo (6–48)	2-yr LC 96%, 2-yr o/s 39%	10.5% grade 2, 7.9% grade 3, zero grade 4	Not reported	180 Gy

MULTIPLE FRAZIONI (33Gy/6 fx - 60Gy/3 fx)

334 pts con 564 lesioni (4-124 cc), 1-5 les.

FU: 8-44 mesi

2yLC: 77.9%(67-96%); 2yOS: 53.7%(33-89%)

Pneumo G3: <3%

Neoplasia primitiva = PROGNOSI

SBRT of lung cancer

Stereotactic body radiotherapy (SBRT) for oligometastatic lung tumors from colorectal cancer and other primary cancers in comparison with primary lung cancer

Atsuya Takeda [a,b], Etsuo Kunieda [c,*], Toshio Ohashi [a,d], Yousuke Aoki [a], Naoyoshi Koike [a], Toshiaki Takeda [b]

[a] *Department of Radiology, Ofuna Chuo Hospital, Japan;* [b] *Department of Radiology, Tokyo Metropolitan Hiroo General Hospital, Japan;* [c] *Department of Radiation Oncology, Tokai University School of Medicine, Japan;* [d] *Department of Radiology, Keio University School of Medicine, Japan*

R&O 2011

44 M1, 188 primitivi polmonari

Characteristic		Univariate analysis			Multivariate analysis		
		HR	95% CI	*p* Value	HR	95% CI	*p* Value
Age		0.98	0.93–1.03	0.35	1.03	0.97–1.10	0.31
Gender				0.41			0.47
Male	(*n* = 165)	1			1		
Female	(*n* = 67)	0.63	0.21–1.90		0.66	0.21–2.04	
Tumor diameter		1.16	0.71–1.90	0.56	1.39	0.83–2.32	0.21
Disease				<0.001			<0.05
Metastases from CRC	(*n* = 21)	1			1		
Metastases from other than CRC	(*n* = 23)	0.13	0.02–1.08	0.06	0.11	0.01–0.99	<0.05
Pathological diagnosed lung ca.	(*n* = 115)	0.13	0.04–0.37	<0.001	0.09	0.02–0.41	<0.005
Clinical diagnosed lung ca.	(*n* = 73)	0.17	0.05–0.55	<0.005	0.14	0.02–0.66	<0.05
Histology				0.62			–
Adeno carcinoma	(*n* = 105)	1					
Squamous cell ca.	(*n* = 45)	1.00	0.32–3.13	0.99			
Other or unknown	(*n* = 82)	0.58	0.18–1.82	0.58			
Location				0.35			0.58
Peripheral	(*n* = 199)	1			1		
Central	(*n* = 33)	1.79	0.52–6.17		1.48	0.37–6.01	
Adjuvant chemotherapy				<0.001			0.33
Done	(*n* = 220)	1			1		
Not done	(*n* = 12)	5.81	2.09–16.15		2.00	0.50–8.09	

Oligometastases Treated With Stereotactic Body Radiotherapy: Long-Term Follow-Up of Prospective Study

Michael T. Milano, M.D., Ph.D.,* Alan W. Katz, M.D., M.P.H.,*
Hong Zhang, Ph.D., M.D.,* and Paul Okunieff, M.D.*,†

*Department of Radiation Oncology, University of Rochester Medical Center, Rochester, NY; and †Department of Radiation Oncology, University of Florida, Gainesville, FL

IJROBP 2012

293 lesioni, 121 pts, 1-5 lesioni metastatiche in <u>1-3 organi</u>

		Breast	Non-breast	
Primary cancer				
Breast	39 (32)	39 (100)	0	NA
Colorectal	31 (26)	0	31 (38)	
Lung, head/neck, esophagus	23 (19)[‡]	0	23 (28)	
Other	28 (23)[§]	0	28 (34)	
Primary histologic type				NA
Adenocarcinoma	89 (74)	39 (100)	50 (61)	
Squamous cell carcinoma	7 (6)	0	7 (9)	
Sarcoma	7 (6)[¶]	0	7 (9)	
Other	18 (15)[¶]	0	18 (22)	
Initial sites involved with oligometastatic disease				
Lung	50 (41)	11 (28)	39 (48)	0.044
Thoracic lymph nodes[‖]	24 (20)	9 (23)	15 (18)	0.54
Liver	54 (45)	13 (33)	41 (50)	0.085
Pelvis/abdomen	6 (5)	2 (5)	4 (5)	0.95
Brain	5 (4)	1 (3)	4 (5)	0.55
Bone	15 (12)	11 (28)	4 (5)	0.0003[*,†]
Initial oligometastatic lesions (*n*)				0.16[*,†]
1	37 (31)	15 (38)	22 (27)	0.20
2	32 (26)	12 (31)	20 (24)	
3	28 (23)	6 (15)	22 (27)	
4–5	24 (20)	6 (15)	18 (22)	

Oligometastases Treated With Stereotactic Body Radiotherapy: Long-Term Follow-Up of Prospective Study

Michael T. Milano, M.D., Ph.D.,* Alan W. Katz, M.D., M.P.H.,*
Hong Zhang, Ph.D., M.D.,* and Paul Okunieff, M.D.*,†

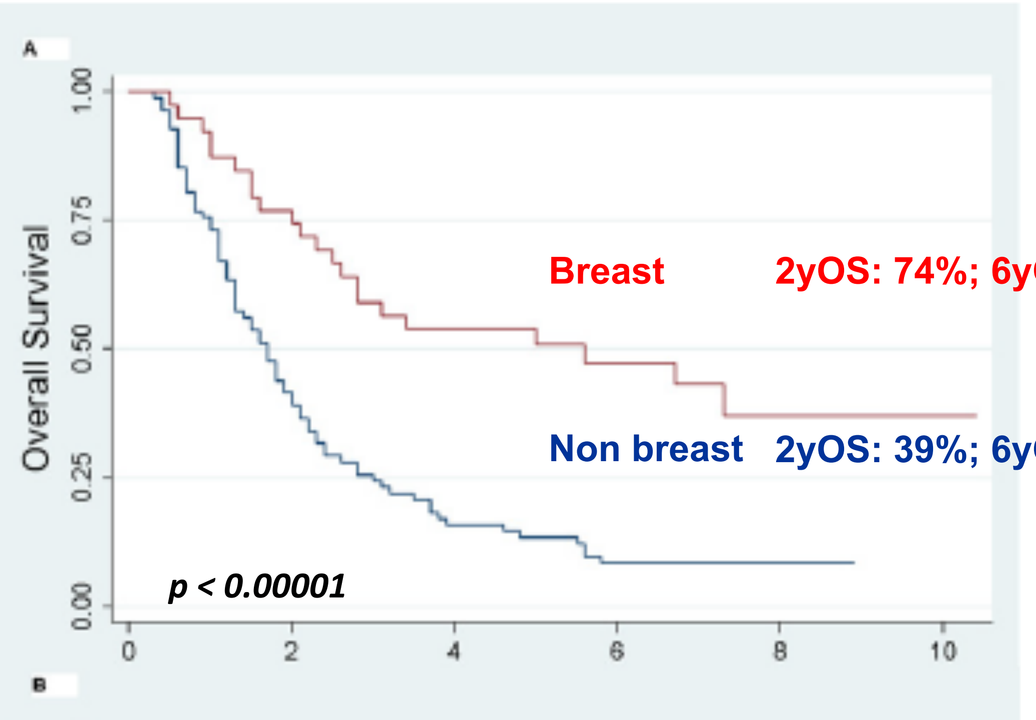
*Department of Radiation Oncology, University of Rochester Medical Center, Rochester, NY; and †Department of Radiation Oncology, University of Florida, Gainesville, FL

