COMPARISON OF THREE DOSE CALCULATION METHODOLOGIES FOR 90-Y MICROSPHERES RADIOEMBOLIZATION

IPOPORTO

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INTRODUCTION

According to 2013/59/Euratom BSS, for all medical exposure of patients for radiotherapeutic purposes, including Nuclear Medicine, doses in target volumes shall be individually planned. Furthermore, doses to non-target volumes (e.g organs-at-risk) shall be as-low-as-reasonably-achievable and consistent with the intended radiotherapeutic purposes.

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PURPOSE

For ^{90}Y microspheres radioembolization, three methods of activity calculation to be administered are usually used: empirical, body-surface-area (BSA) and partition methods. Accuracy and effectiveness of dose distribution calculation in the liver was compared using these three methods.

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METHODS

EMPIRICAL MODEL

The % involvement by the tumor in the liver	Recomends Y-90 dose (GBq)
< 25 %	2.0
25 % - 50 %	2.5
> 50 %	3.0

The empirical model accepts the safety margins of the doses known from the previously published clinical data.

BSA MODEL

BSA calculation

$$BSA\,(m^2) = 0.20247\,x\,height\,(m)^{0.725}\,x\,weight\,(kg)^{0.425}$$

Activity

$$A(GBq) = (BSA - 0.2) + \left(\frac{V_{tumour}}{V_{total\ liver}}\right)$$

The BSA method varies ^{90}Y activity according to the patient's morphological characteristics (BSA - Body Surface Area) and the size of the tumor within the liver, calcuted from CT images.

PARTITION MODEL

$$Dose_{tissue} = \frac{49670(Gy/GBq/g)xA_{total}(GBq)}{organ\ mass\ (g)}$$

$$Dose_{healthy\ liver} = \frac{49670xA_{total}x\left(1 - \frac{Lung\ shunt}{100}\right)}{V_{healthy\ liver} + \frac{T}{N}x\,V_{tumour}}$$

$$Dose_{tumour} = \frac{T}{N}\,x\,Dose_{healthy\ liver}$$

$$Dose_{lung} = \frac{49670xA_{total}x\left(\frac{Lung\ shunt}{100}\right)}{V_{healthy\ liver} + \frac{T}{N}x\,V_{tumour}}$$

The partition model involves selecting safe radiation doses to the normal liver and lung. The radiation dose to the normal liver parenchyma should not exceed 80 Gy in normal liver and 70 Gy in cirrhotic liver. The dose to the lung should not exceed 25 Gy.

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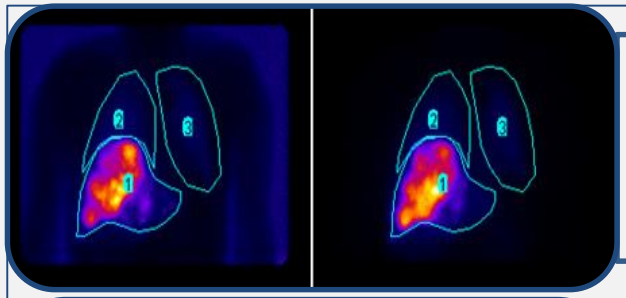
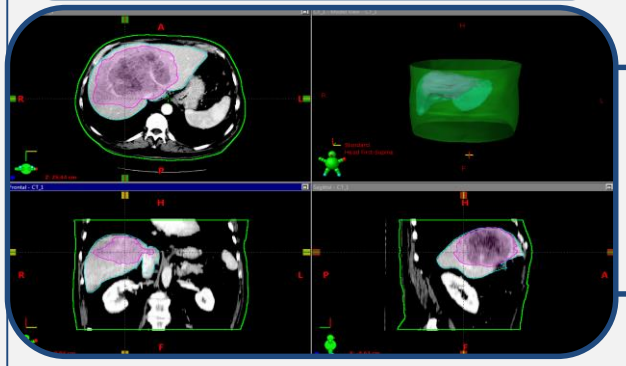
METHODS



- Calculate the percentage shunted to the lungs.



- Determine the volumes of the normal liver and tumour from CT scan.

BSA MODEL

- Determination of the injected activity.

PARTITION MODEL

- Posterial calculation of the dose in total liver, healthy liver, tumour liver and lung.

