DNA-gated material as simultaneous drug delivery and radioimaging tool

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Abstract

Development of nanobiomaterials for medical and biomedical applications has been increased day by day during the last decades. Most of the nanobiomaterials prepared used mesoporous silica nanoparticles (MSN) as inorganic scaffolds in which certain species could be entrapped in the inner of the pores and certain biomolecules (molecular gates) could be grafted into the external surface in order trigger cargo release. Particularly molecular gate-like systems have excelled due to its capacity to prevent uncontrolled leakage of drugs before the application of the required stimulus for its action.[1] Commonly these MSNs equipped with molecular gates were applied as drug delivery[2] and diagnostic systems.[3] Irruption of DNA nanotechnology in development of these materials promises a huge range of new possible applications.[4] At this respect, the use of aptamers[5] highlighted because of its unique benefits as other targeting agents making them solid alternatives to antibodies and peptides in diagnostic assays. Combination of MSNs and aptamers have been successful for developing several recognition systems[6] and even they were applied for resonance imaging.[7] But, as far we known, the application of these systems for radioimaging diagnostic have not been explored. Combination of drug delivery systems with radiolabeling emerged as a powerful tool to develop nano-radiopharmaceuticals for theranostic (therapy + diagnostic) systems.

In this preliminary study we explored the application of MSNs functionalized an antiMUC1 aptamer (responsive to the tumor marker mucine 1 glycoprotein)[8] as a nano-radiopharmaceutical for breast cancer imaging. MSNs were first loaded with safranin O (a fluorogenic dye employed as model drug) and functionalized onto the external surface with (3-aminopropyl)triethoxysilane. Finally antiMUC1 aptamer was immobilized electrostatically over the surface blocking the dye leakage from the pores. Characterization of the nanobiomaterial successfully confirmed the typical structural properties preserving its *on-command* drug delivery capability. For explore the nano-radiopharmeceutical applications nanobiomaterial was successfully labelled with 99mTc (over 98% of labelling). The behavior of the mesoporous silica self-decorated with antiMUC1 aptamer in induced mice with breast cancer showed excellent results (high migration to tumor) as can be seen from planar imaging results (see **Fig.1**). Moreover biodistribution studies clearly confirmed also this uptake as can be seen on **Fig.2**.

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Figures

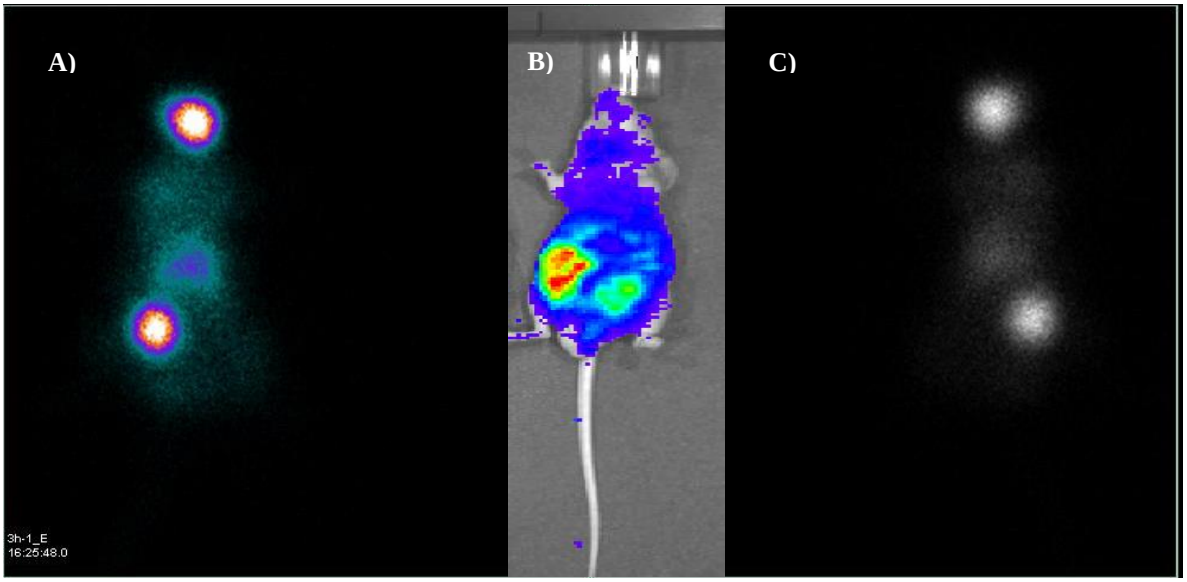

Figure 01. a) Planar imaging of inducted mouse with breast cancer after injection of loaded mesoporous silica capped with aptamer anti-MUC1. b) Bioluminescence images from nude mice on day 21 after intra-ventricular injection with 2x106 Breast Cancer cells revealing tumoral lesions. c) Inverse Planar imaging of inducted mouse with breast cancer after injection of loaded mesoporous silica capped with aptamer anti-MUC1.

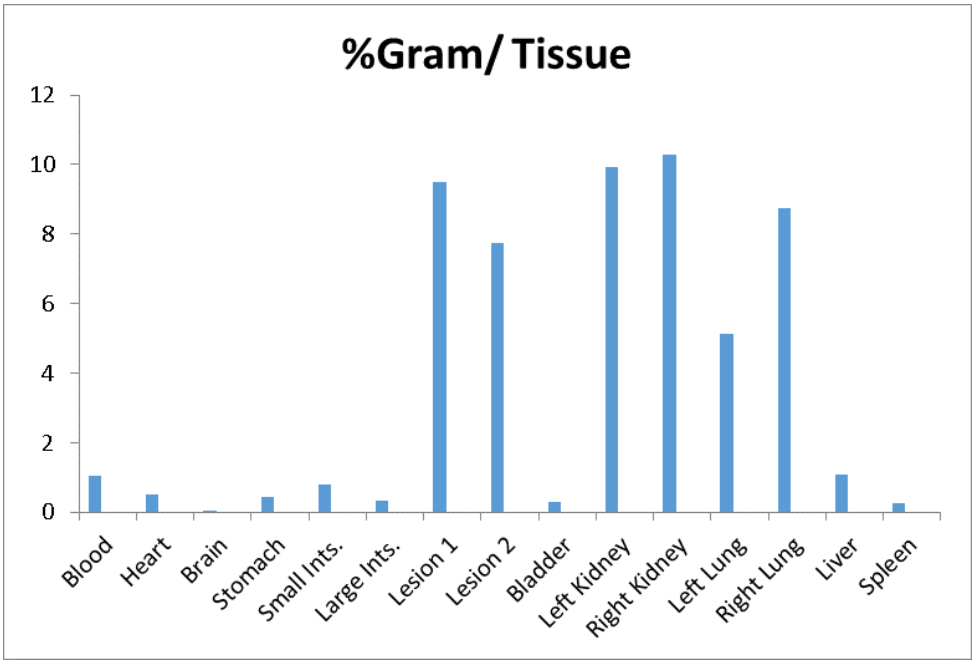

Figure 02. Biodistribution profile of S1-MUC1 in breast tumor inducted mouse expressed as percentage of radiation per gram of tissue