IJROBP 2012

2yLC

Breast vs. **non-Breast**

87% **74%**



Breast **2yOS: 74%; 6yOS: 47%**

Non breast **2yOS: 39%; 6yOS: 9%**

STEREOTACTIC BODY RADIOTHERAPY FOR OLIGOMETASTATIC LUNG TUMORS

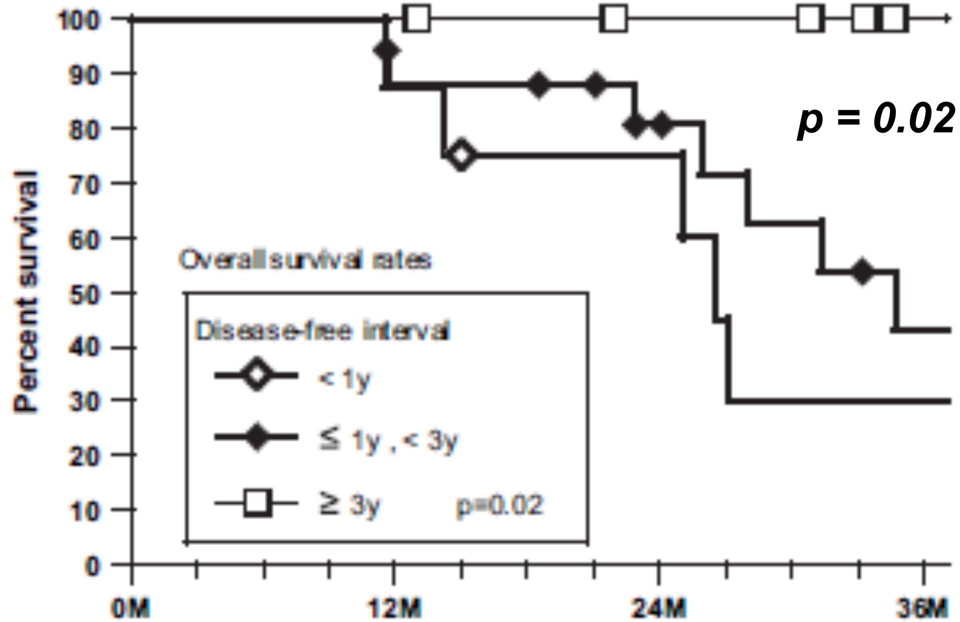
IJROBP 2008

Yoshiki Norihisa, M.D.,* Yasushi Nagata, M.D., Ph.D.,* Kenji Takayama, M.D.,* Yukinori Matsuo, M.D., Ph.D.,* Takashi Sakamoto, M.D.,† Masato Sakamoto, M.D.,‡ Takashi Mizowaki, M.D., Ph.D.,* Shinsuke Yano, B.S.,* and Masahiro Hiraoka, M.D., Ph.D.*

*Department of Radiation Oncology and Image-Applied Therapy, Kyoto University Graduate School of Medicine, Kyoto, Japan; †Department of Radiation Oncology, Kumamoto University Graduate School of Medical Sciences, Kumamoto, Japan; and ‡Department of Radiology, Japanese Red Cross Society Wakayama Medical Center, Wakayama, Japan

34 pazienti, 1-2 metastasi polmonari (< 4 cm)
Primitivo in controllo, Non altre sedi di M+

- **48 Gy in 4 fx (BED 105.6)**
- **60 Gy in 5 fx (BED 132)**



p = 0.02

***Disease-free interval* correla significativamente con OS**

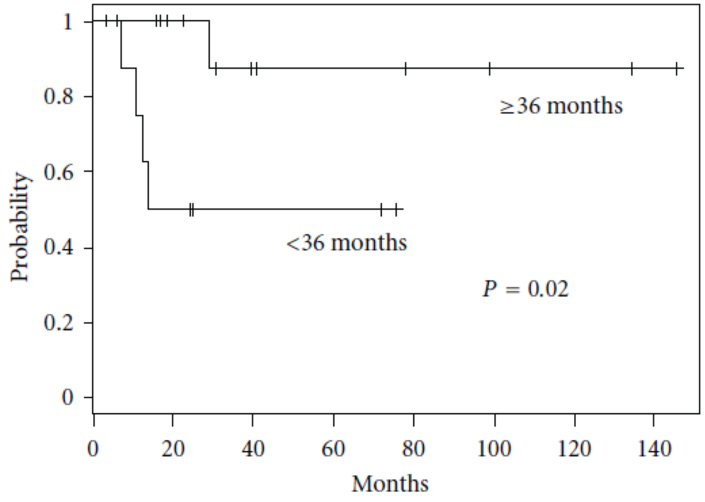
Clinical Study

Clinical Outcomes of Stereotactic Body Radiotherapy for Patients with Lung Tumors in the State of Oligo-Recurrence

Tetsuya Inoue, Norio Katoh, Rikiya Onimaru, and Hiroki Shirato

Department of Radiology, Hokkaido University Graduate School of Medicine, North 15 West 7, Kita-ku, Sapporo 060-8638, J

22 pazienti, 1-2 lesioni (< 5 cm)
48 Gy in 4 fx (BED 105.6)



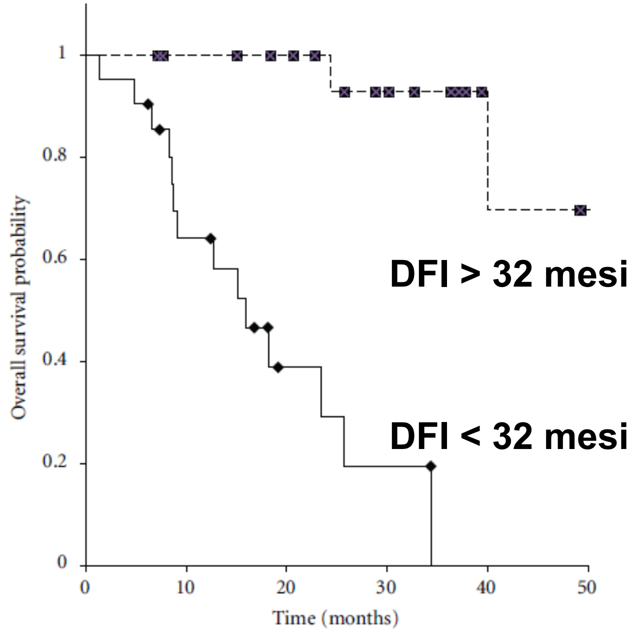
Clinical Study

Stereotactic Body Radiotherapy for Metastatic Lung Cancer as Oligo-Recurrence: An Analysis of 42 Cases

Wataru Takahashi,[1] Hideomi Yamashita,[1] Yuzuru Niibe,[2] Kenshiro Shiraishi,[1] Kazushige Hayakawa,[2] and Keiichi Nakagawa[1]

[1] *Department of Radiology, University of Tokyo Hospital, 7-3-1, Hongo, Bunkyo-ku, Tokyo 113-8655, Japan*
[2] *Department of Radiology and Radiation Oncology, Kitasato Universtiy, Kanagawa 252-0374, Japan*

42 pazienti, 1-2 lesioni (< 4 cm)
48 Gy in 4 fx (BED 105.6)



▪ Correlazione dose-risposta in termini di Controllo tumorale

Cyberknife 15-30 Gy
32 pz. (22 NSCLC/12 M1 singole)

