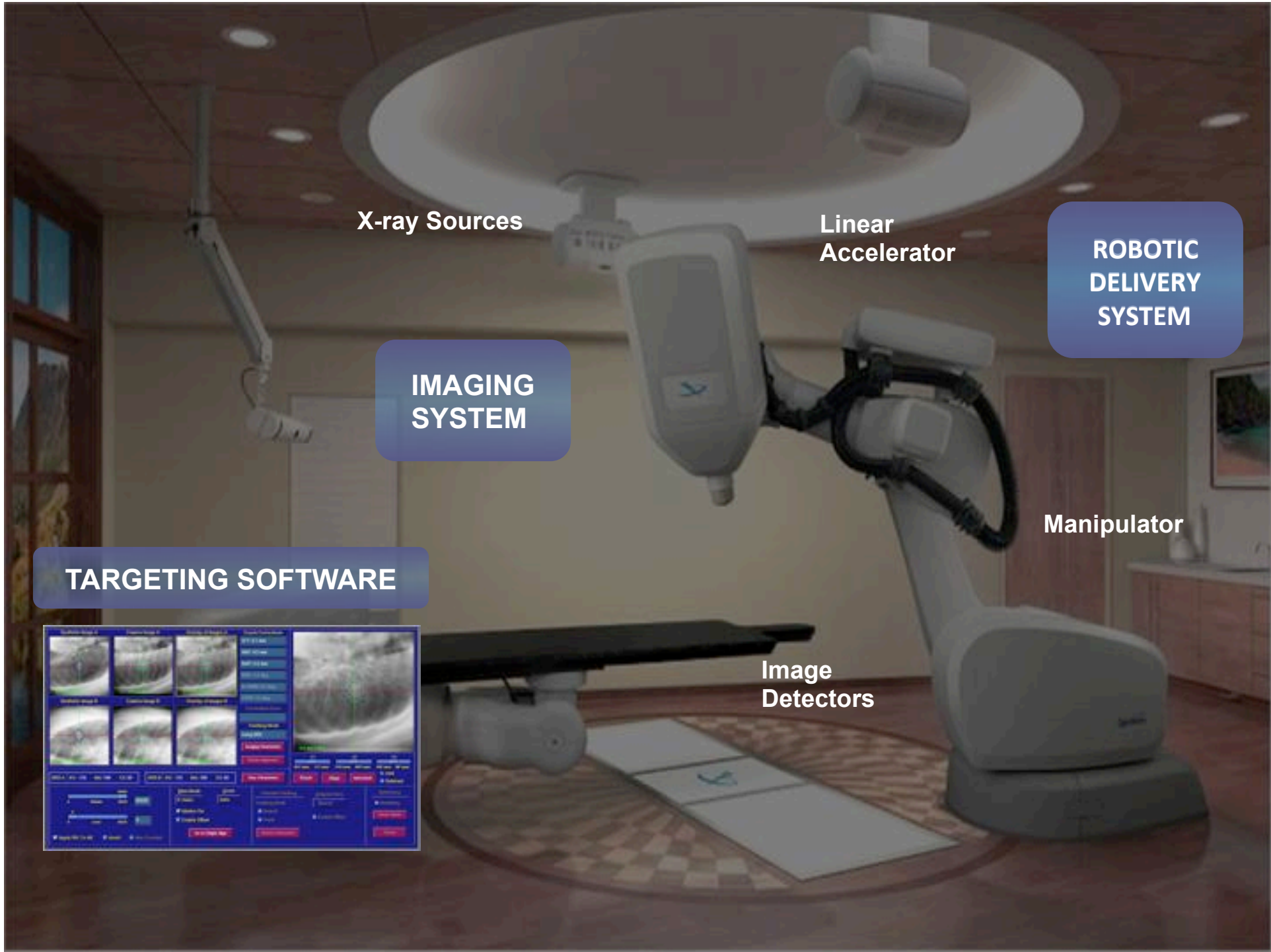




RADIOCHIRURGIA E RADIOTERAPIA STEREOTASSICA CON SISTEMA CYBERKNIFE NEL TRATTAMENTO DELLE METASTASI CEREBRALI.

**Dott.ssa Valentina Borzillo
U.O.C. Radioterapia
INT Fondazione G. Pascale
Napoli**



X-ray Sources

Linear Accelerator

ROBOTIC DELIVERY SYSTEM

IMAGING SYSTEM

Manipulator

TARGETING SOFTWARE

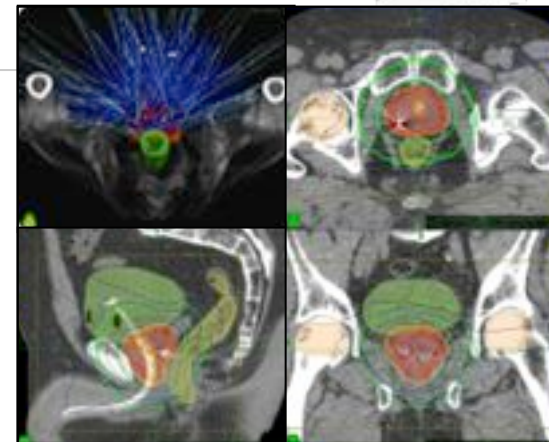
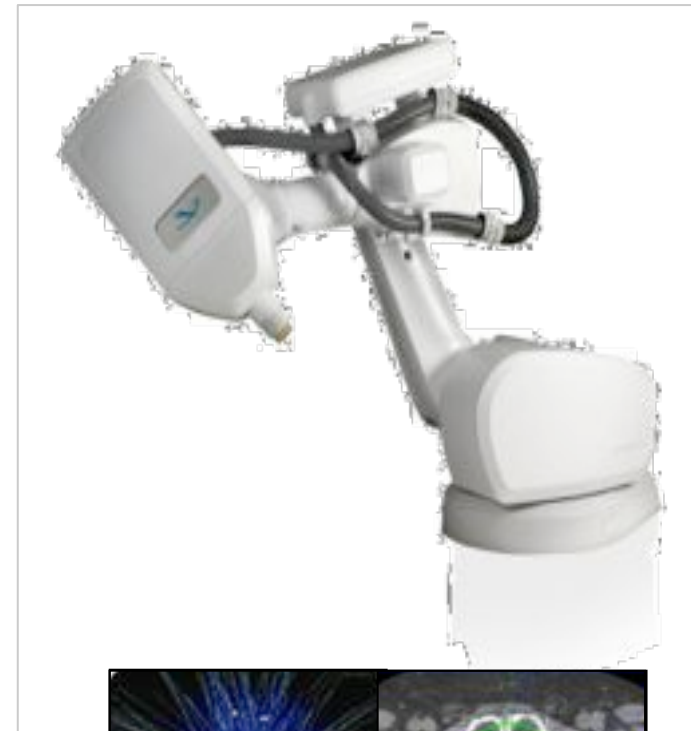