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RESULTS

^{99m}Tc-MAA

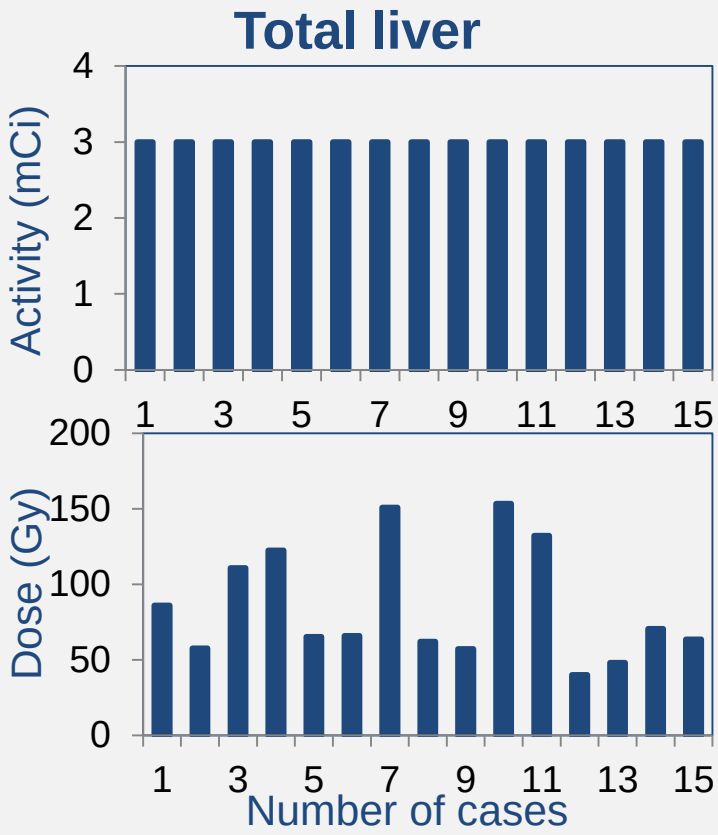

Fig. 1: The activity (~3.00 mCi) and dose (82.60 ± 38.11 Gy) in total liver determined from ^{99m}Tc-MAA biodistribution (surrogate of ^{90}Y).

RADIOEMBOLIZATION

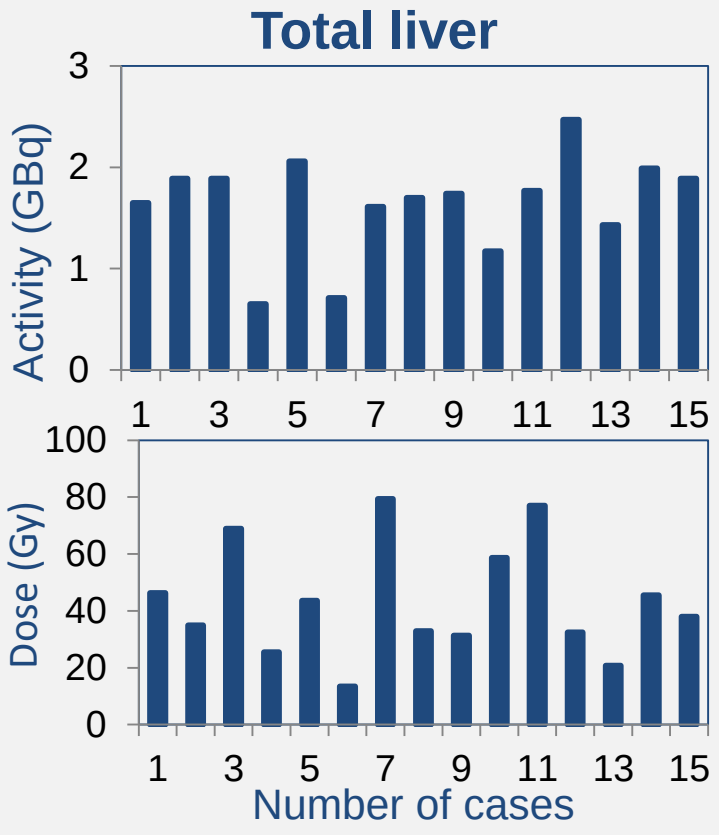

Fig. 2: The activity (1.64± 0.49 GBq) and dose (43.24 ± 19.87 Gy) in total liver determined from *^{90}Y-Microsphere* therapy.

