Metastasi scheletriche

Fattibilità e ruolo dello studio dosimetrico nei trattamenti con 223Ra-chloride

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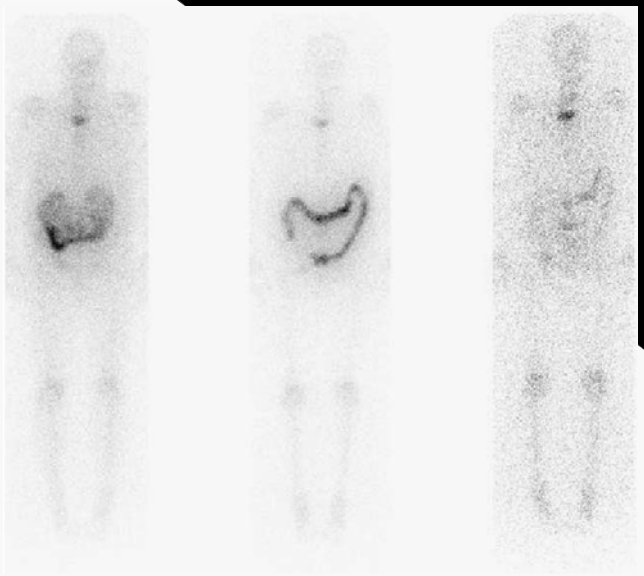
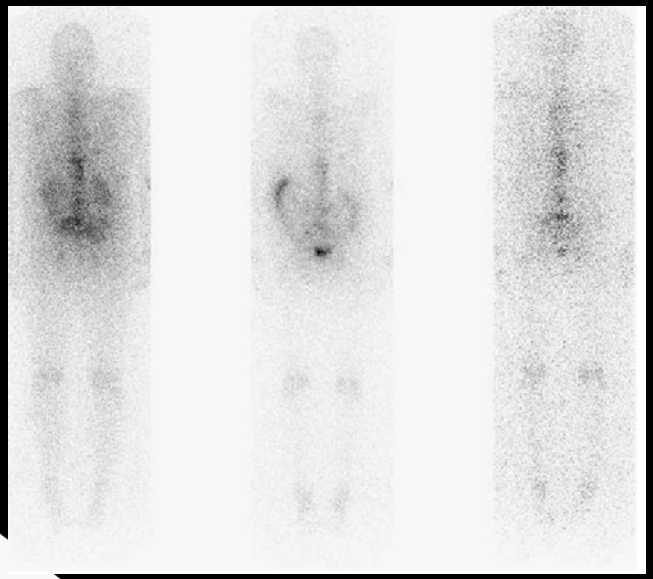
Imaging of 223Ra-Chloride