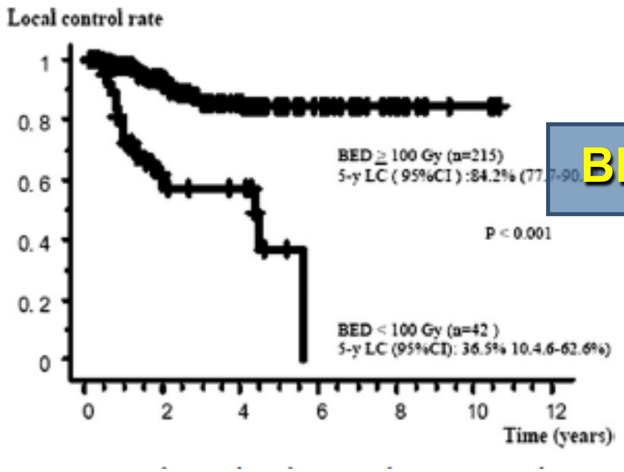
TABLE 4. Response by Radiation Dose

Dose	No. of Patients	Response			
		CR	PR	MR	SD
≤20 Gy	10	1	5	3	1
25 Gy	20	8	5*	4	3*
30 Gy	2	0	2	0	0
Total	32	9	12	7	4

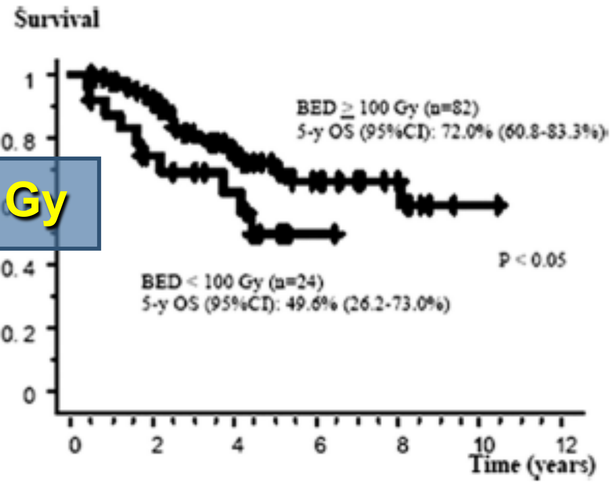
*One patient in eac[h] ... PET scans.
CR, complete response; PR, partial response; MR, minor response; SD, stable disease.

maggior Controllo Locale con dosi > 20 Gy

Le, JTO 2006



BED ≥ 100 Gy



Onishi, JTO 2007

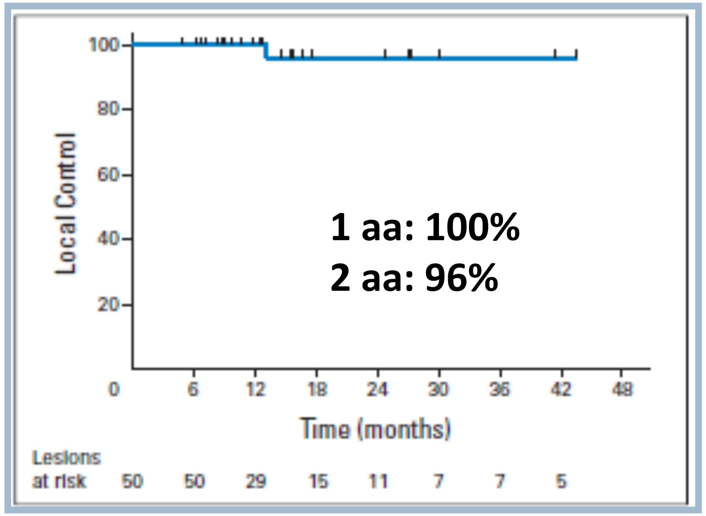
- **Il controllo locale non è necessariamente associato alla sopravvivenza**

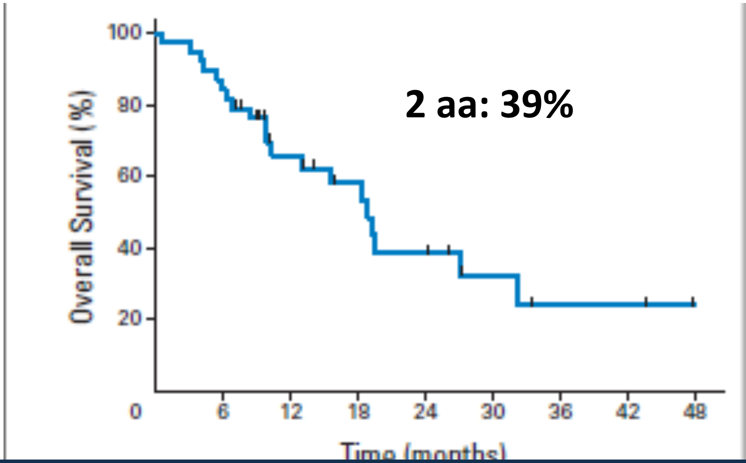
Multi-Institutional Phase I/II Trial of Stereotactic Body Radiation Therapy for Lung Metastases

JCO 2009

Kyle E. Rusthoven, Brian D. Kavanagh, Stuart H. Burri, Changhu Chen, Higinia Cardenes, Mark A. Chidel, Thomas J. Pugh, Madeleine Kane, Laurie E. Gaspar, and Tracey E. Schefter

38 pz. (68 lesioni, max diam. 7 cm)
Fase I: Dose-escalation 48 → 60 Gy
Fase II: 60 Gy in 3 frazioni





Distant progression 63%
4 mesi dopo SRT (PFS 8 mesi)

Thirty-one (82%) of 38 patients had one or more of the following unfavorable prognostic features: ≥ 3 thoracic lesions, extrathoracic disease, disease-free interval less than 36 months, or ≥ 2 prior chemotherapy regimens for metastatic disease.

SELECTION

ANTICANCER RESEARCH 33: 655-660 (2013)

Ablative or Palliative Stereotactic Body Radiotherapy with Helical Tomotherapy for Primary or Metastatic Lung Tumor

MICHELA MARCENARO[1], STEFANO VAGGE[1], LILIANA BELGIOIA[1], DARIO AGNESE[1], GIORGIO LAMANNA[1], ELISA MANTERO[1], MARCO GUSINU[2], STEFANIA GARELLI[2], FRANCESCA CAVAGNETTO[2], STEFANO AGOSTINELLI[2] and RENZO CORVÒ[1]

Divisions of [1]Radiation Oncology and [2]Medical Physics, IRCCS San Martino – IST National Cancer Research Institute and University, Genoa, Italy

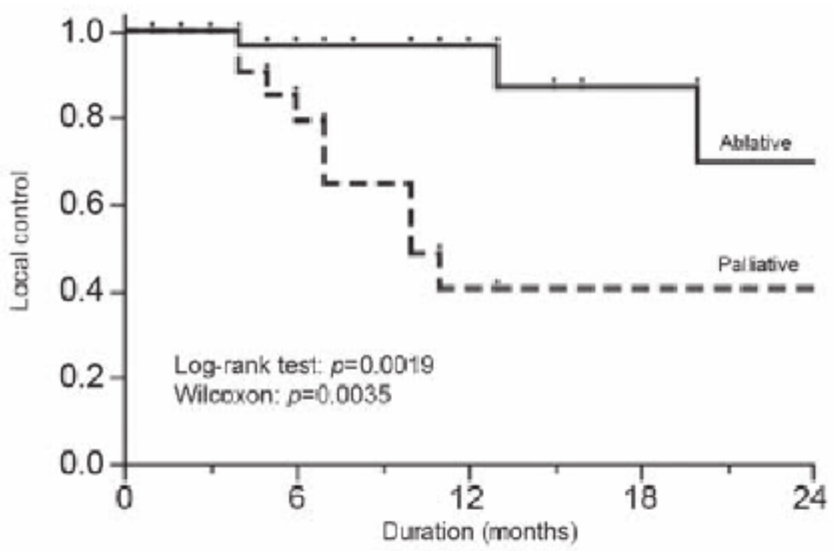


Figure 2. *Local control for ablative stereotactic body radiotherapy (SBRT) and palliative SBRT (40.4% and 69.6%, 24 months respectively).*