Image Detectors

CyberKnife® Robotic Radiosurgery System

POSSIBILITÀ DI:

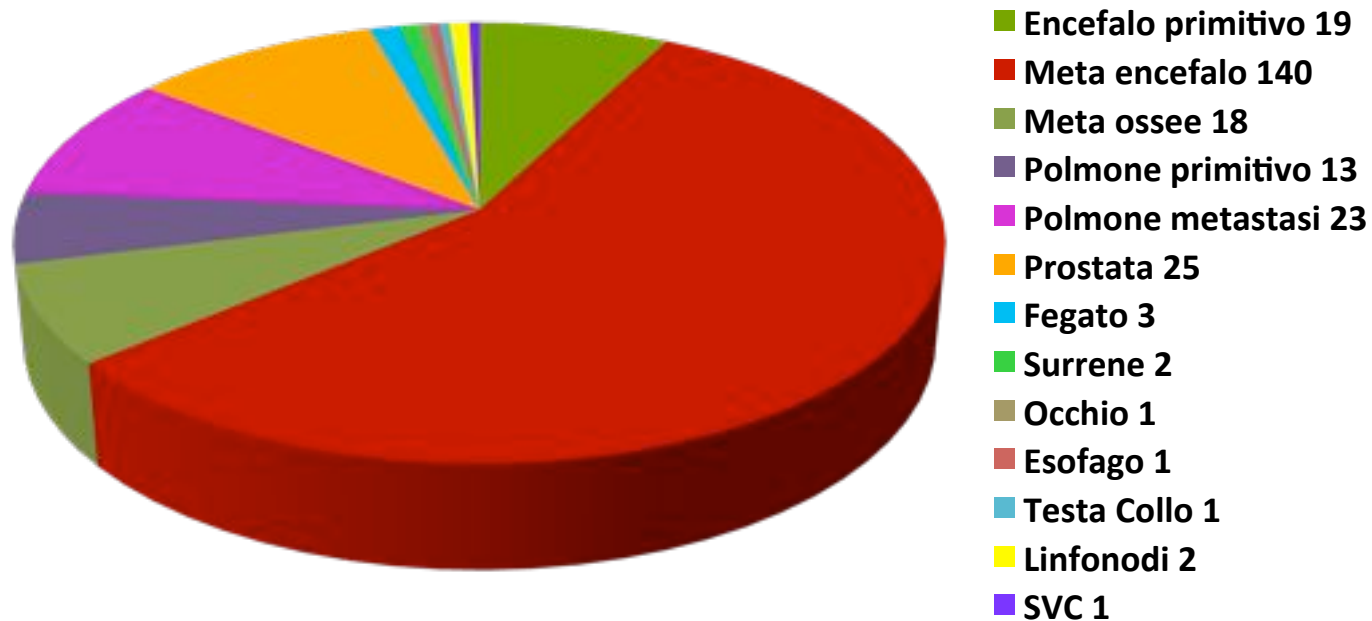
- **Utilizzare sistemi di fissazione non cruenta**
- **Ottenere un'accuratezza sub-millimetrica**
- **Ottenere un elevato gradiente di dose, in modo da colpire il bersaglio con dosi elevate e salvaguardare allo stesso tempo gli organi critici circostanti**
- **Trattare lesioni di forma irregolare con un buon indice di conformazione**
- **Trattare con estrema precisione lesioni in aree cliniche critiche**



