XXIV CONGRESSO NAZIONALE

AIRO 2014

Padova, 8-11 novembre

Centro Diagnostico Italiano CDI
Cyberknife Centre

Stereotactic Body Radiotherapy (SBRT) with Cyberknife in the treatment of hepatic metastases: the experience of the CDI of Milan

L.C Bianchi, A.Bergantin, A.S Martinotti, C.Vite, F.Ria, M.Invernizzi, G.Beltramo

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30-50% pz with cancer have liver metastases

15-20% with colon-rectum cancer have liver metastases as first localization

Most common primary sites are lung, breast, urinary bladder, esophagus, pancreas ,head-neck cancer, optic melanoma and ovarian cancer.

Neuroendocrin tumors

Grover at al Oncologist 2004
Mazzaglia et al Curr treat option oncol 2007
Bojalian at al Gynecol Oncol 2004

Hugh et al, Aust NZ J Surg 1997

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Majority of liver metasatses initially clinically silent and symtoms present at a late stage

Imaging techniques (TC and MRI) can detective liver metastases erlier in a asyntomatic patients.

Sharma et al, J of HBP Surgery 2008

Hugh et al, Aust NZ J Surg 1997

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Patients with resected metastatic colon rectal cancer have 5 year survival rate > 30%

Surgery has a positive impact on survival

So resection remains the standard of care when resecability criteria are satisfied :
N°of lesions (>3-4)
Dimension of lesions (>5-6cm)
Invasion of major vascular structures
Reduction in residual hepatic volume

Fong Y. CA Cancer J. Clinic 1995
Simmonds P.C. Br. J. Cancer 2006
Khatri et al J. Clin Oncol 2005
Kemeni N.Oncology 2006
Poston et al J Clin Oncol 2005

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Surgery is technically difficult and only 20% of metastatic colon rectal cancer patients are candidates for surgical resection

A variety of ablative techniques have been developed for the remaining 80%

Fong Y. CA Cancer J. Clinic 1995

Simmonds P.C. Br. J. Cancer2006

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Ablative technique

Radio Frequency (RFA)

OS 3 years → 30-40% vs 70% surgery resection

Controindication → proximity to bladder and major biliard tract

Percutaneous ethanol injection (PEI)

casistical data are in epatocarcinoma lesions.

OS 5 years → 48%
→ 36%

Chemoembolization transarterial (TACE)

3 clinical trials → no statistical significance in-term of survival

Okuda 1993

Livraghi al al radiology 2003

Guenette et al JourSurgOnc 2010

Livraghi 1995

Pellettier 1990 - GETCH 1995-Pellettier 1998

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Unsuccessful outcome after radiation therapy is caused by

Inadequate dose to tumor
(TCP very low with standard doses)

Excessive dose to normal tissues

Need for dose intensification able to achieve a better “uncomplicated tumor control

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SBRT is an external beam radiation therapy method used to very precisely deliver a high dose of radiation to an extracranial target with in the body, using either a single dose or a small number of fractions.

Specialized treatment planning results in high target dose and steep dose gradients beyond the target.

SBRT can be applied using non invasive or minimally invasive stereotactic localization and radiation delivery techniques.

practice guideline for the performance of SBRT
REPORT 2010

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Survival Efficacy Following Stereotactic Body Radiation Therapy for Limited Liver Metastases

B. Goodman, C. Calley, M. Maluccio, P. Helft, E. Chiorean, and H. Cardenes; *Indiana University, Indianapolis, IN*

ORIGINAL ARTICLE

Multicentre results of stereotactic body radiotherapy for secondary liver tumours

Betul Berber[a], Rafael Ibarra[1], Laura Snyder[1], Min Yao[2], Jeffrey Fabien[2], Michael T. Milano[3], Alan W. Katz[3], Karyn Goodman[4], Kevin Stephans[5], Galal El-Gazzaz[6], Federico Aucejo[6], Charles Miller[6], John Fung[6], Simon Lo[7], Mitchell Machtay[7] & Juan Sanabria[1]

Departments of [1]Surgery, and [2]Radiation Oncology, University Hospitals Case Medical Center, Case Western Reserve University, Cleveland, OH, [3]Department of Radiation Oncology, University of Rochester Medical Center, Rochester, [4]Department of Radiation Oncology, Memorial Sloan Kettering Cancer Center, New York, NY, Departments of [5]Radiation Oncology and [6]Surgery, Cleveland Clinic Foundation, Lerner College, Cleveland, OH, USA