2-y LC 69% (ablative) vs. 40% (palliative) p=0.002

2-y OS 58% (ablative) vs. 49% (palliative) p=0.57

Sembra che la dose richiesta per ottenere un adeguato controllo delle localizzazioni metastatiche debba essere superiore a quella richiesta per controllare le neoplasie primitive

"… higher local failure rate in lung metastases group than in primary lung group…"

Nagata , IJROBP 2002

Attenzione a:
- Precedente RT
- Chemioterapia

TABLE 3. Observed Radiation-Related Toxicities and Treatment Received

Dose (Gy)	PTV Volume (cc)	Location	Time to Toxicity (mo)	Prior Thoracic RT	Before or After RT Chemotherapy	Toxicity	Grade
25	20.3	Peripheral	3	None	None	Pleural effusion	2
25	20.2	Peripheral	6	None	None	Pneumonitis	3
25	74.3	Central	6	None	Carboplatin, paclitaxel, gemcitabine	Tracheoesophageal fistula	5
25	69.6	Central	3	None	FOLFOX, FOLFIRI, bevacizumab	Pneumonitis	2
25	61.9	Central	6	None	Megestrol acetate	Pneumonitis, atrial fibrillation	2
25	86.3	Central	5	Yes	Cisplatin, 5-flourouracil	Pneumonitis, pleural effusion (vs. recurrence)	5
25	36.6	Central	5	Yes	Gemcitabine, gefitinib, trastuzumab	PE and recalled pneumonitis	5
30	50.6	Peripheral	5	None	None	Pneumonitis	2

PTV, planning target volume; FOLFOX, 5-fluorouracil (5-FU), leucovorin, oxaliplatin; FOLFIRI, 5-FU, leucovorin, irinotecan; PE, pulmonary embolism.

Le, JTO 2006

Is the dose still important for lung metastases?

- Is LC the primary end-point?
- Does LC of lung metastases have an impact on survival?
- Should we lower the dose to treat more lesions (if so, how many)?

- **Ci sono altri fattori prognostici utili a selezionare i pazienti?**

Stereotactic Body Radiotherapy for Multisite Extracranial Oligometastases

Cancer 2011

Final Report of a Dose Escalation Trial in Patients With 1 to 5 Sites of Metastatic Disease

Joseph K. Salama, MD[1]; Michael D. Hasselle, MD[2]; Steven J. Chmura, MD, PhD[2,3]; Renuka Malik, MD[2]; Neil Mehta, MD[2]; Kamil M. Yenice, MD[2]; Victoria M. Villaflor, MD[3,4]; Walter M. Stadler, MD[3,4]; Philip C. Hoffman, MD[3,4]; Ezra E. W. Cohen, MD[3,4]; Philip P. Connell, MD[2,3]; Daniel J. Haraf, MD[2,3]; Everett E. Vokes, MD[2,3,4]; Samuel Hellman, MD[2]; and Ralph R. Weichselbaum, MD[2,3,5]

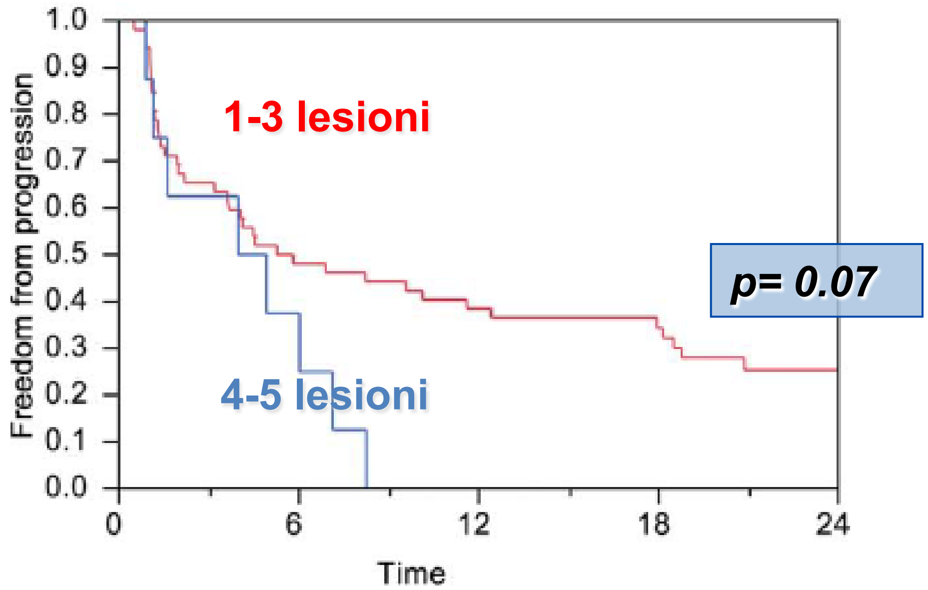
61 paz→ 113 lesioni

Dose di partenza: 8 Gy x 3

Escalation di 6 Gy (2 Gy/fr)

Dose finale 20 Gy x 3

Metastatic lesions treated per protocol	113	
Lung	41	36.3
Lymph nodes	22	19.4
Liver	22	19.4
Osseous	15	13.3
Adrenal	9	8.0
Soft tissue	3	2.7
Pancreas	1	0.9
Mean metastatic sites per patients	2	(1-5)
1 lesion on protocol	33	55
2 lesions on protocol	11	18
≥3 lesions on protocol	16	27



2yOS: 60% vs. 22%

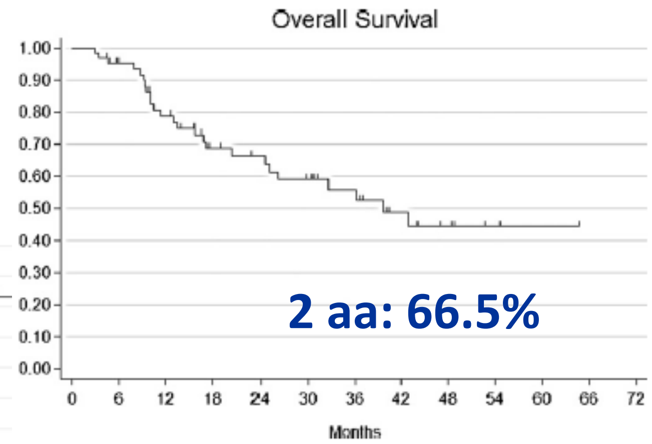
Stereotactic body radiation therapy for lung metastases