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^{99m}Tc-MAA

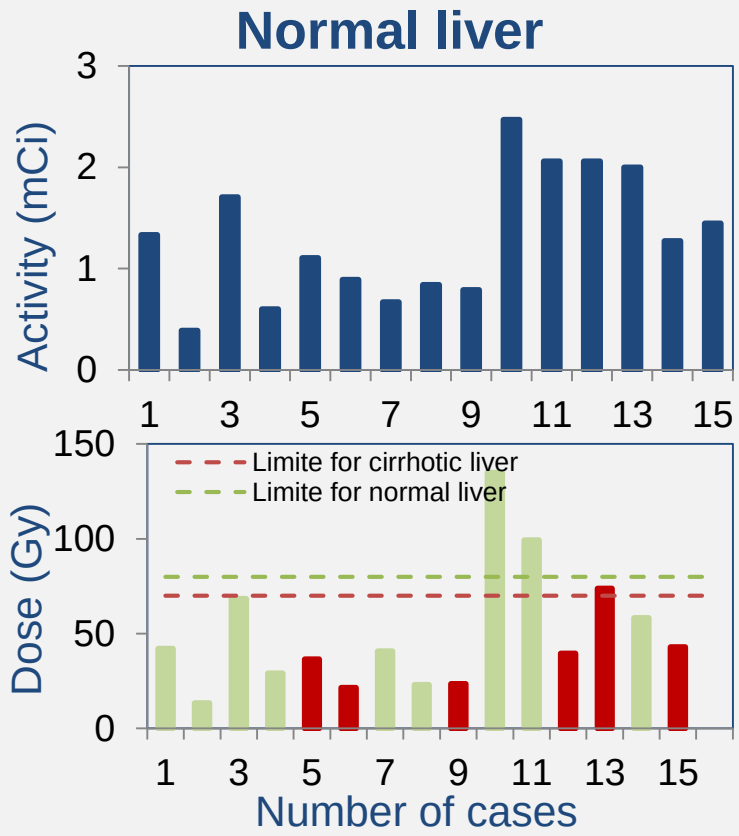

Fig. 3: The activity (1.26± 0.62 mCi) and dose (48.04 ± 32.84 Gy) in healthy liver determined from ^{99m}Tc-MAA biodistribution.

RADIOEMBOLIZATION

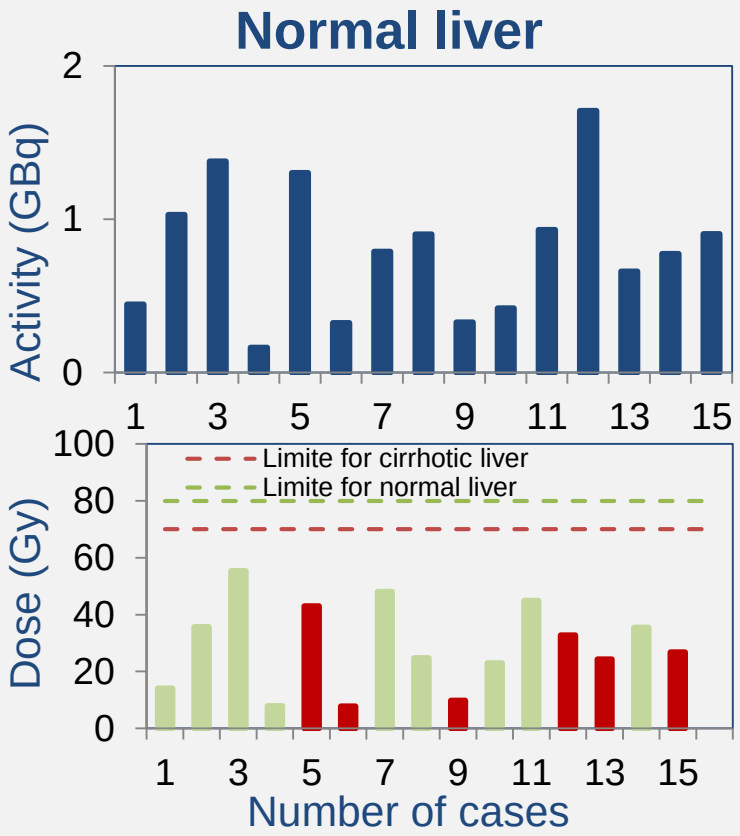

Fig. 4: The activity (0.80± 0.43 GBq) and dose (28.91 ± 15.05 Gy) in healthy liver determined from ^{90}*Y-Microsphere* therapy.