Anterior view



Posterior view

Images acquired at 4, 48 and 144 h post injection of 10,01MBq

Imaging and image-based planar dosimetry are feasible

Hindorf et al. Nucl Med Comm 2012; 33:726-732

Characteristics of 223Ra

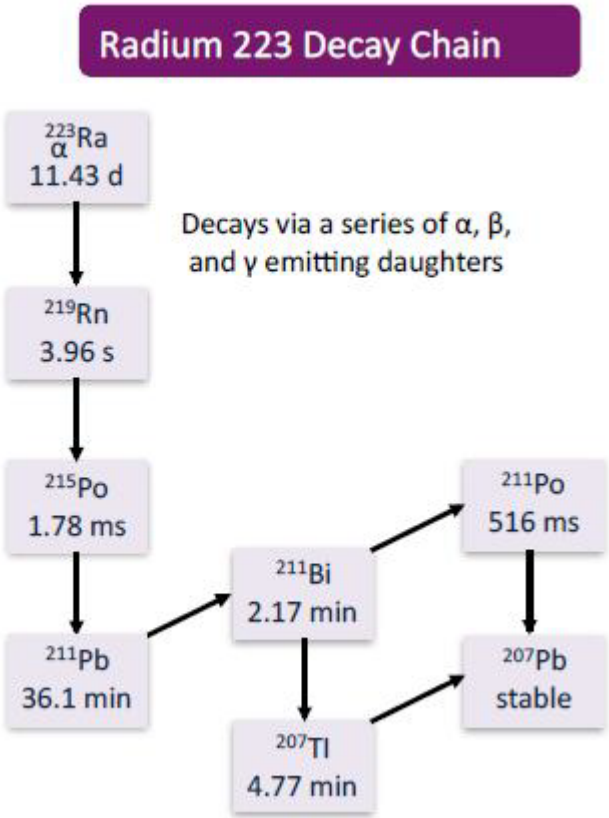
Radium 223 is primarily an α-emitter

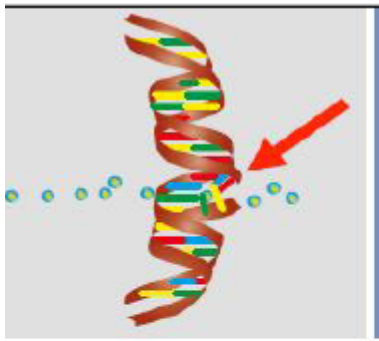
t½ = 11.43 days

Of the total decay energy

- 95.3% emitted as α particles
- 3.6% emitted as β particles
- 1.1% emitted as γ or X-rays

Easily measured on standard dose





β-emitters

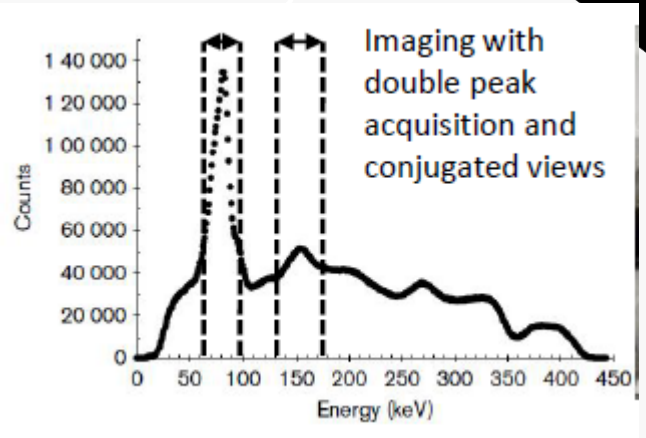
- Low-LET b-radiation → single-strand DNA breaks
- Single-strand breaks: easily repaired using the opposite strand as a template
- Single-strand breaks → less likely to induce cell death

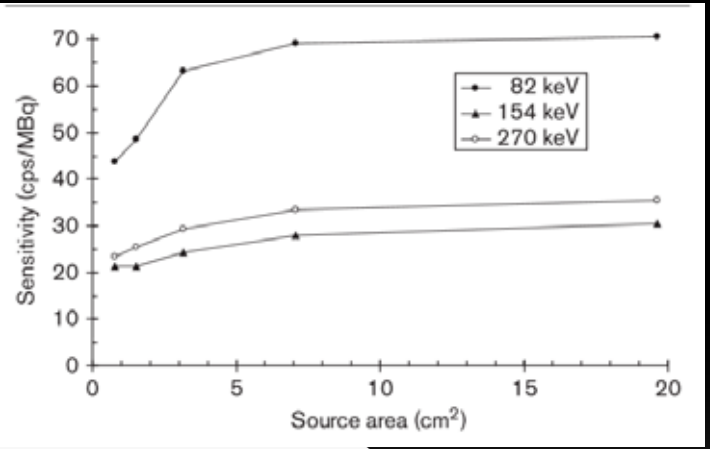
α-emitters

- High-LET α-particles → double-strand DNA breaks
- Double-strand breaks: difficult to repair
- Failure to repair → to apoptosis
- Misrepaired double-strand breaks → chromosomal aberrations → mitotic cell death

How is dosimetry of ^{223}Ra possible?