Habermehl et al. Radiation Oncology 2013, 8:175
http://www.ro-journal.com/content/8/1/175

RADIATION ONCOLOGY

RESEARCH Open Access

Single-dose radiosurgical treatment for hepatic metastases - therapeutic outcome of 138 treated lesions from a single institution

Daniel Habermehl[1,2*], Klaus K Herfarth[1], Justo Lorenzo Bermejo[2], Holger Hof[1], Stefan Rieken[1], Sabine Kuhn[1], Thomas Welzel[1], Jürgen Debus[1] and Stephanie E Combs[1]

Is Stereotactic Body Radiation Therapy an Attractive Option for Unresectable Liver Metastases? A Preliminary Report From a Phase 2 Trial

Marta Scorsetti, MD,* Stefano Arcangeli, MD,* Angelo Tozzi, MD,* Tiziana Comito, MD,* Filippo Alongi, MD,* Pierina Navarria, MD,* Pietro Mancosu, MSc,* Giacomo Reggiori, MSc,* Antonella Fogliata, MSc,‡ Guido Torzilli, MD,† Stefano Tomatis, MSc,* and Luca Cozzi, PhD‡

In literature
SBRT ……..

effective and safe treatment
good local control
limited toxicity profile

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Cyberknife system

In 1991 Jonh Adler, an american neurosurgeon,
develop a delivering stereotactic radiosurgery system without the need for rigid immobilization.
Articulated mechanical arm that allows a 6-point great mobility of the source in space.

Circular collimator (5-60mm)
6 MV X band

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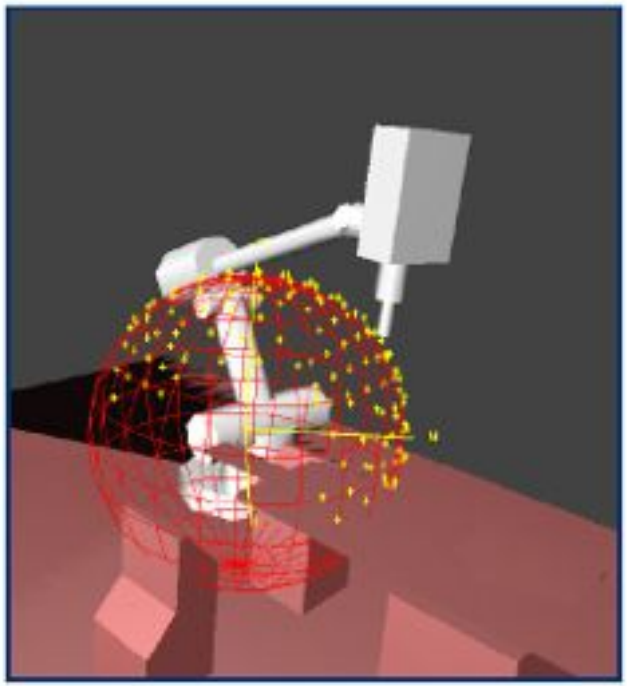
Cyberknife System

130 nodes
For each node : 12 directions
Total : 1500 different orientations of beam

No Complanar
No isocentric

High conformability of dose



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Cyberknife System

2 sources RX + 2 in amorphous silicon detectors.
Images acquired in real time and compared with the CT data (DRR)

IGRT

Before delivery of each beam, the robot corrects the direction according to the movements of the patient.

High Accuracy (<1mm)

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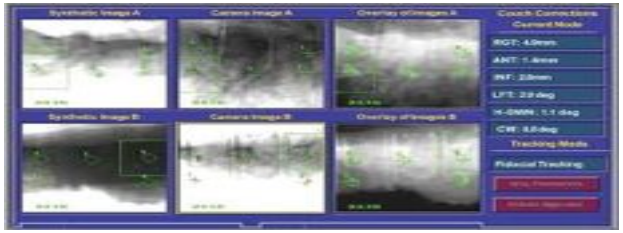
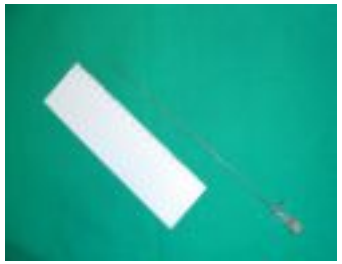
Cyberknife system

The image guided system is based on:
For the skull anatomy bone (skull traking)
Spine anatomy and bone deformations (X sight)

For soft tissue location of fiducials (fiducial traking)





Preloaded needle 19G

Accuracy of radiotherapy delivery *depends on the visualisation of implanted gold fiducials at the time of treatment* and comparison with references images obteined during treatment planning, . The advantage of Cyberknife tracking sistem is *to verify in every step of treatment the real position of neoplstic target* and the possibility *to adjust* the aim of robotic arm if the target position change during radiotherapy treatment.

