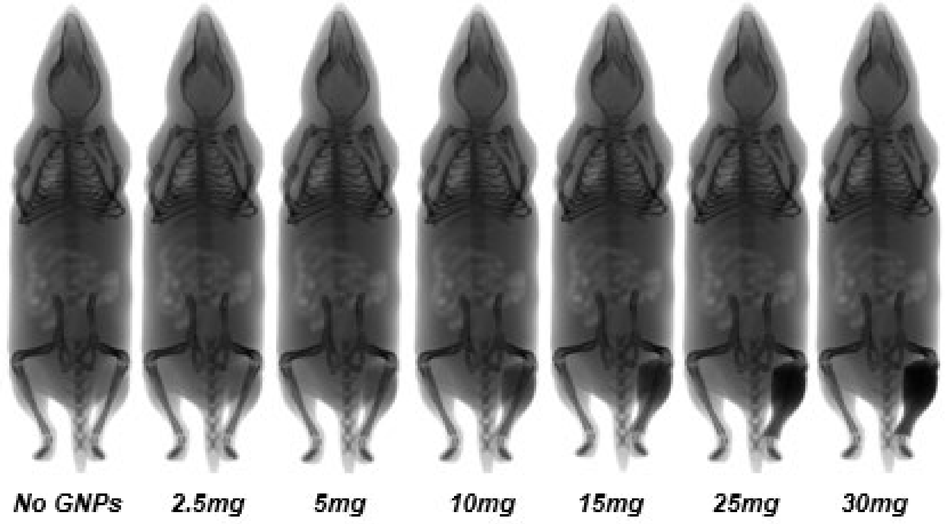
AN IN-SILICON STUDY, BASED ON PRECLINICAL DATA, FOR IMAGING AND DOSIMETRY ASSESSMENT OF GNPs IN RODENTS' LEG MUSCLE.

K. Chatzipapas[1], S. Sarpaki[1], I. Pilatis[1], M. Rouchota[1], G. Loudos[1], P. Papadimitroulas[1]

[1]*Bioemission Technology Solutions, Research & Development, Athens, Greece*

Introduction

Cell therapy offers promising opportunities to cure several diseases that currently do not have effective therapy. The incorporation of gold nanoparticles (GNPs) in cell therapy offers the advantage of evaluating the treatment evolution. Monte Carlo (MC) techniques play a crucial role in the investigation of imaging and dosimetry assessment allowing the standardization of the muscle injury treatment protocols. The goal is to in-silico investigate different concentrations of GNPs in rodents' leg muscles, to assess the dosimetry and to quantify the stem-cells based on the Au concentration.



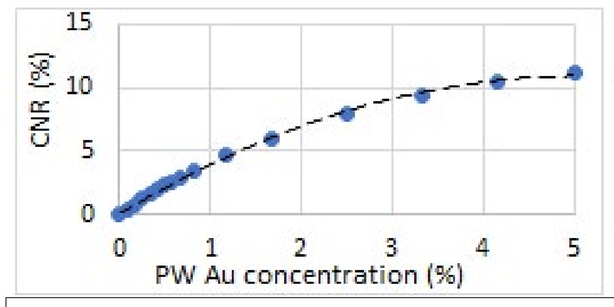
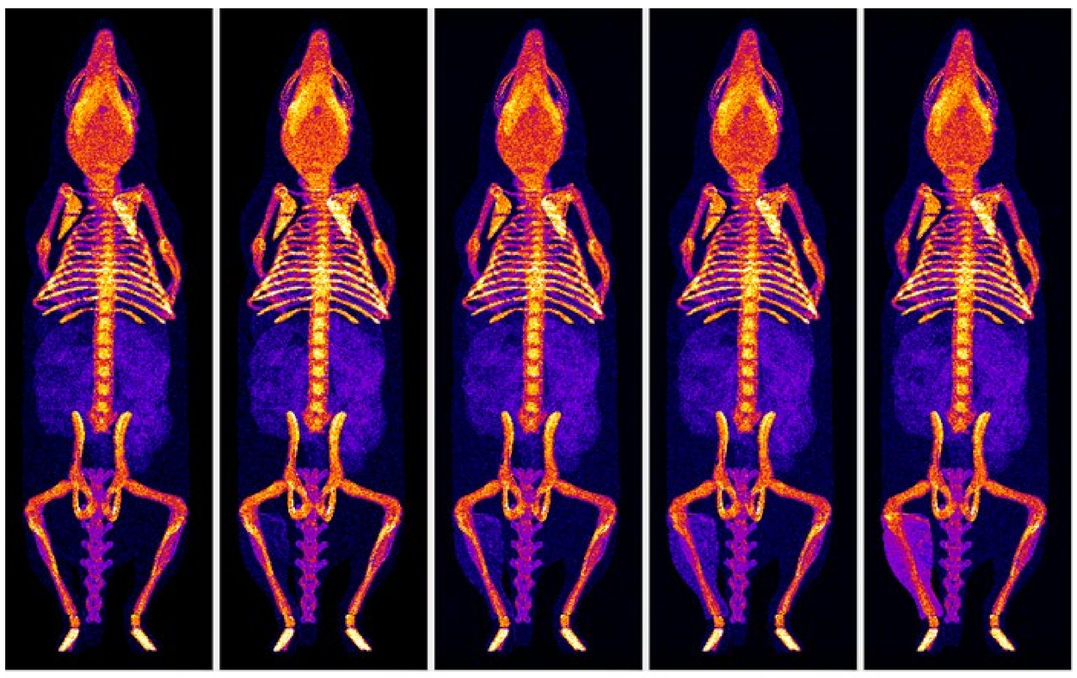


Figure 2: The correlation between CNR and PW of GNPs concentration.