- Energy windows set at: 82keV (20%), 154keV(15%), 270keV (10%)
- Medium-energy collimators
- Accurate scanner calibration
- PVE analysis

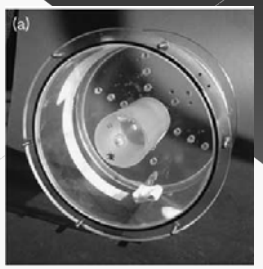




- Attenuation correction

Energy window (centre, width)	Sensitivity (cps/MBq)	FWHM (cm)	μ_{eff}/ϕ (Perspex) (cm^2/g)
82 keV, 20%	69	1.07	0.071
154 keV, 20%	31	1.13	0.048
270 keV, 20%	34	1.12	0.046

- Quantification test with phantoms



Data from: Hindorf et al. Nucl Med Comm 2012; 33:726-732

How is predictive dosimetry possible for ^{223}Ra?

Skeletal scintigraphy (and/or SPECT-CT) images before therapy are usually performed.

- ^{99m}Tc-MDP whole body scan (740MBq)
- Energy window at 140keV (20%)
- LEHR collimators

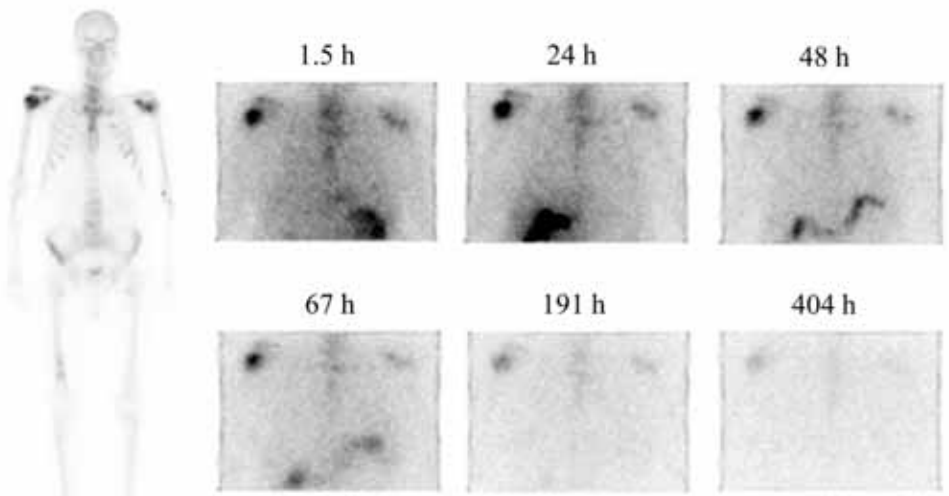


Fig. 2 ^{99m}Tc-MDP WB image and the series of anterior static images obtained at different times after administration of ^{223}Ra-dichloride in patient 1. The static images were acquired at 1.5, 24, 48, 67, 191 and 404 h

