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# AIRO2022

Radioterapia di precisione per un'oncologia innovativa e sostenibile

BOLOGNA, 25-27 NOVEMBRE  
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 Associazione Italiana  
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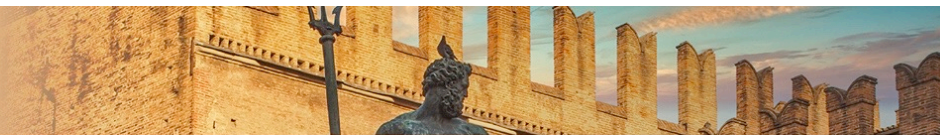
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## **HIGH DOSE PROTON AND PHOTON-BASED RADIATION THERAPY FOR 213 LIVER LESIONS: A MULTI-INSTITUTIONAL DOSIMETRIC COMPARISON WITH A CLINICAL PERSPECTIVE**

Marco Lorenzo Furio Bonù, M.D.

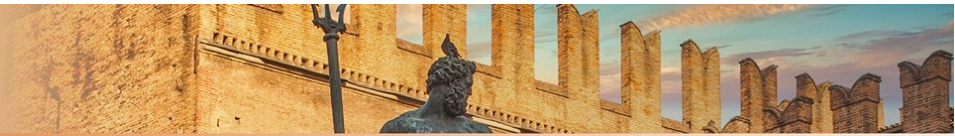
University of Brescia, Istituto del Radio O. Alberti, Spedali Civili di  
Brescia, Italy



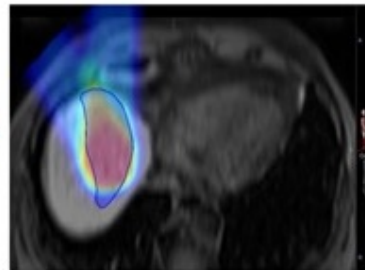
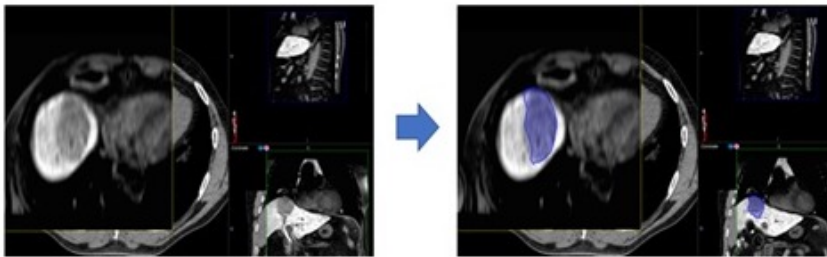
## DICHIARAZIONE

Relatore: Marco Lorenzo Furio Bonu'

- Posizione di dipendente in aziende con interessi commerciali in campo sanitario **(NIENTE DA DICHIARARE)**
- Consulenza ad aziende con interessi commerciali in campo sanitario **(NIENTE DA DICHIARARE)**
- Fondi per la ricerca da aziende con interessi commerciali in campo sanitario **(IPSEN)**
- Partecipazione ad Advisory Board **(NIENTE DA DICHIARARE)**
- Titolarità di brevetti in compartecipazione ad aziende con interessi commerciali in campo sanitario **(NIENTE DA DICHIARARE)**
- Partecipazioni azionarie in aziende con interessi commerciali in campo sanitario **(NIENTE DA DICHIARARE)**
- Altro **(NIENTE DA DICHIARARE)**



## HIGH DOSE PROTON AND PHOTON-BASED RADIATION THERAPY FOR 213 LIVER LESIONS: A MULTI-INSTITUTIONAL DOSIMETRIC COMPARISON WITH A CLINICAL PERSPECTIVE



### BEST FITTING ISODOSE FOR MRI FOCAL LIVER REACTION:

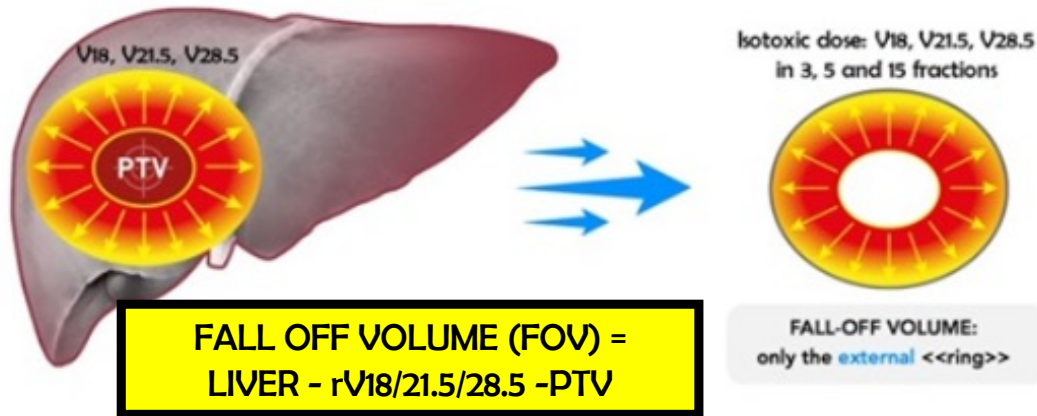
- 18 gy for 3 fractions
- 21.5gy for 5 fractions
- 28.5gy for 15 pt fractions