CyberKnife® Robotic Radiosurgery System

OUR experience

Trattamenti CK da Novembre 2012 a Dicembre 2013



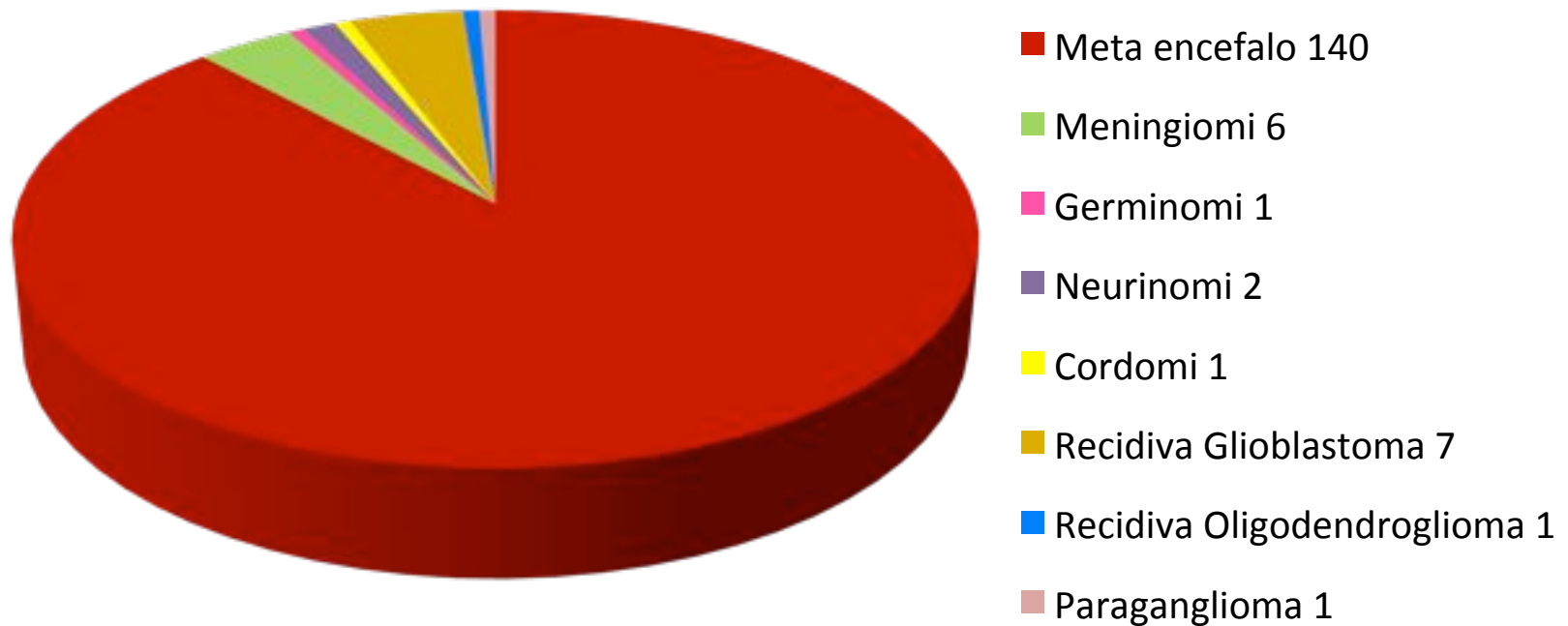
Totale trattamenti 249

Totale pazienti 210

CyberKnife® Robotic Radiosurgery System

OUR experience

Trattamenti Encefalo CK da Novembre 2012 a Dicembre 2013



La Nostra Esperienza...

Selection criteria

Radisurgery (SRS)/ Stereotactic RT (SRT)

- good performance status KPS >70
- n° of lesions ≤ 4
- limited volume ($\emptyset < 3-4$ cm)
- good prognosis
(expected survival >6 months)
- controlled extracranial disease



La Nostra Esperienza...

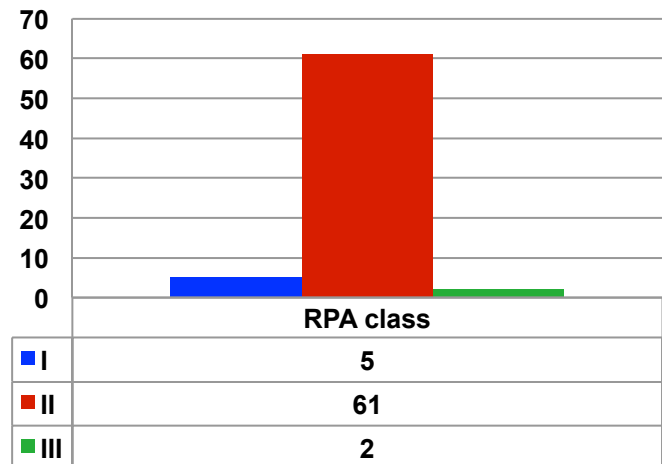
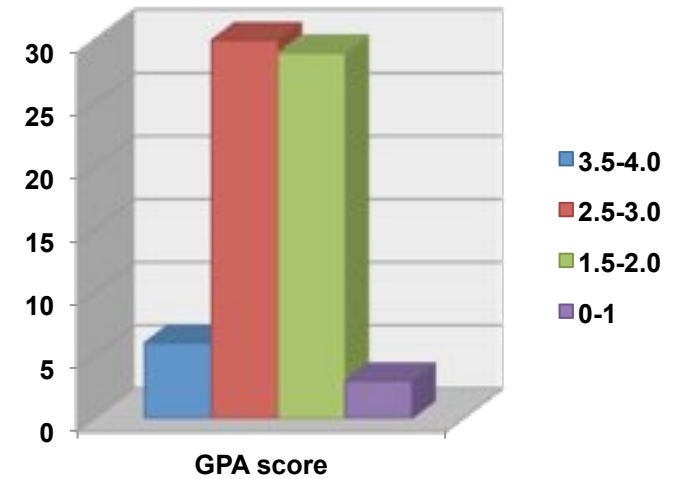
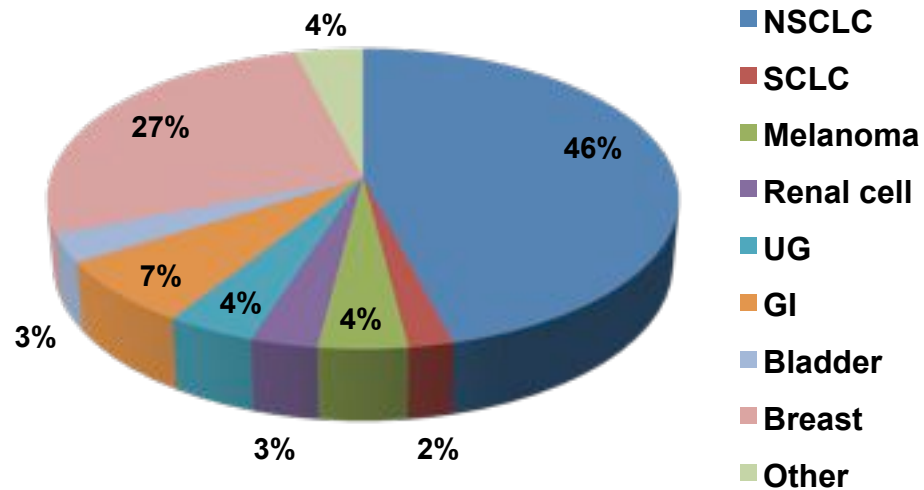
DA NOVEMBRE 2012 A NOVEMBRE 2013