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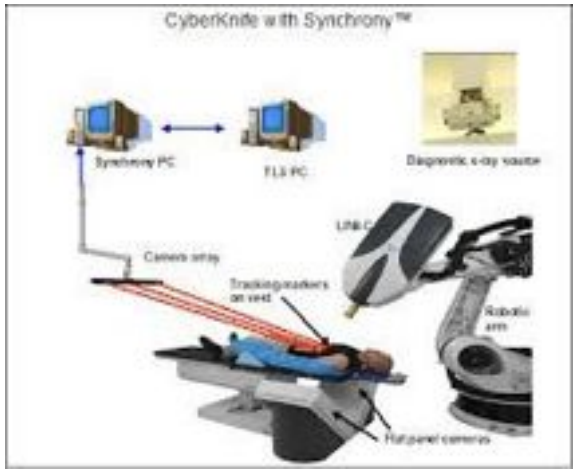
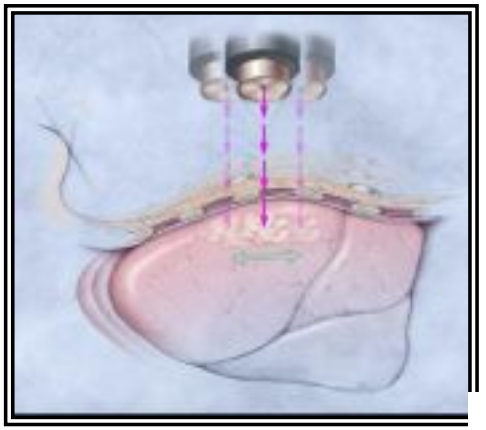
Cyberknife system

Respiratory guided radiation therapy: **synchrony system**

The internal movement (lesion) is monitored by the system Fiducial traking
The outward movement is monitored through, the system LED + room

Model matching: relates the inner and outer movement thus allowing to follow in a continuous way the movement of the lesion with breaths





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Inclusion criteria

inoperable or medically unsuitable for resection
N of lesions < 4
Max volume = 6 cm
KPS > 70
Good respiratory function
no controindications to fiducials position

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Materials/Methods

Patient characteristics

2009- 2014

No. of patients	**44**
Age	median 64 ys (34-89)
Gender (male : female)	19:25
Primary site	colon-rectum 19
	breast 10
	lung 8
	other sites 7
Extraehepatic disease	34 %(15 pz)

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No patient have prior ablation therapies

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Materials/Methods

Patient characteristics

2009- 2014

N.of lesions	**71**
Median volume of PTV	36CC (2.5-542)
N. of lesions for patient	1 for 28 pz (63%) 2 for 8 pz (18%) 3 for 8 pz (18%)

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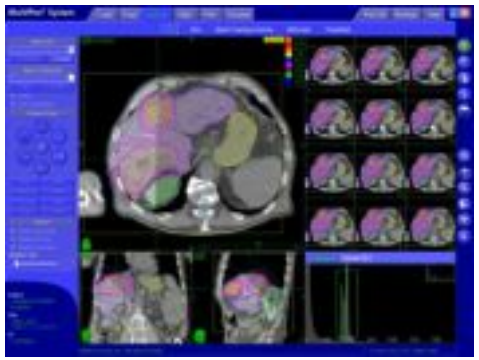
Materials/Methods

Treatment planning

2009- 2014

To allow fiducial stabilization and resolution of swelling, planning studies will be imaged >= 7 days after fiducial placement.

CT scans will be taken for treatment planning. CT slices will be 1 – 1.5mm, with 300-512 slices taken.



All patients will undergo MRI T1 – T2 imaging
This study will be fused to the treatment planning CT.

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Materials/Methods

2009- 2014

Target delineation

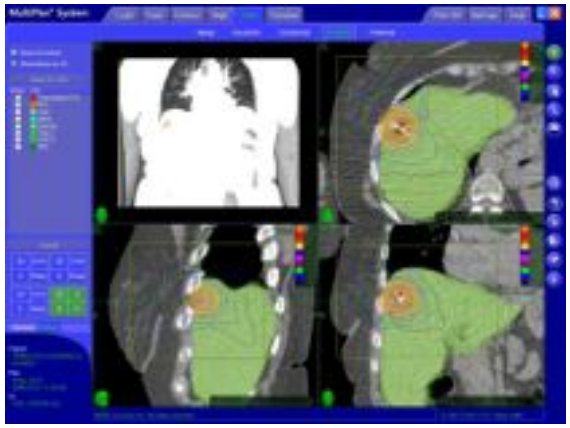
Gross Tumor Volume (GTV) identified on CT scans with MDC and integrated with MRI images.