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^{99m}Tc-MAA

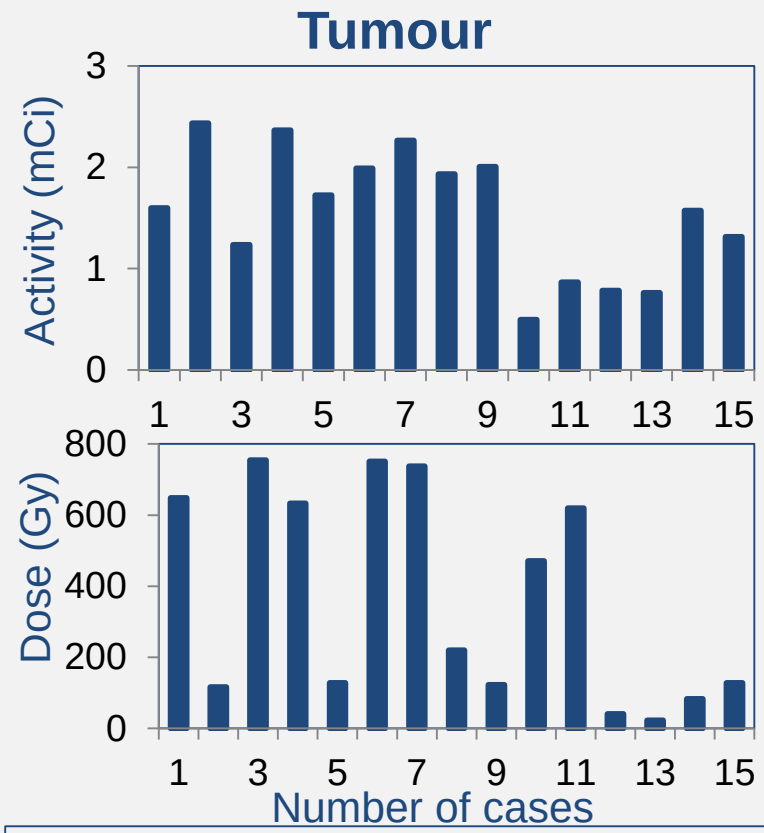

Fig. 5: The activity (1.49± 0.59 mCi) and dose (364.96 ± 295.59 Gy) in tumour liver determined from ^{99m}Tc-MAA biodistribution.

RADIOEMBOLIZATION

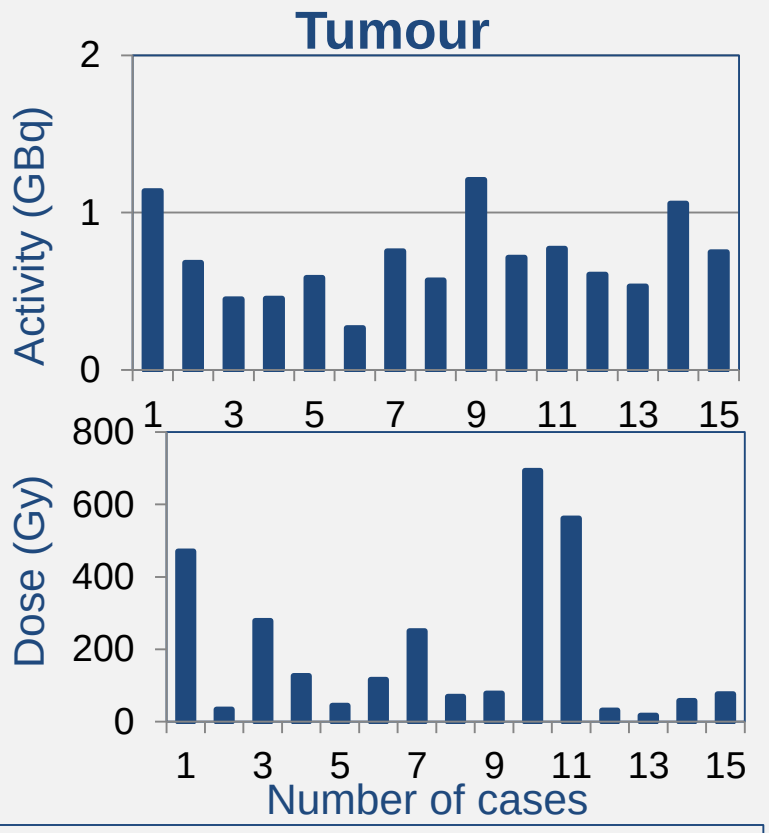

Fig. 6: The activity (0.70± 0.26 GBq) and dose (193.64 ± 215.20 Gy) in tumour liver determined from ^{90}*Y-Microsphere* therapy.