PATIENT/LESION CHARACTERISTICS		
	N°	%
Number of patients	68	
Gender (M/F)	33/35	49%/51%
Age [median (range)] (y)	59 (29-86)	
KPS scale (≥ 70 / < 70)	(66/2)	(97%/3%)
N° of treated lesions (1/2/ ≥ 3)	(40/15/13)	(59%/22%/19%)
N° of extracranial metastatic organs (0/1/ ≥ 2)	(26/24/18)	(38%/35%/27%)



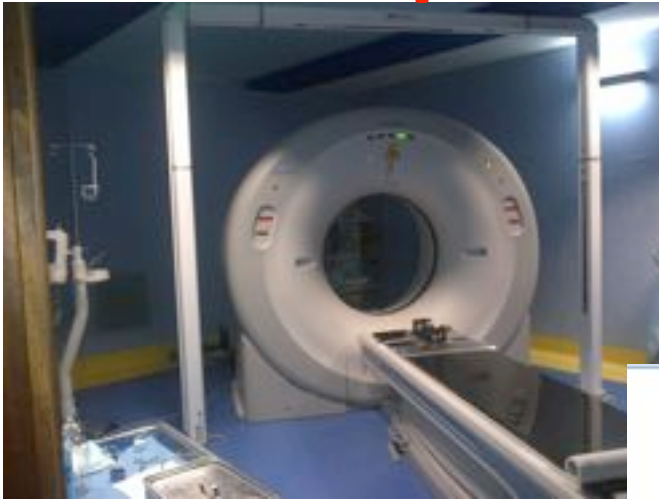
La Nostra Esperienza...

Primary Site



La Nostra Esperienza...

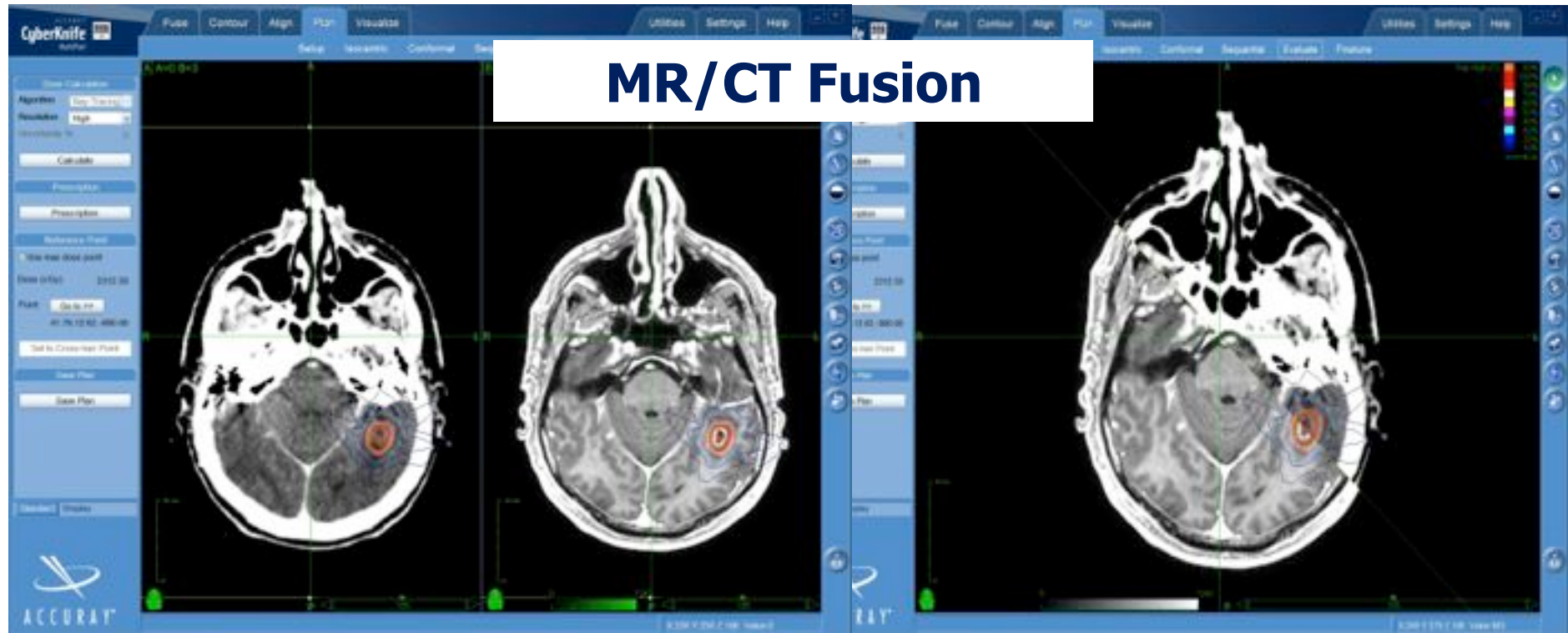
CT/Set-up



**Simul-TC con mdc
Slice 1mm**

La Nostra Esperienza...