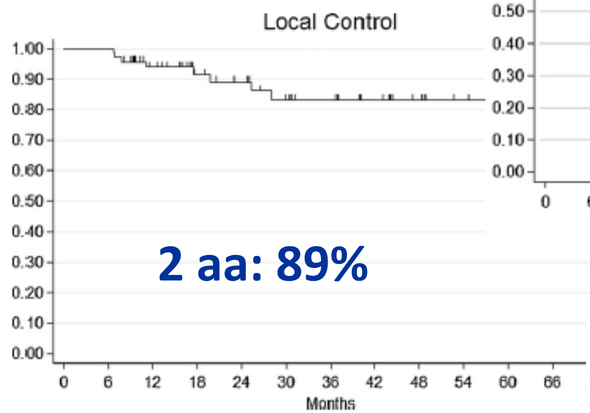
Umberto Ricardi[a], Andrea Riccardo Filippi[a,*], Alessia Guarneri[a], Riccardo Ragona[b], Cristina Mantovani[a], Francesca Giglioli[b], Angela Botticella[a], Patrizia Ciammella[c], Cristina Iftode[a], Lucio Buffoni[d], Enrico Ruffini[e], Giorgio Vittorio Scagliotti[f]

[a] Radiation Oncology Department, University Hospital S. Giovanni Battista di Torino, Via Genova 3, 10126, Torino, Italy
[b] Medical Physics, University Hospital S. Giovanni Battista di Torino, Via Genova 3, 10126 Torino, Italy
[c] Radiation Oncology Department, Arcispedale S.M. Nuova Hospital, Viale Risorgimento 80, 42123 Reggio Emilia, Italy
[d] Medical Oncology Department, University Hospital S. Giovanni Battista di Torino, Via Genova 3, 10126 Torino, Italy
[e] Thoracic Surgery Department, University Hospital S. Giovanni Battista di Torino, Via Genova 3, 10126 Torino, Italy
[f] Thoracic Oncology Department, University Hospital S. Luigi, Regione Gonzole 10, 10043 Orbassano, Italy

Lung Cancer 2012

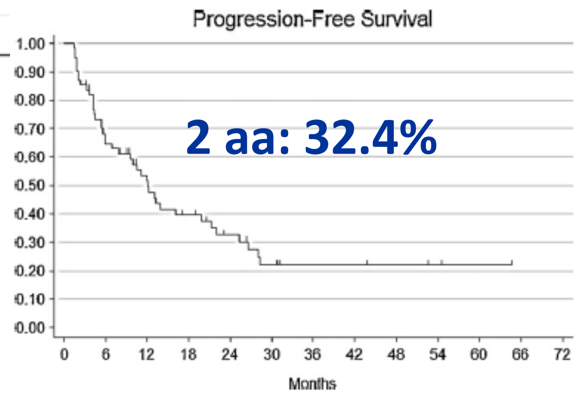
61 pazienti con 1-3 metastasi (77 lesioni)
Max diametro 5 cm
Malattia extra toracica controllata o assente
FEV1> 40%





45 Gy/3 fx (22 pts)
26 Gy/1 fx (51 pts)
36 Gy/3 fx (4 pts)

Prescrizione all'isodose dell'80%

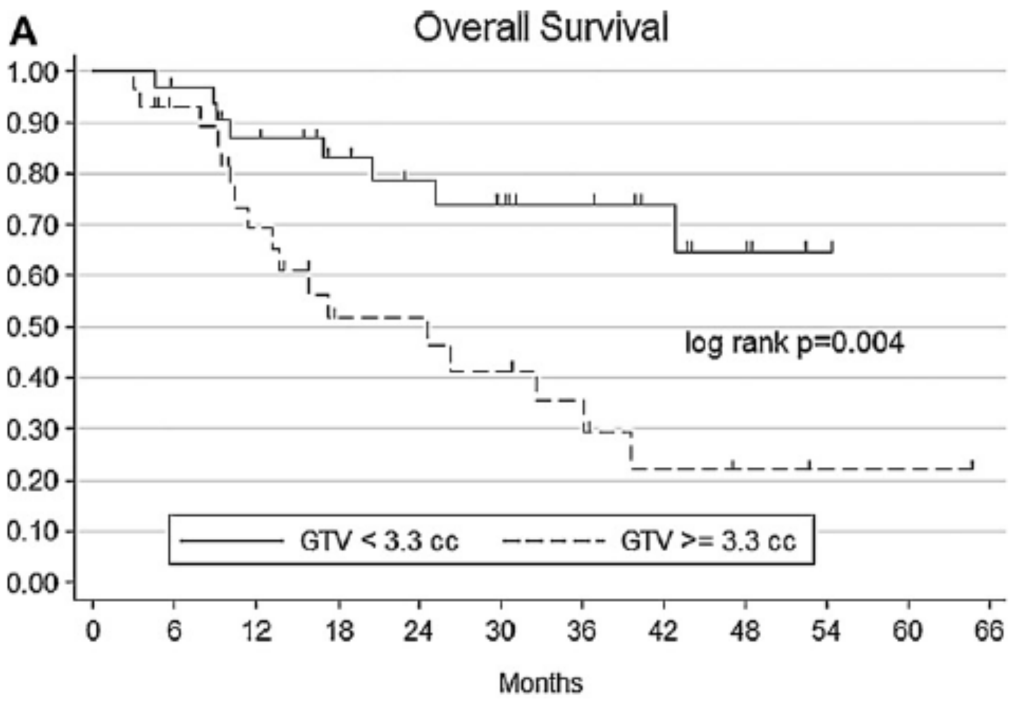


FU mediano: 20.4 mesi (3-77.4)

Factors	OS		CSS		LC		PFS	
	HR	p	HR	p	HR	p	HR	p
Age (years)	1.02	0.385	1.04	0.144	0.92	0.112	1.01	0.557
Gender	0.62	0.340	0.40	0.107	0.56	0.557	1.12	0.772
Position	1.24	0.584	1.02	0.963	0.60	0.587	0.76	0.381
Tumor volume	1.10	0.012	1.17	0.001	0.65	0.645	1.11	0.012
Disease-free interval	0.99	0.824	0.99	0.385	1.01	0.139	1.00	0.320
n Lung mets	0.79	0.609	0.77	0.617	0.06	0.927	1.65	0.068
Prior chemotherapy	0.56	0.335	0.70	0.583	0.01	0.999	1.17	0.109
Biologically effective dose	0.99	0.805	0.98	0.204	1.00	0.778	0.99	0.749

GTV significativo

GTV non significativo



Ricardi, 2012

Conclusioni (1)

- **Il tumore <u>primitivo</u> incide nella selezione complessiva del paziente fornendo una valutazione prognostica generale**

- **Il <u>*Disease-free interval*</u> (e i trattamenti pregressi) sembra il parametro prognosticamente più importante nella selezione del paziente**

- **Il <u>volume</u> della lesione di per sé non rappresenta un limite assoluto, provvedendo una dose "adeguata" e limitando la potenziale tossicità**

- **Il <u>numero</u> delle lesioni non è un limite assoluto. La selezione è frutto di una valutazione che tenga conto della evolutività della malattia e della tecnica del trattamento**