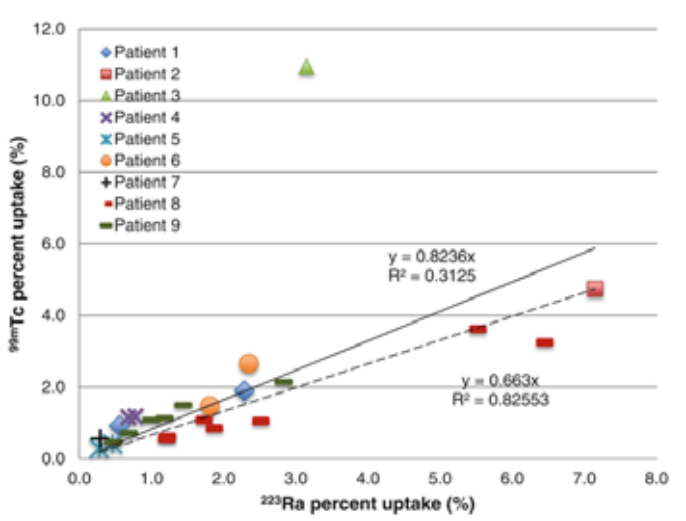
^{99m}Tc-MDP WB

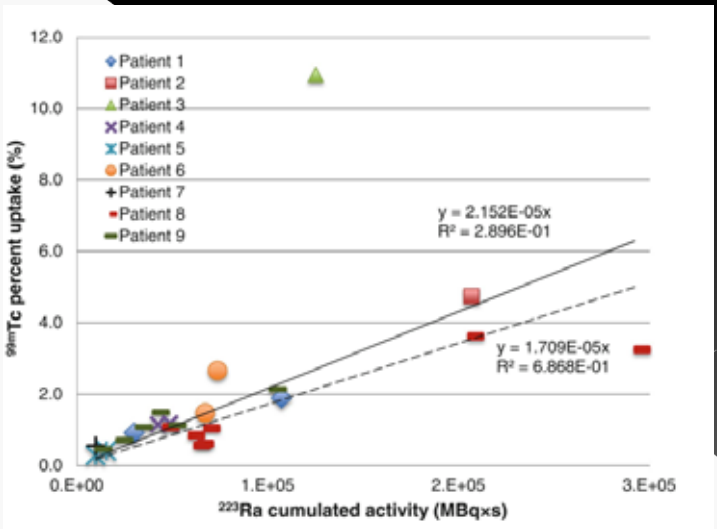
30min static images

Data from: Pacilio M et al Eur J Nucl Med Mol Imaging (2016) 43: 21-33

How is predictive dosimetry possible for ^{223}Ra?

- Good correlation between ^{99m}Tc and ^{223}Ra uptake:
  - Lesion delineation on MDP WB images, unlikely impossible on ^{223}Ra images.
  - %uptake of ^{223}Ra is slightly higher that that of ^{99m}Tc probabily because of differences in biodistribution

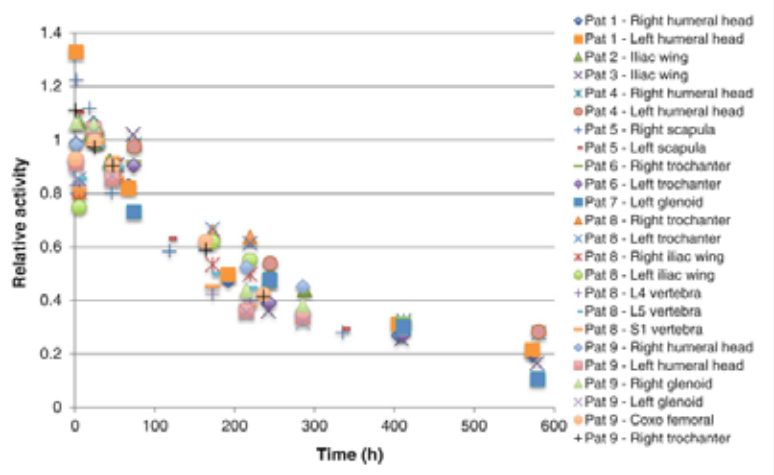


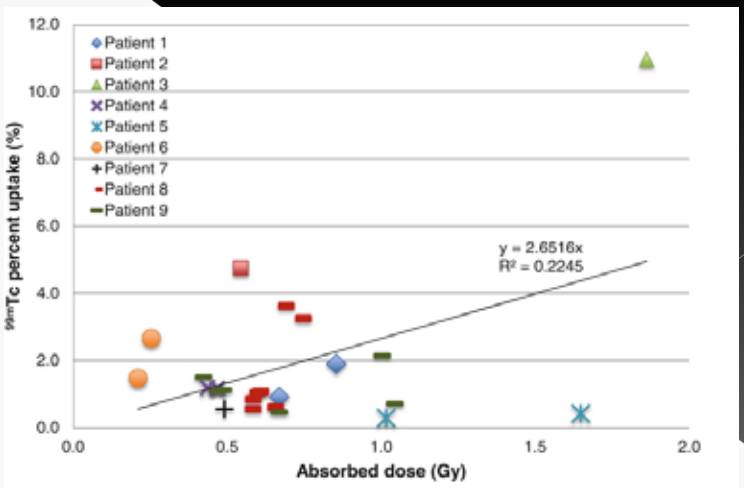


Data from: Pacilio M et al Eur J Nucl Med Mol Imaging (2016) 43: 21-33

How is predictive dosimetry possible for ^{223}Ra?