Contouring



VOLUMES

GTV: tumor

CTV = GTV

PTV: is CTV plus 2 mm margin

OARs

Lens

Optic nerve

Whole brain

Spinal cord

Optic chiasm

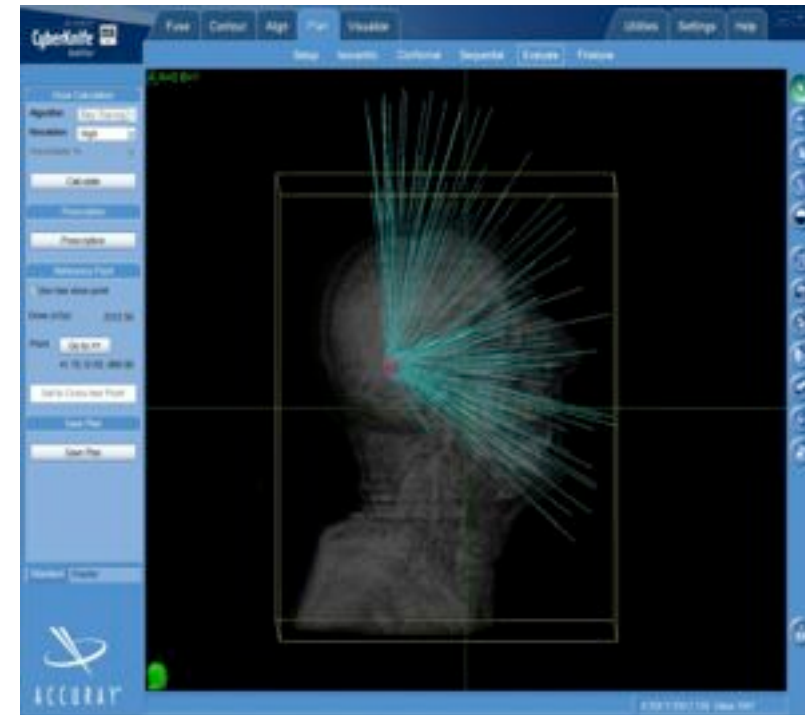
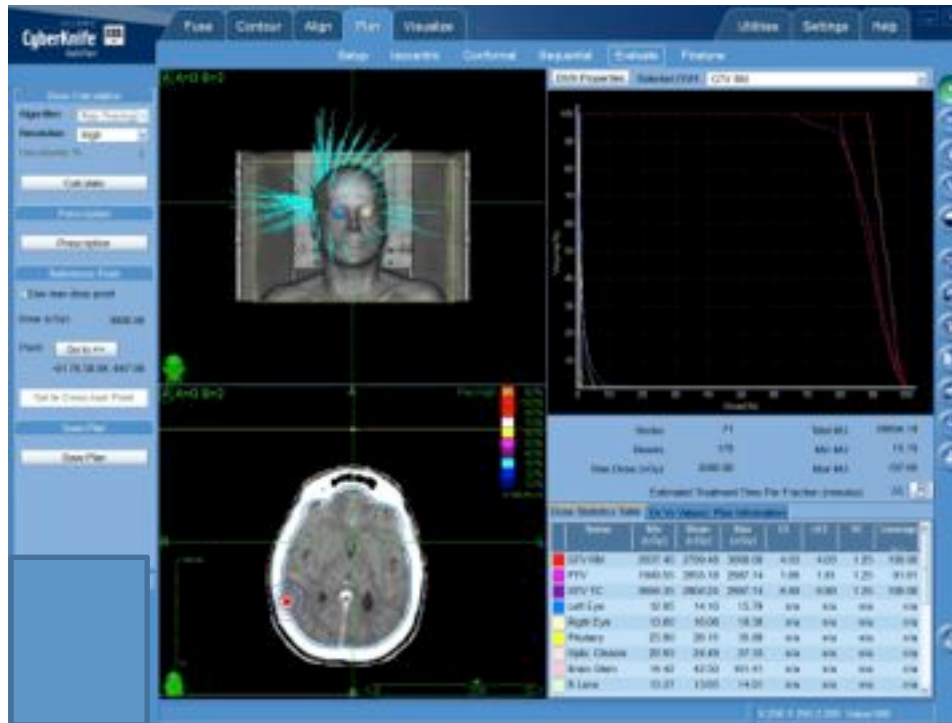
Eyes

Brain stem

choclea Skin

La Nostra Esperienza...

Planning



- **77% frazione singola (range 10-24 Gy)**
- **3% due frazioni (range 18-21 Gy)**
- **17% tre frazioni (range 18-24Gy)**
- **3% con cinque frazioni (range 20-25Gy)**

**La dose è stata
prescritta
all'isodose dell'80%**

An Overview of Hypofractionation and Introduction to This Issue of *Seminars in Radiation Oncology*

Table 2 Mostly Unvalidated Normal Tissue Dose Constraints for SBRT

Serial Tissue	Volume (mL)	Volume Max (Gy)	Max Point Dose (Gy)	Endpoint (Grade 3)
SINGLE-FRACTION TREATMENT				
Optic pathway	<0.2	8	10	Neuritis
Cochlea			12	Hearing loss
Brainstem	<1	10	15	Cranial neuropathy
Spinal cord	<0.25	10	14	Myelitis
	<1.2	7		
Cauda equina	<5	14	16	Neuritis
Sacral plexus	<3	14.4	16	Neuropathy
Esophagus*	<5	14.5	19	Stenosis/fistula
Ipsilateral brachial plexus	<3	14.4	16	Neuropathy
Heart/pericardium	<15	16	22	Pericarditis
Great vessels	<10	31	37	Aneurysm
Trachea and ipsilateral bronchus*	<4	8.8	22	Stenosis/fistula
Skin	<10	14.4	16	Ulceration
Stomach	<10	13	16	Ulceration/fistula
Duodenum*	<5	8.8	16	Ulceration
Jejunum/ileum*	<5	9.8	19	Enteritis/obstruction
Colon*	<20	11	22	Colitis/fistula
Rectum*	<20	11	22	Proctitis/fistula
Bladder wall	<15	8.7	22	Cystitis/fistula
Penile bulb	<3	14	34	Impotence
Femoral heads (right and left)	<10	14		Necrosis
Renal hilum/vascular trunk	<2/3 volume	10.6		Malignant hypertension
Parallel Tissue	Critical Volume (mL)	Critical Volume Dose Max (Gy)	Endpoint (Grade 3)	
Lung (right and left)	1,500	7	Basic lung function	
Lung (right and left)	1,000	7.4	Pneumonitis	
Liver	700		Basic liver function	
Renal cortex (right and left)	200		Basic renal function	