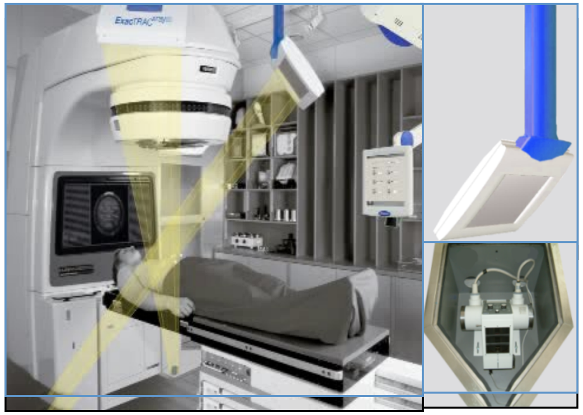
Targeting

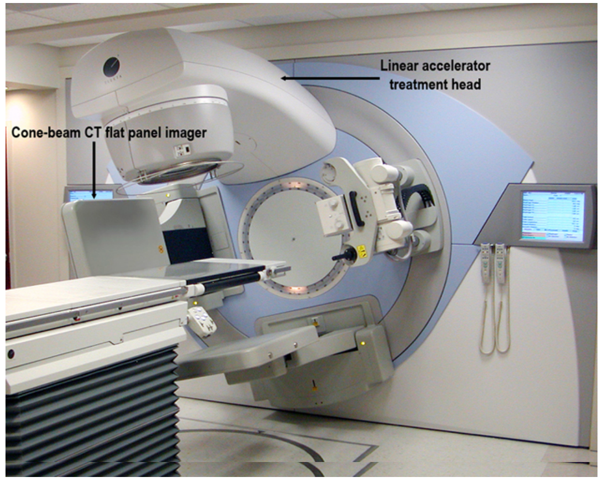
- **E' fondamentale considerare le possibili fonti di errore**
  - **Errore di definizione e di delineazione del bersaglio**
  - **Errore di posizionamento del paziente**
  - ***Organ Motion* indotto dal respiro**

L'impatto è maggiore per le tecniche a elevata disomogeneità e si traduce in un rischio aumentato di:

- ***Sottodosaggio del bersaglio***
- ***Incremento di tossicità***

Image-guided Radiotherapy - IGRT




Linear accelerator treatment head
Cone-beam CT flat panel imager

?


vero

Breathing Adapted Radiotherapy

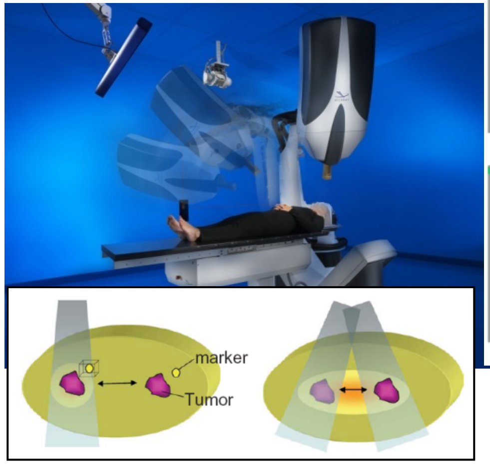
Breath-Hold

Free-breathing Synchronisation

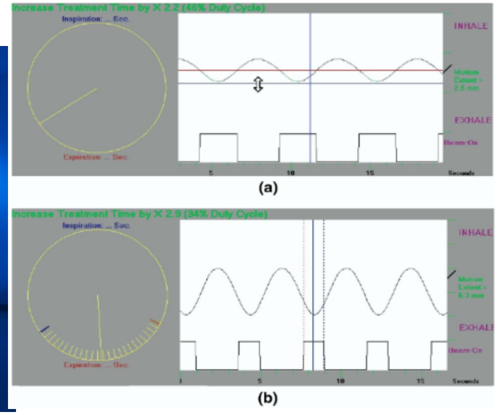
Controlled Breath-hold (ABC)

Voluntary Breath-hold

Free-breathing Moving-beam (tracking)



Free-breathing Gating

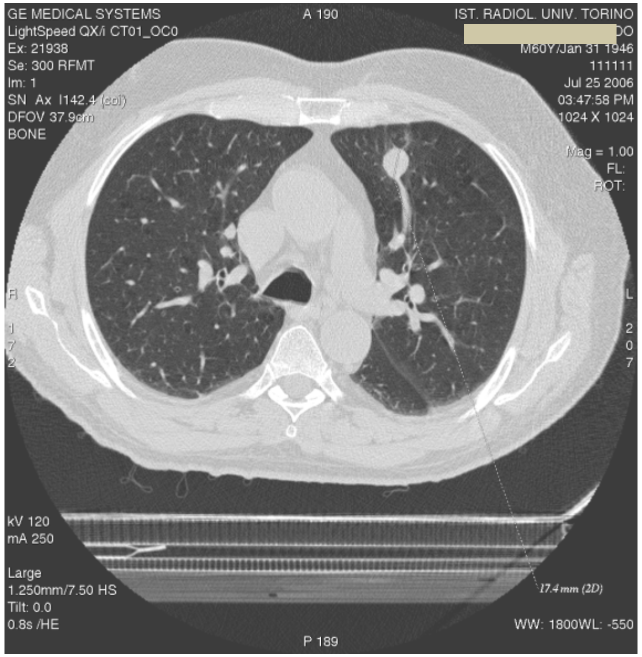


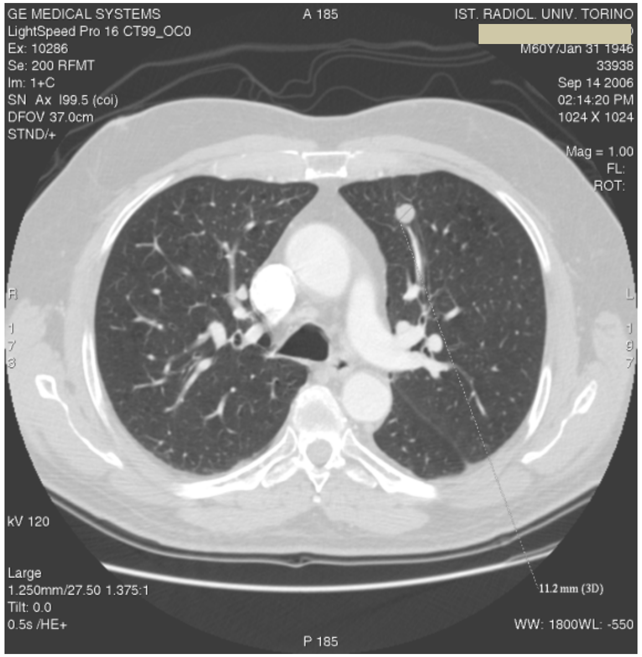
Minimizzare il movimento indotto dal respiro

"Inseguire" il bersaglio nel corso dei suoi movimenti legati al respiro

Sincronizzare l'irradiazione con una predefinita fase respiratoria (espirio)

RECIST criteria: **not useful for SBRT → not necessarily expected to produce a complete response in order to permanently control a tumor (… and vice versa)**





Role of PET/CT ?

Early and late lung radiographic injury following stereotactic body radiation therapy (SBRT)

Marco Trovo[a,b], Anna Linda[c,d], Issam El Naqa[b], Cylen Javidan-Nejad[d], Jeffrey Bradley[b,*]

[a] Department of Radiation Oncology at the Oncologic Referral Center of Aviano, Italy
[b] Department of Radiation Oncology, Washington University School of Medicine, St. Louis, United States
[c] Department of Radiology at the University of Udine, Italy
[d] Department of Diagnostic Radiology at the Mallinckrodt Institute of Radiology, St. Louis, United States

Lung Cancer 2009

Pulmonary injury and tumor response after stereotactic body radiotherapy (SBRT): Results of a serial follow-up CT study

Matthias Guckenberger[a,*], Katrin Heilman[a], Joern Wulf[b], Gerd Mueller[a], Gabriele Beckmann[a], Michael Flentje[a]

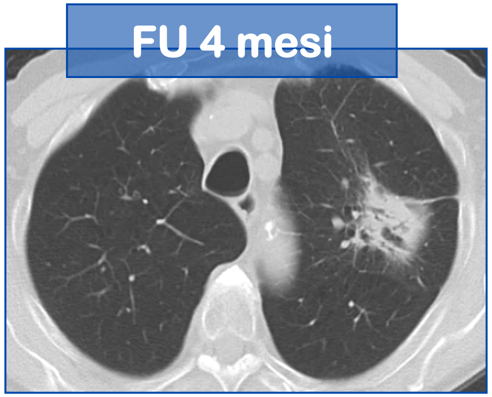
[a]Department of Radiation Oncology, Julius-Maximilians University, Wuerzburg, Germany, [b]Department of Radiooncology, Lindenhofspital, Bern, Switzerland

Radiother Oncol 2007

CT APPEARANCE OF RADIATION INJURY OF THE LUNG AND CLINICAL SYMPTOMS AFTER STEREOTACTIC BODY RADIATION THERAPY (SBRT) FOR LUNG CANCERS: ARE PATIENTS WITH PULMONARY EMPHYSEMA ALSO CANDIDATES FOR SBRT FOR LUNG CANCERS?

