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Perspective

THE ROLE OF SMALL ANIMAL OPTICAL IMAGING IN DRUG DISCOVERY

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INTRODUCTION

For the purpose of developing novel treatments for cancer, molecular imaging of tumors in preclinical models is of the utmost importance. With recent advancements in optical imaging technologies and sophisticated molecular probes for in vivo imaging, this field is developing at a breakneck pace. The purpose of this review is to describe optical probes for cancer imaging and to provide a brief overview of the rodent imaging options. Evaluation of pathophysiological processes in rodents, such as cancer, can be carried out using molecular imaging in a manner that is not invasive. In point of fact, these methods facilitate studies of the therapeutic activity and antitumor efficacy of new anticancer drugs, enable longitudinal follow-up of tumor development, and enable real-time information for early diagnosis. Molecular imaging can play an important role in drug discovery in the laboratory, during the translation phase from in vitro assays to preclinical systems, and ultimately in evaluating the biodistribution, pharmacokinetics, and biological activity of potentially therapeutic molecules. Drug development is a costly, complicated process with a very small chance of success for any given molecule. Another common method of clinical imaging, MRI is now being used in specialized animal facilities thanks to recent advancements and adaptations. The idea behind 1H-MRI is that when a sample in a magnetic field is subjected to a radiofrequency pulse, its protons absorb energy and produce a signal that can be detected during the relaxation phase. The number of protons determines how strong the signal [1,2].

DISCUSSION

Two fundamental rate constants can be used to describe the relaxation process. This method has a low sensitivity (mM concentrations), but it has excellent spatial resolution. For detecting tumors and measuring morphologic parameters, MRI is very helpful. Multiple safe imaging sessions are possible, allowing longitudinal follow-up of tumor growth because there is no harmful radiation. Finally, in order to enable functional imaging, contrast agents that have an effect on either the T1 or T2 relaxation time constants are being developed. Another common method of clinical imaging, MRI is now being used in specialized animal facilities thanks to recent advancements and adaptations. The idea behind 1H-MRI is that when a sample in a magnetic field is subjected to a radiofrequency pulse, its protons absorb energy and produce a signal that can be detected during the relaxation phase. The number of protons determines how strong the signal is. Two fundamental rate

constants—longitudinal relaxation and transverse relaxation—can be used to describe the relaxation process. This method has a low sensitivity (mM concentrations), but it has a high spatial resolution (m). For detecting tumors and measuring morphologic parameters, MRI is very helpful. Multiple safe imaging sessions are possible, allowing longitudinal follow-up of tumor growth because there is no harmful radiation. Finally, in order to enable functional imaging, contrast agents that have an effect on either the T1 or T2 relaxation time constants are being developed. A wide range of nanoparticles have been developed as contrast agents for use in in vivo fluorescence imaging over the past few years. These particles offer novel optical and structural properties due to their size. They are able to detect targeted biomarkers with low expression because they have a higher signal intensity than organic fluorophores. Moreover, as a result of their generally enormous surface region, nanoparticles can oblige numerous tests, empowering multivalent focusing of a few biomarkers and hence expanding the proclivity of every individual test. Nanoparticles possess all of these properties, making them excellent candidates for therapeutic, biomedical imaging, or a combination of the two (theranostics). The tumor-specific contrast agent underglycolated mucin 1 (uMUC-1), a tumor antigen that is present on more than 90% of breast cancers and is predictive of chemotherapeutic response, was described as a tumor-specific contrast agent made up of iron oxide nanoparticles labeled with Cy5.5 dye. Nanoparticle probes were less abundant in treated tumors than in untreated tumors following doxorubicin treatment, indicating that uMUC-1 expression had decreased. Similar outcomes were obtained with MRI and in vivo fluorescence imaging to support these findings. Non-invasive imaging was also used to monitor the successful delivery of small interfering RNA using the same kind of nanoparticle [3].

All in all, nano-sized contrast specialists offer a few benefits over regular specialists since they can be latently focused on to the growths through the EPR impact or effectively designated by unambiguous ligands. Most importantly, nanoparticles can combine imaging with drug (or siRNA) delivery or provide dual-modality imaging that combines NIR with either MRI or PET. As a result, these nanoparticles hold great promise for disease detection and treatment. From the cellular to several centimeter scale, optical imaging is a cost-effective, user-friendly, and non-radiative tool that can quickly provide semi-qualitative (2D), quantitative (3D), and functional information. Quantifying enzymatic activities and protein levels is best done using fluorescence molecular tomography. 2D-fluorescent reflectance optical imaging is poised to become the most popular method for molecular imaging, particularly for researchers who do not have a background in medical imaging or who do not have access to a facility for nuclear medicine or extremely expensive magnets. However, the creation of a large number of highly specific tracers or smart contrasting agents will be essential for cancer imaging in mice in the future [4-6].

CONCLUSION

The study of cancer in small animals will soon reach new heights thanks to the combination of high-resolution techniques like micro-CT or MRI with highly sensitive functional imaging techniques like PET, SPECT, or optical imaging, which will provide effective tools for evaluating new treatments. Importantly, legal agencies' use of NIR fluorophores in human clinical trials is a major roadblock to the widespread application and production of these probes. The FDA recently established the Process Analytical Technologies initiative as a response to this problem, which will undoubtedly make it easier to produce and use NIR probes. The surface of nanoparticles can be

grafted with specific ligands to increase the tumor targeting selectivity. Again, the RGD peptide is one of the most frequently described ligands for targeting tumors; however, several other specific tumor ligands have also been investigated. Using a copolymer-functionalized QD conjugated to an antibody that targets a prostate-specific membrane antigen, targeted imaging in vivo was demonstrated in a mouse model. From the cellular to the animal level, gold nanoparticles with anti-EGFR monoclonal antibodies have numerous potential applications.

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