**ISOTOXIC DOSE TO THE LIVER**

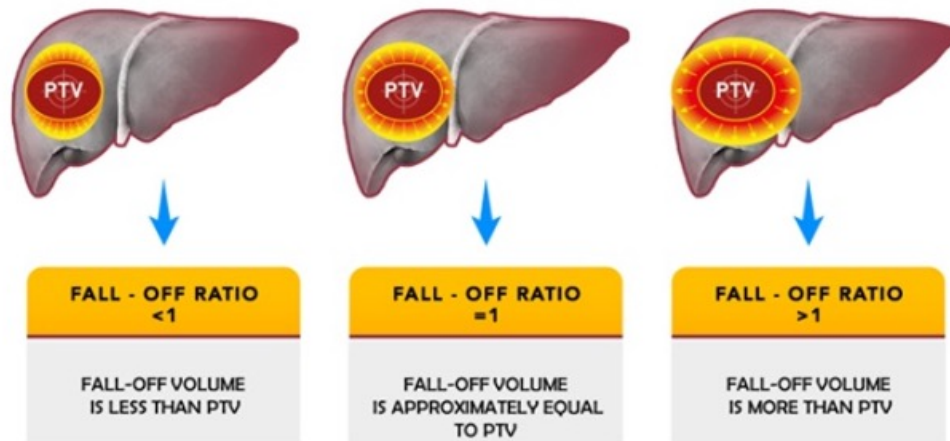
**BACKGROUND AND PURPOSE:** Stereotactic radiotherapy (SRT) and Proton therapy (PT) are both options in the management of liver lesions. Limited clinical-dosimetric comparison are available. Plans optimization in high dose RT concerning healthy liver uses the concept of cc of liver spared form a certain dose, not taking into account the volume of healthy liver damaged.

**MATERIAL AND METHODS:** Primary endpoint was to assess and compare liver sparing of SRT and PT and found new parameters useful for plan optimization. We hypothesize that Focal Liver Reaction (FLR) is determined by a similar biologic dose, despite the dose-fractionation used. FLR was identified on follow-up MRI. Best fitting isodose for FLR were 18Gy, 21.5 Gy and 28.5Gy for 3, 5 and 15 fractions (isotoxic dose).

**STANDARD PLAN OPTIMIZATION ACCOUNT FOR LIVER SPARED, NOT FOR LIVER «LOST»**



**MATERIAL AND METHODS (CONTINUATION):** A so-called Fall-off Volume (FOV) was defined as the area of healthy liver (liver-PTV) receiving more than the isotoxic dose. Fall-off Ratio (FOR) was defined as the ratio between FOV and PTV, that represents a proxy of the fraction of liver damaged, applying a correction factor for PTV dimension. Secondary endpoints were freedom from local recurrence (FFLR), progression free survival (PFS), overall survival (OS), acute and late toxicity.



**FALL OFF RATIO (FOR) = FALL OFF VOLUME/PTV**

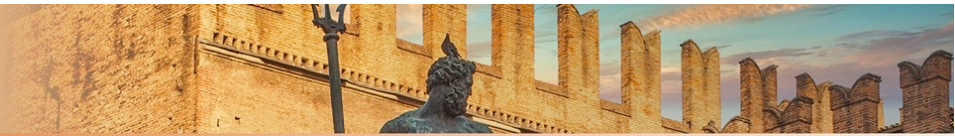


Table 2. Fall-off volume is defined as the Whole liver minus PTV minus area respected from the isotoxic isodose ( rV18-rV21.5-rV28 for three, five, fifteen fractions, respectively) minus PTV, resulting the area of healthy liver out-of PTV receiving 18/21.5/28.5 Gy. Fall-off ratio is defined as fall-off volume/ PTV. Only plans covered as per ICRU 83 were considered.

TECHNIQUE	fall-off volume	fall-off ratio (fall-off volume/PTV)	N°	p
<b>V-MAT FFF</b>	156 cc (74-784 cc)	4.5 (0.47-26.4)	43	
<b>V-MAT FF</b>	180 cc (62-489 cc)	6.2 (1-52.7)	68	
<b>Cyberknife</b>	130 cc (21-383 cc)	5 (2.9-22.4)	44	
<b>Proton therapy</b>	87 cc (51.1-236.38 cc)	0.57 (0.18-1.37)	6	<0,001

Legenda. V-MAT= Volumetric-modulated arc therapy; FF= flattening filter technique; FFF= flattening filter free technique

**RESULTS:** 178 Pts for 213 lesions were identified. FOR resulted lower for PT (p<0.001). Among photons, a significantly advantage in terms of healthy liver sparing was found for Vmat FFF technique with 5mm jaws (p=0.013) and Cyberknife (p=0.03). Three years FFLR resulted 83% in the whole series. Multivariate analysis showed portal vein thrombosis (OR 5.2, I.C. 1.1-24 p=0.034) and BED <124 Gy in case of plans that meet ICRU 83 prescriptions (OR 3.57, I.C. 1.1-11.5, p=0.033) to be related with a poorer FFLR. Classic Radiation induced liver disease (RILD, any grade) affected 2 patients, in both cases resolved at 6 months.

## CONCLUSIONS

- VMAT FFF 5 MM JAWS AND CYBERKNIFE SPARES MORE HEALTHY LIVER THAN VMAT FF 10 MM JAWS
- PROTON THERAPY SEEMS TO SPARE MORE HEALTHY LIVER (DESPITE TREATING BIGGER LESIONS) THAN BEST AVAILABLE PHOTON THECNQUES
- FOV AND FOR ARE MODERN INSTRUMENTS TO MEASURE, COMPARE AND OPTIMIZE LIVER PLANS