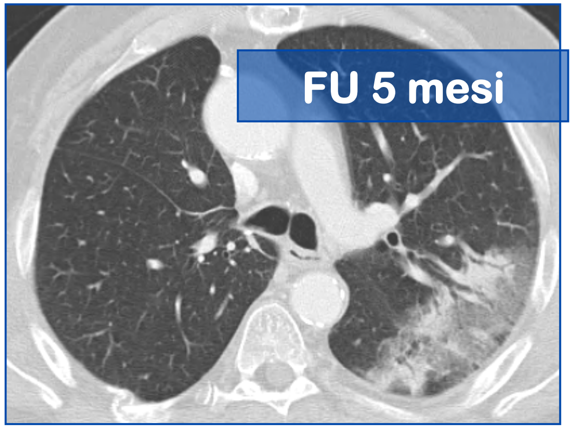
Tomoki Kimura, M.D., Ph.D.,*† Kanji Matsuura, M.D., Ph.D.,* Yuji Murakami, M.D.,* Yasutoshi Hashimoto, M.D.,* Masahiro Kenjo, M.D.,* Yuko Kaneyasu, M.D., Ph.D.,* Koichi Wadasaki, M.D., Ph.D.,* Yutaka Hirokawa, M.D., Ph.D.,‡ Katsuhide Ito, M.D., Ph.D.,* and Motoomi Okawa, M.D., Ph.D.†

IJROBP 2006



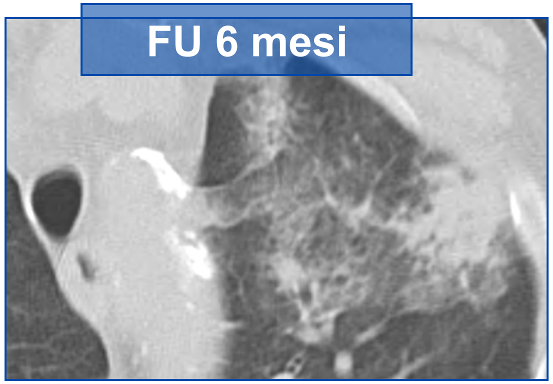
DIFFUSE CONSOLIDATION

Diffuso e omogeneo incremento dell'attenuazione parenchimale, che oscura vasi e vie aeree