THREE-FRACTION TREATMENT				
Optic pathway	<0.2	15 (5 Gy/fx)	19.5 (6.5 Gy/fx)	Neuritis
Cochlea			20 (6.67 Gy/fx)	Hearing loss
Brainstem	<1	18 (6 Gy/fx)	23 (7.67 Gy/fx)	Cranial neuropathy
Spinal cord	<0.25	18 (6 Gy/fx)	22 (7.33 Gy/fx)	Myelitis
	<1.2	11.1 (3.7 Gy/fx)		
Cauda equina	<5	21.9 (7.3 Gy/fx)	24 (8 Gy/fx)	Neuritis
Sacral plexus	<3	22.5 (7.5 Gy/fx)	24 (8 Gy/fx)	Neuropathy
Esophagus*	<5	21 (7 Gy/fx)	27 (9 Gy/fx)	Stenosis/fistula
Ipsilateral brachial plexus	<3	22.5 (7.5 Gy/fx)	24 (8 Gy/fx)	Neuropathy
Heart/pericardium	<15	24 (8 Gy/fx)	30 (10 Gy/fx)	Pericarditis
Great vessels	<10	39 (13 Gy/fx)	45 (15 Gy/fx)	Aneurysm
Trachea and ipsilateral bronchus*	<4	15 (5 Gy/fx)	30 (10 Gy/fx)	Stenosis/fistula
Skin	<10	22.5 (7.5 Gy/fx)	24 (8 Gy/fx)	Ulceration
Stomach	<10	21 (7 Gy/fx)	24 (8 Gy/fx)	Ulceration/fistula
Duodenum*	<5	15 (5 Gy/fx)	24 (8 Gy/fx)	Ulceration
Jejunum/ileum*	<5	16.2 (5.4 Gy/fx)	27 (9 Gy/fx)	Enteritis/obstruction
Colon*	<20	20.4 (6.8 Gy/fx)	30 (10 Gy/fx)	Colitis/fistula
Rectum*	<20	20.4 (6.8 Gy/fx)	30 (10 Gy/fx)	Proctitis/fistula
Bladder wall	<15	15 (5 Gy/fx)	30 (10 Gy/fx)	Cystitis/fistula
Penile bulb	<3	21.9 (7.3 Gy/fx)	42 (14 Gy/fx)	Impotence
Femoral heads (right and left)	<10	21.9 (7.3 Gy/fx)		Necrosis
Renal hilum/vascular trunk	<2/3 volume	18.6 (6.2 Gy/fx)		Malignant hypertension
Parallel Tissue	Critical Volume (mL)	Critical Volume Dose Max (Gy)	Endpoint (Grade 3)	
Lung (right and left)	1,500	10.5 (3.5 Gy/fx)	Basic lung function	
Lung (right and left)	1,000	11.4 (3.8 Gy/fx)	Pneumonitis	
Liver	700	17.1 (5.7 Gy/fx)	Basic liver function	
Renal cortex (right and left)	200	14.4 (4.8 Gy/fx)	Basic renal function	

FIVE-FRACTION TREATMENT				
Optic pathway	<0.2	20 (4 Gy/fx)	25 (5 Gy/fx)	Neuritis
Cochlea			27.5 (5.5 Gy/fx)	Hearing loss
Brainstem	<1	26 (5.2 Gy/fx)	31 (6.2 Gy/fx)	Cranial neuropathy
Spinal cord	<0.25	22.5 (4.5 Gy/fx)	30 (6 Gy/fx)	Myelitis
	<1.2	13.5 (2.7 Gy/fx)		
Cauda equina	<5	30 (6 Gy/fx)	34 (6.8 Gy/fx)	Neuritis
Sacral plexus	<3	30 (6 Gy/fx)	32 (6.4 Gy/fx)	Neuropathy
Esophagus*	<5	27.5 (5.5 Gy/fx)	35 (7 Gy/fx)	Stenosis/fistula
Ipsilateral brachial plexus	<3	30 (6 Gy/fx)	32 (6.4 Gy/fx)	Neuropathy
Heart/pericardium	<15	32 (6.4 Gy/fx)	38 (7.6 Gy/fx)	Pericarditis
Great vessels	<10	47 (9.4 Gy/fx)	53 (10.6 Gy/fx)	Aneurysm
Trachea and ipsilateral bronchus*	<4	18 (3.6 Gy/fx)	38 (7.6 Gy/fx)	Stenosis/fistula
Skin	<10	30 (6 Gy/fx)	32 (6.4 Gy/fx)	Ulceration
Stomach	<10	28 (5.6 Gy/fx)	32 (6.4 Gy/fx)	Ulceration/fistula
Duodenum*	<5	18 (3.6 Gy/fx)	32 (6.4 Gy/fx)	Ulceration
Jejunum/ileum*	<5	18.5 (3.7 Gy/fx)	35 (7 Gy/fx)	enteritis/obstruction
Colon*	<20	25 (5 Gy/fx)	38 (7.6 Gy/fx)	colitis/fistula
Rectum*	<20	25 (5 Gy/fx)	38 (7.6 Gy/fx)	proctitis/fistula
Bladder wall	<15	18.3 (3.66 Gy/fx)	38 (7.6 Gy/fx)	cystitis/fistula
Penile bulb	<3	30 (6 Gy/fx)	50 (10 Gy/fx)	Impotence
Femoral heads (right and left)	<10	30 (6 Gy/fx)		Necrosis
Renal hilum/vascular trunk	<2/3 volume	23 (4.6 Gy/fx)		Malignant hypertension
Parallel Tissue	Critical Volume (mL)	Critical Volume Dose Max (Gy)	Endpoint (Grade 3)	
Lung (right and left)	1,500	12.5 (2.5 Gy/fx)	Basic lung function	
Lung (right and left)	1,000	13.5 (2.7 Gy/fx)	Pneumonitis	
Liver	700	21 (4.2 Gy/fx)	Basic liver function	
Renal cortex (right and left)	200	17.5 (3.5 Gy/fx)	Basic renal function	