CTV coincides with the GTV (unplanned expansion).

PTV defined as CTV by adding a margin of 3mm.

Treatment delivering

Median total dose	**45 GY** (20-50)
Isodose	80%
Fractions	1-4



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Dose contraints Organ at risk

Parallel organs	*1fr.*	*3fr.*	*5fr.*
	D .Max to critic volume		
Liver			
Min critical vol : 700cc	9Gy	15Gy	21Gy
Kidneys Min critical vol : 200cc	8Gy	16Gy	17.5Gy
Serial organs	D .Max to critic volume		
Stomach (max critical vol <10cc)	11.2Gy	16.5Gy	18Gy
Bowel (max critical vol <5cc)	11.9Gy	17.7Gy	19.5Gy
Spinal cord (<0.3cc)	10Gy	18Gy	23Gy
Heart (<15cc)	16Gy	24Gy	32Gy

AAPM

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Results

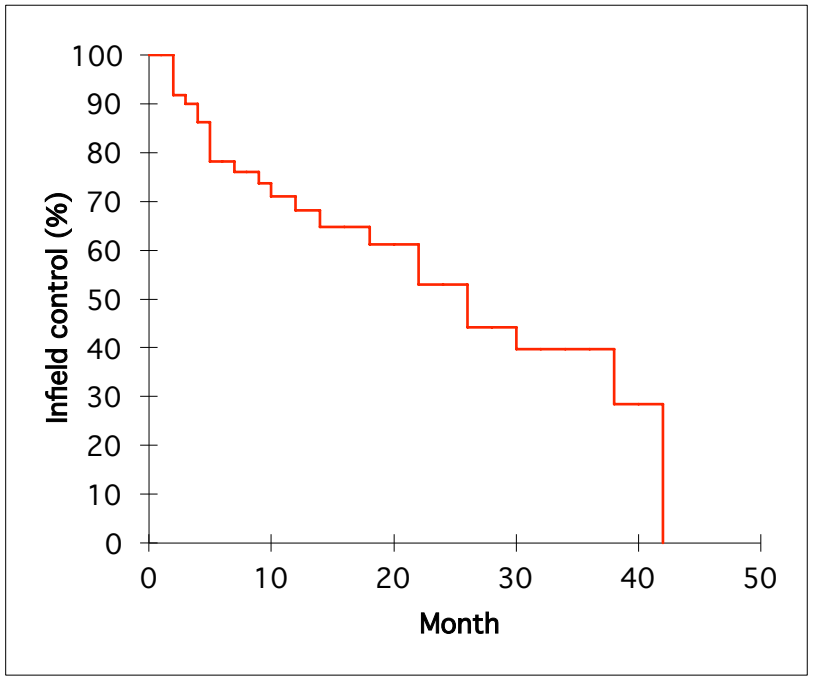
2009- 2014

Median of follow up 11 months (2-20)

Local control

1 year 68%

2 years 53.3%



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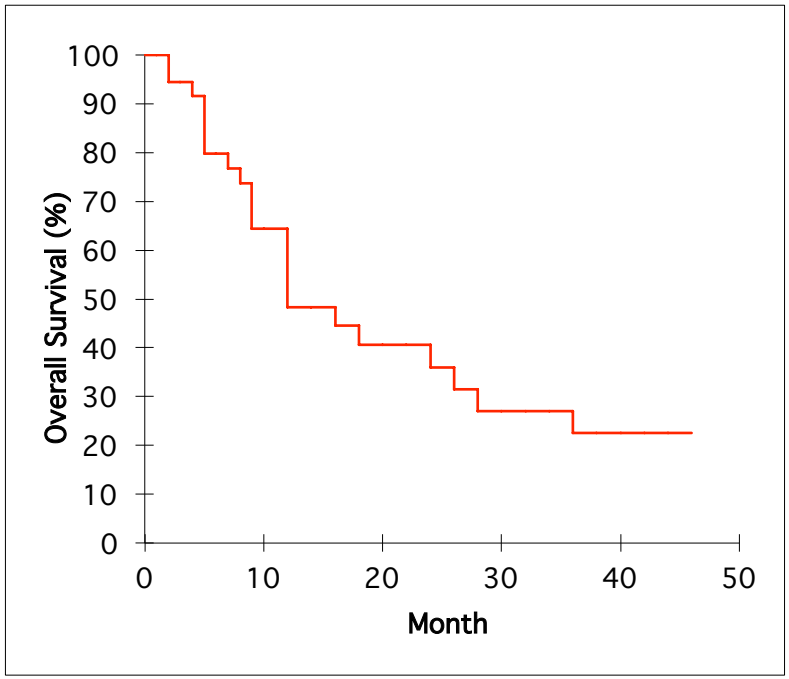
Results
2009- 2014