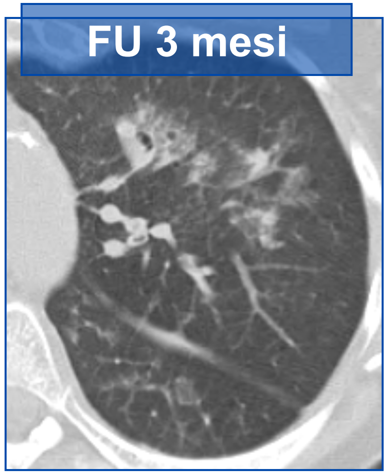
DIFFUSE GGO

Sfumato incremento densità. Strutture bronco-vascolari identificabili



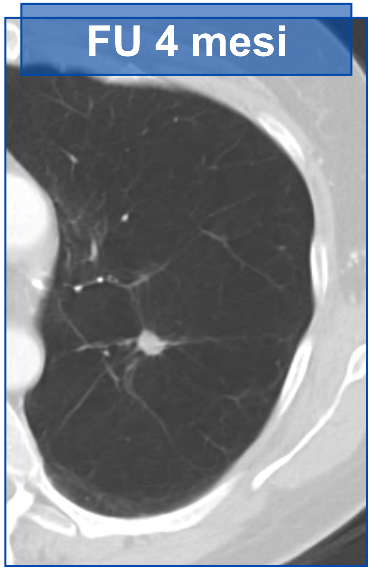
PATCHY CONSOLIDATION AND GGO

Aree sparse di aumento della densità, alcune sfumate altre compatte



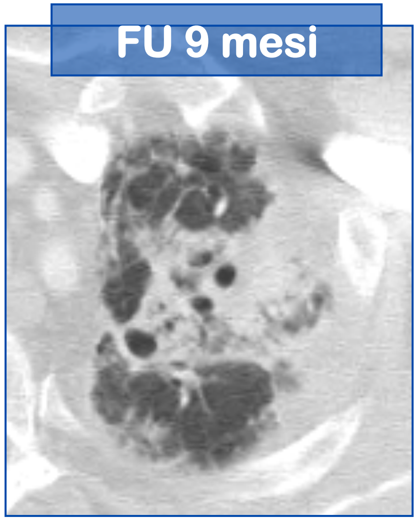
PATCHY GGO

Aree sparse di sfumato incremento di densità, con parenchima normale



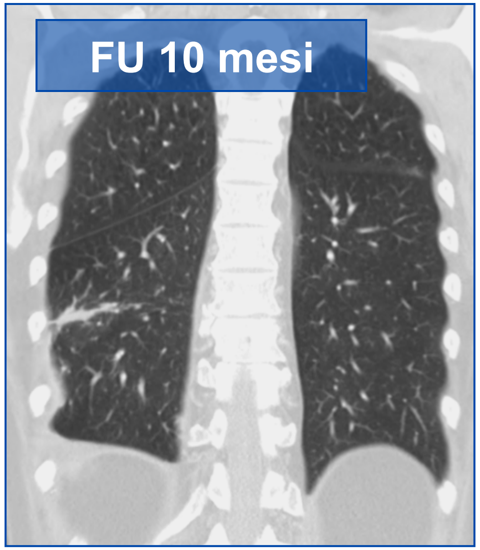
NESSUNA MODIFICA

Courtesy of M. Trovò

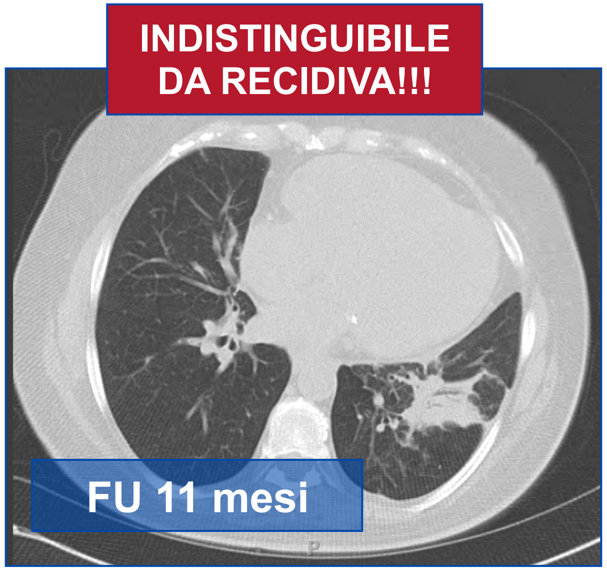


MODIFIED CONVENTIONAL PATTERN

Consolidazioni parenchimali, perdita di volume, bronchiectasie

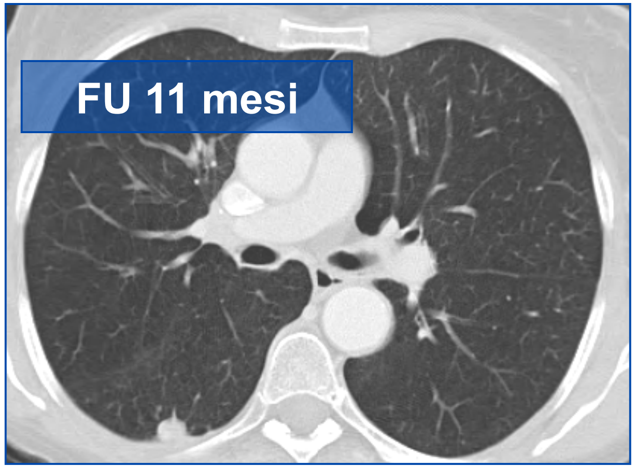


SCAR-LIKE PATTERN



MASS-LIKE PATTERN

Area di addensamento focale limitata alla regione della neoplasia

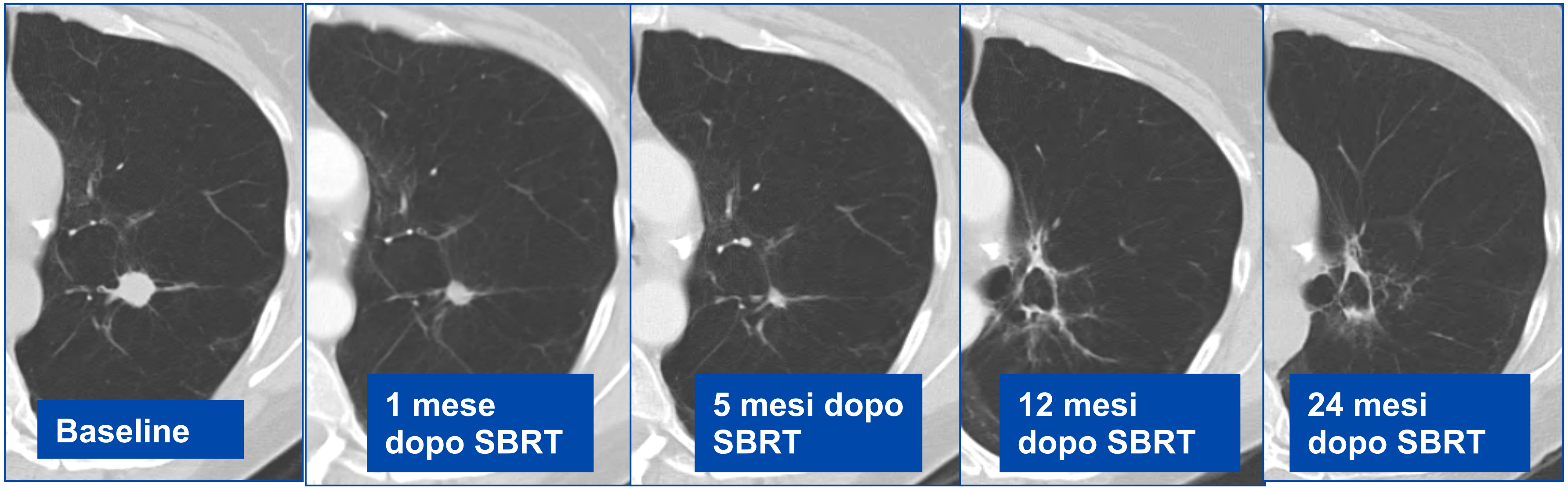


NESSUNA MODIFICA

Courtesy of M. Trovò

Pattern evolutivi – diagnosi differenziale con PD

SBRT | 0-3 mesi | 3-6 mesi | 6-18 mesi | 24 mesi



Non lesioni radiologiche. Risposta parziale

Non lesioni radiologiche. Risposta parziale

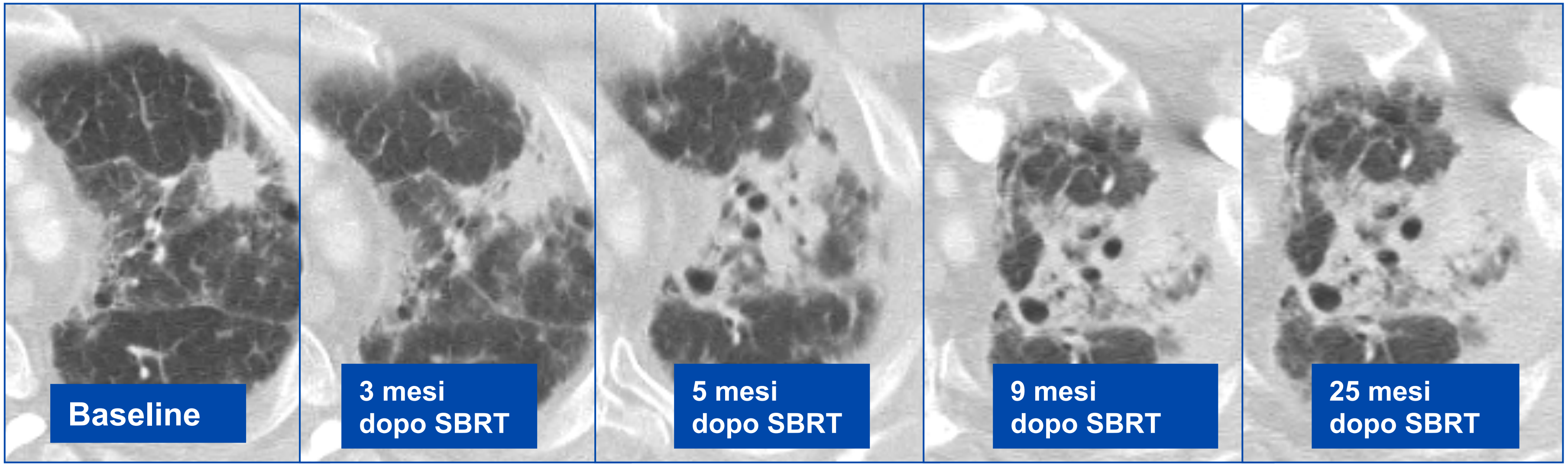
Fibrosi Scar-like

Non lesioni significative. Risposta completa

Courtesy of M. Trovò

Pattern evolutivi – diagnosi differenziale con PD

SBRT | 0-3 mesi | 3-6 mesi | 6-18 mesi | 24 mesi



Patchy GGO

Diffuse consolidation

Consolidazione più densa, bronchiectasie

Non ulteriori modificazioni

Courtesy of M. Trovò

Conclusioni (2)

- La SRT delle metastasi polmonari in pazienti oligometastatici è un trattamento efficace con basso profilo di tossicità

- Dosi “adeguate” sono preferibili in ottica “curativa”, anche se l’impatto sulla sopravvivenza è incerto

- La selezione dei pazienti resta l’aspetto cruciale … e più controverso

- In generale, andrebbero applicati gli stessi criteri di selezione utilizzati per definire le indicazioni alla metastasectomia

- Sono indispensabili procedure IGRT e sono auspicabili tecniche di controllo del respiro