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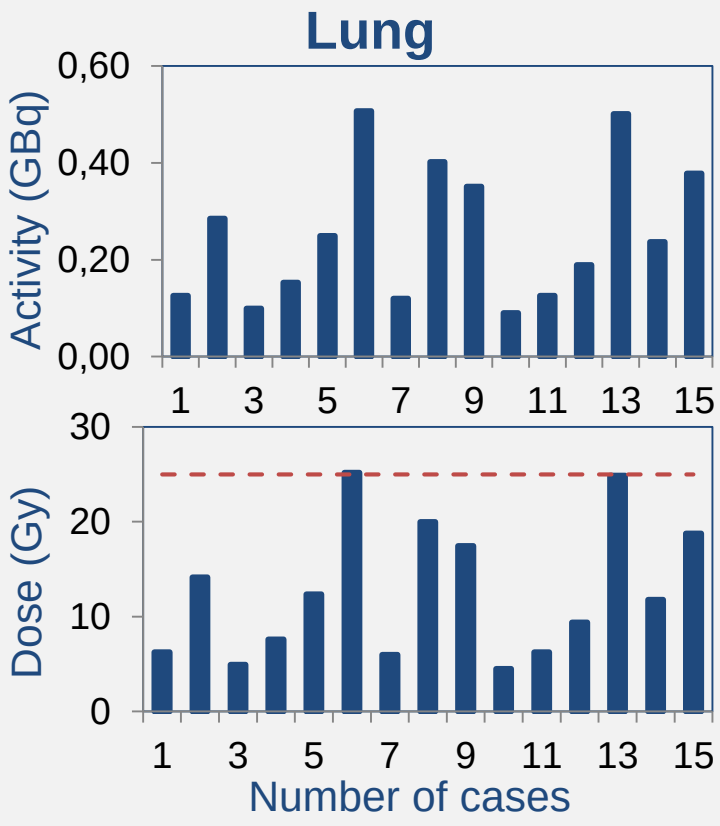

Fig. 7: The activity (0.25± 0.14 mCi) and dose (12.63 ± 7.14 Gy) in the lungs determined from ^{99m}Tc-MAA biodistribution.

RADIOEMBOLIZATION

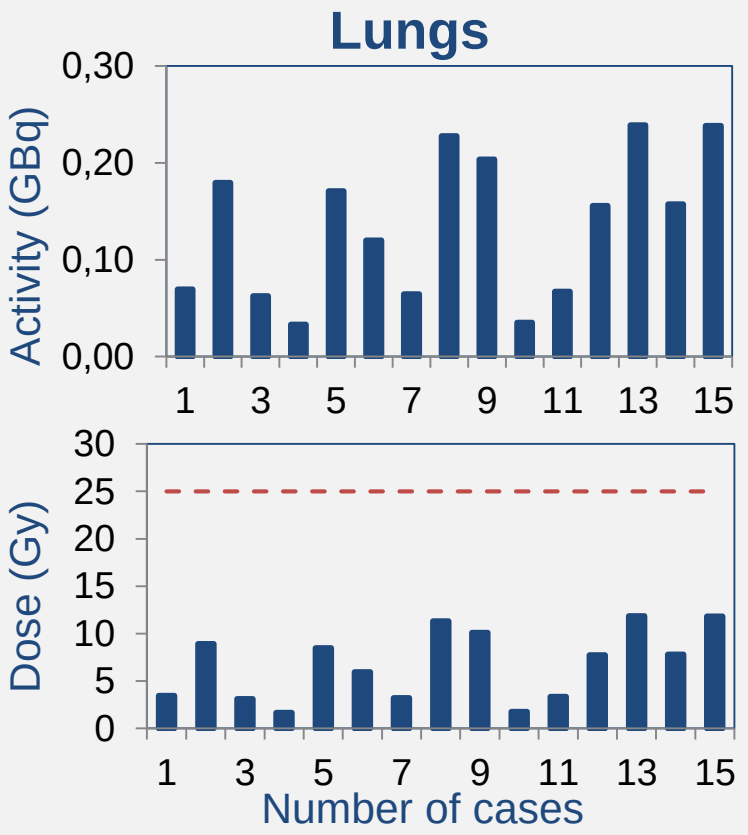

Fig. 8: The activity (0.13± 0.07 GBq) and dose (6.70 ± 3.72 Gy) in the lungs liver determined from ^{90}*Y-Microsphere* therapy.

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CONCLUSIONS

Difference between ^{99m}Tc-MAA and ^{90}Y-Microspheres dose calculation

TOTAL LIVER	Activity	45.29 %
	Dose	47.66 %
NORMAL LIVER	Activity	36.10 %
	Dose	39.82 %
TUMOUR	Activity	52.79 %
	Dose	46.94 %
LUNGS	Activity	46.94 %
	Dose	46.94 %

The ^{99m}Tc-MAA is the pretreatement simulation for assessment of extra-hepatic depositions and lung shunting. The different physical properties, surgical procedures and timing between catheterizations results in MAA cause a discordance with microsphere distribution. The correlation between MAA and microsphere therapy dose calculation was performed for 15 patients.

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