Median of follow up 11 months (2-20

<u>Overall survival</u>
1 year 48.3%
2 years 36%



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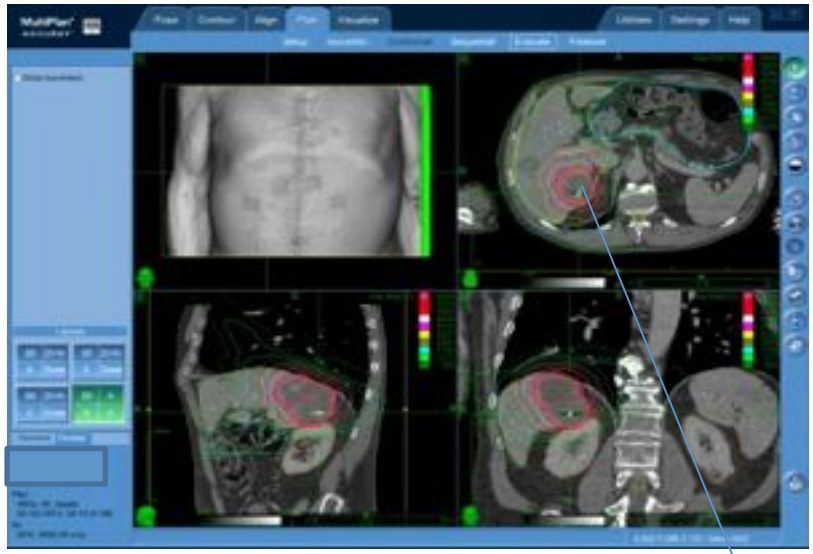
Cyberknife Stereotactic Radiosurgery Treatment



Marker

Man, **72 years old**
prescription dose of
48GY in 4 fractions with >
95% of the PTV
encompassed within the
prescription isodose
volume.

Female**, 44 Years old**
prescription dose **54Gy in 3 fractions**

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Results

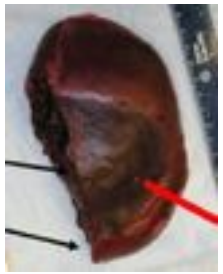
2009- 2014

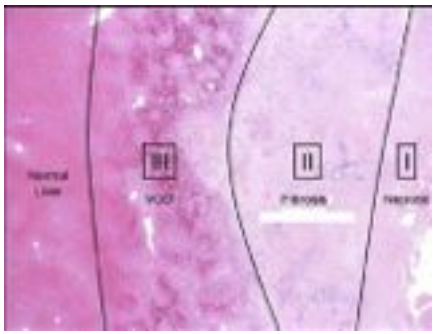
RTOG toxicity criteria

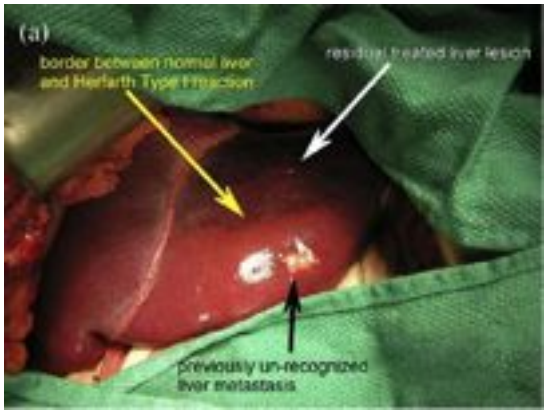
G1-G2 toxicity were present in **all patients** → Steroid therapy

G3 toxicity **no observed**

NO RILD







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Conclusion

2009- 2014

SBRT for unresectable liver metastases can be considered an effective, safe, and non-invasive therapeutic option, with good rates of local control and a low treatment-related toxicity.

Multidisciplinary approach

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Thank you !!!!!!