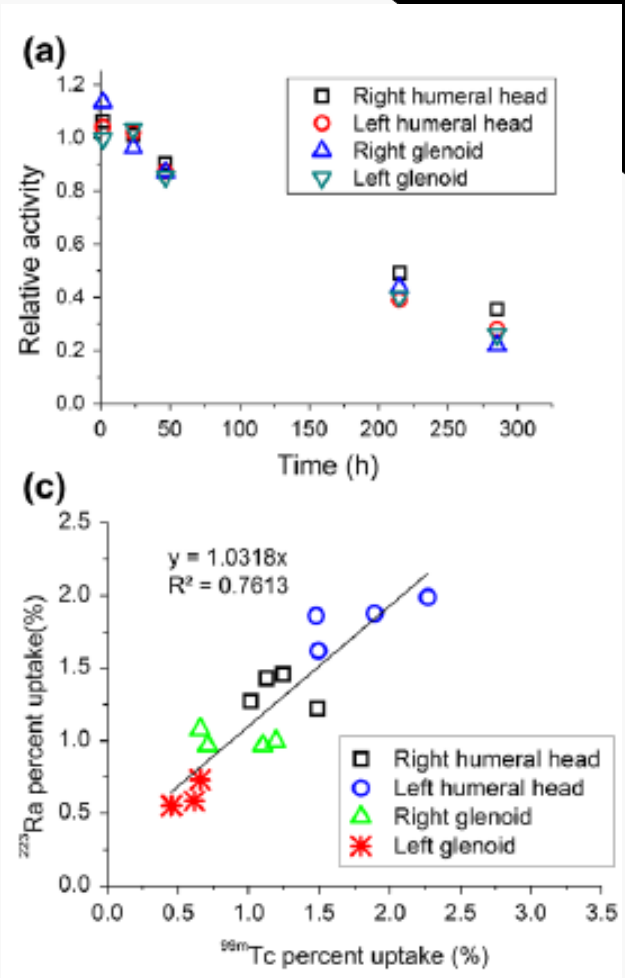
- Poor correlation between ^{99m}Tc uptake and absorbed dose from ^{223}Ra:
  - Absorbed dose depends on uptake, biokinetics, lesion mass
  - Biokinetics and lesion mass vary independently from uptake.



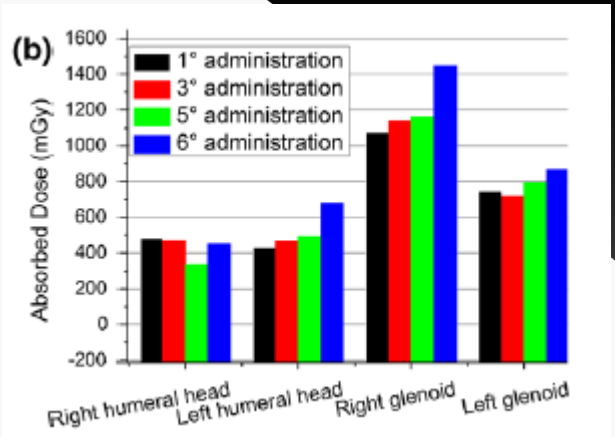


Data from: Pacilio M et al Eur J Nucl Med Mol Imaging (2016) 43: 21-33

An italian case report of image-based dosimetry



- Very good correlation of ^{99m}Tc-MDP and ^{223}Ra uptake in a single case study
- Similar kinetics of lesions
- Dose assessments in serial administrations



Data from: Pacilio M et al Ann Nucl Med (2016) 30:163-168

Conclusions

- Data confirm the feasibility of quantiative ^{223}Ra imaging with the aim to assess the absorbed dose to bone lesions.
- Optimal timing for ^{223}Ra imaging is: 1-5h, 18-24h, 48-60h 7-15 d.
- The uptake of ^{99m}Tc-MDP correlates significantly with ^{223}Ra uptake
- The follow-up of the uptake level of ^{223}Ra can be efficiently quantitatively performed by ^{99m}Tc-MDP (to check for symptomatic skeletal event-free survival or overall survival)
- The macrodosimetry of bone metastasis is feasible, but its predictive value in clinical outcomes must be still demonstrated.
- At present the possibility that a microdosimetric approach is needed to understand and predict the clinical response of bone metastasis cannot be excluded.