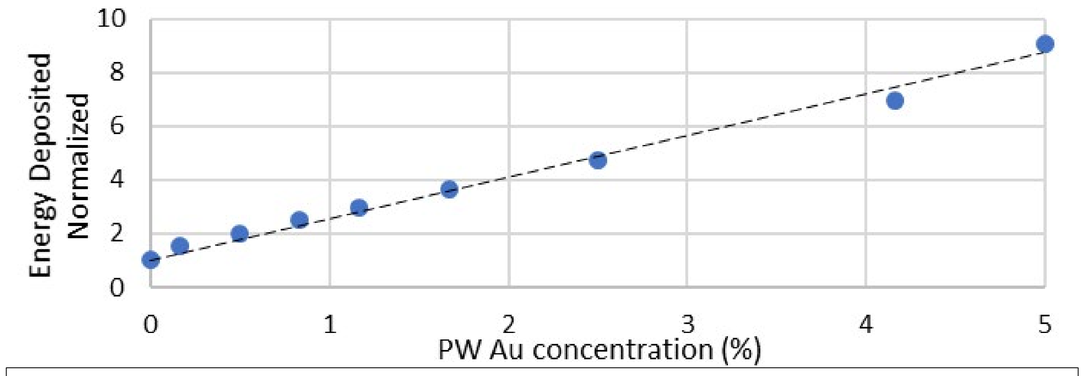


Figure 3: The correlation of the Energy Deposition and the Au concentration per weight of muscle.

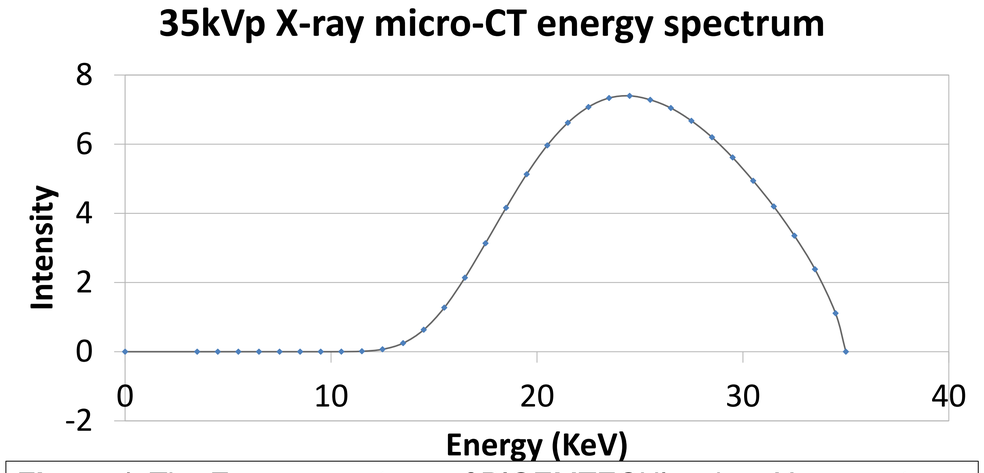


Figure 1: The Energy spectrum of BIOEMTECH's micro-X-ray system.

Methods

- ✓ This study exploited:
  - GATE[1] MC Simulations toolkit
  - MOBY[2] computational rodent phantom
- ✓ Modelling and simulation of X-ray imaging of a whole rodent using 16 different levels of Au concentrations in leg muscle (0-5%).
- ✓ A 35kVp X-ray source was modelled (***fig.1***), to simulate the preclinical X-ray system of our lab.
- ✓ The segmentation of the muscle was executed in VivoQuant 4.0 to accurately imitate in-vivo data that were existed in our lab.

Results

- ✓ This study standardized a methodology for the assessment of GNPs as contrast agents.
- ✓ Even at low Au concentrations, the Contrast-to-Noise-Ratio (CNR) rises, ranging from 0 up to 11 %, as depicted in ***fig.2***.
- ✓ 3D-dose-maps were exploited, while in-house algorithms were developed, to measure the deposited energy.
- ✓ Linear correlation between the dose enhancement and the concentration percentage of Au was measured. The dose enhancement ranges from 1 up to 9 times, as shown in ***fig.3***.

Conclusion/ Discussion

- ✓ The use of low energy spectrum can explain this study's results, because of its big cross section, when interacting with materials of high atomic number, like the Au.
- ✓ The uptake ratio of gold nano in the leg muscle of rodents can be measured using low energy X-ray imaging systems.
- ✓ A mathematical estimation of energy deposition in function with Au concentration has been developed.

Future steps:

- ❖ Standardization of the procedure incorporating additional in-vivo experiments.
- ❖ Simulation of micro-CT system.
- ❖ Investigation of a rat mathematical phantom.
- ❖ Investigation into the incorporation of spherical nanoparticles in the simulation instead of inserting homogeneous gold concentration in the tissue.

References

1. S. Jan, et al. "GATE: a simulation toolkit for PET and SPECT," Phys Med Biol 49, 18 (2004).
2. W. Segars, B. Tsui. "4D MOBY and NCAT phantoms for medical imaging simulation of mice and men," Journal of Nuclear Medicine 48, 203P (2007).

Aknowledgements

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