*Avoid circumferential irradiation.

CONSTRAINTS

JOURNAL OF APPLIED CLINICAL MEDICAL PHYSICS, VOLUME 12, NUMBER 2, SPRING 2011

Dose tolerance limits and dose volume histogram evaluation for stereotactic body radiotherapy

Jimm Grimm,^a Tamara LaCouture, Raymond Croce, Inhwan Yeo, Yunping Zhu, and Jinyu Xue

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journal homepage: www.elsevierhealth.com/journals/ctrv



Complications of Treatment

Stereotactic radiosurgery and hypofractionated stereotactic radiotherapy: Normal tissue dose constraints of the central nervous system

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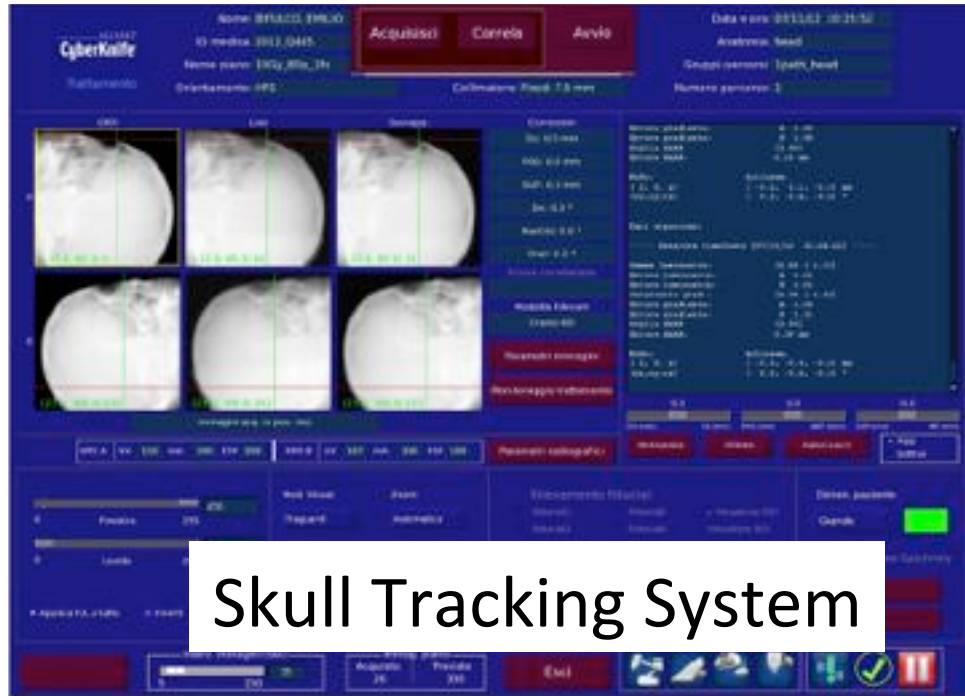
Table 2

Summary of central nervous system dose expected to yield acceptable toxicity outcomes after single fraction SRS.

Structure	Outcome	Constraint
Brain parenchyma ^a	Necrosis	Tissue V12 <5–10 ml Tissue V10 <10 ml
Brainstem	Necrosis or neurologic deficits	<10–12 Gy maximum
Optic nerve/optic chiasm	Vision loss, anopsia, decreased visual acuity	<10–12 Gy maximum
Carotid artery	Occlusion	<20–23 Gy maximum
Acoustic neuroma	Symptomatic cranial nerve V and/or VII neuropathy Hearing preservation	<12–13 Gy at tumor margin <12–13 Gy at tumor margin
Modiolus of cochlea	Hearing preservation	<4–5 Gy maximum
Cochlea	Hearing preservation	<6 Gy maximum
Spinal cord (RTOG 06-31)	Symptomatic myelopathy	0.35 ml <10 Gy ^b 0.035 ml <14 Gy ^b
Cauda equina (RTOG 06-31)	Symptomatic neuritis	<16 Gy maximum ^b 5 ml <14 Gy ^b
Spinal cord (conservative)	Symptomatic myelopathy	<8–10 Gy maximum
Thecal sac (conservative)	Symptomatic myelopathy	<10–14 Gy maximum

La Nostra Esperienza...

Delivery



La Nostra Esperienza...

Risultati

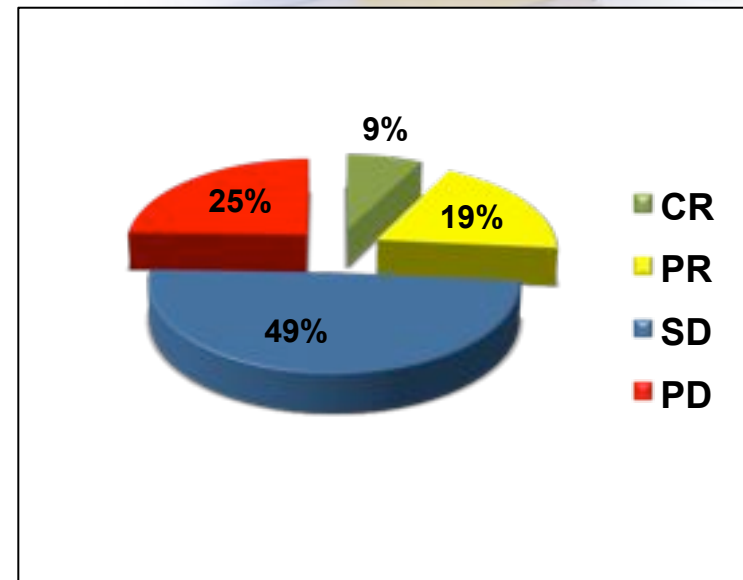
- Il Follow up è stato in media 5.3 mesi (range 1-12)
- sopravvivenza globale del 81% (55/68pz)
- 53 erano valutabili per il controllo locale

Remissione completa (CR) nel 7.5% (4/53)

Remissione parziale nel 19% (10/53)

Stabilità di malattia nel 49% (26/53)

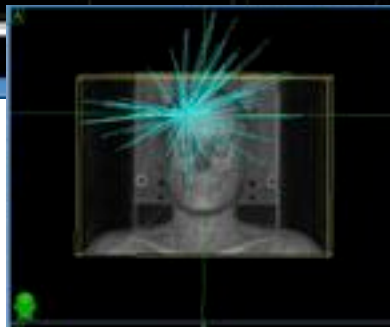
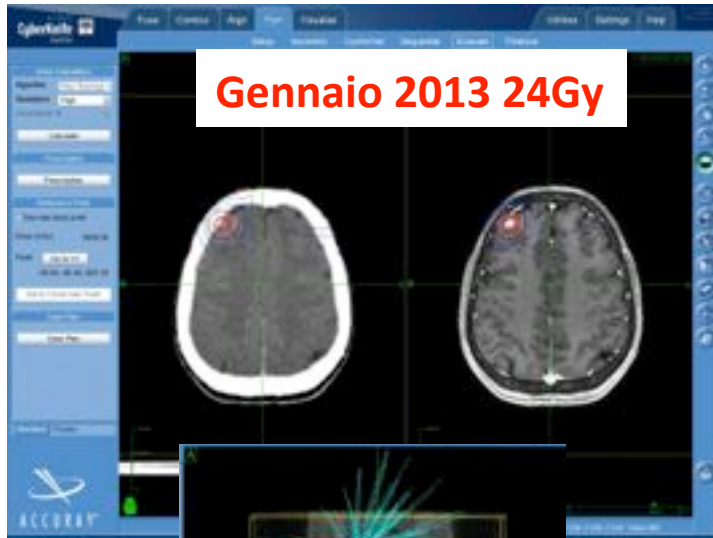
Progressione di malattia nel 24.5% (13/53).



Nostra esperienza....

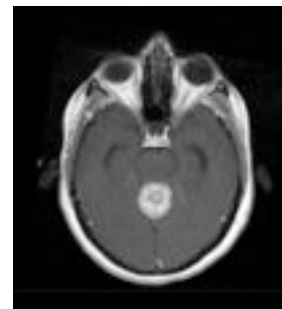
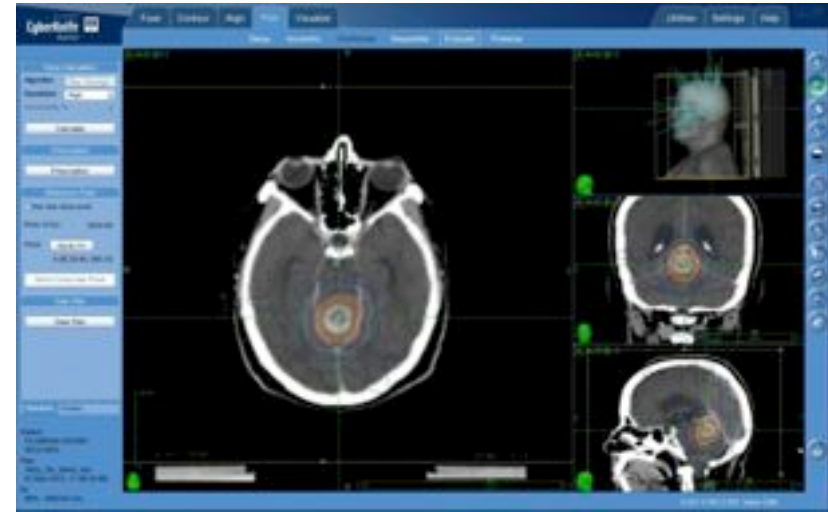
M+ da CA MAMMELLA

SRS

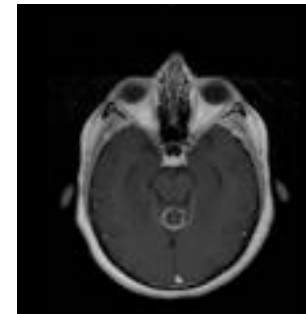


Agosto 2013

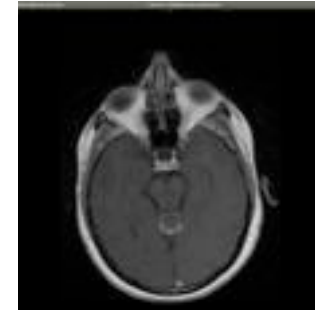
SRT



**RM pre RT
maggio 2013**



RM luglio 2013



RM ottobre 2013



**Grazie
per
l'attenzione**