Imaging Recommendations for Molecular Imaging

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Ind J Med Paediatr Oncol 2023;44:343–344.

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Abstract

In vivo molecular imaging is having a great potential that will have an impact on the medicine by detecting diseases in early stages like screening, identifying extent of disease, selecting disease- and patient-specific therapeutic treatment which will be the hallmark of the personalized medicine, for directed targeted therapy, and also for measuring molecular-specific effects of treatment. Currently, most commonly used molecular modalities are positron emission tomography- or single-photon emission computed tomography-based techniques.

Keywords

- molecular imaging

With the many ongoing preclinical research related to the novel molecular targets of different diseases which can be identified by using the more advanced and multifunctional contrast agents will be useful for the molecular targets that are developed along with new technologies and instrumentation for multimodality molecular imaging. Contrast-enhanced molecular ultrasound with molecularly-targeted contrast microbubbles is explored as a clinically translatable molecular imaging strategy for screening, diagnosing, and monitoring diseases at the molecular level. Optical imaging with fluorescent molecular probes and ultrasound imaging with molecularly-targeted microbubbles are attractive strategies since they provide real-time imaging, are relatively inexpensive, produce images with high spatial resolution, and do not involve exposure to ionizing similarly along the irradiation. Raman spectroscopy/microscopy has also emerged as the most potential molecular optical imaging strategy for ultrasensitive detection of multiple biomolecules/biochemicals in both in vivo and ex vivo versatility. Photoacoustic imaging is a hybrid of optical and ultrasound modalities involving optically excitable molecularly-targeted contrast agents and quantitative detection of resulting oscillatory contrast agent movement with ultrasound. Current preclinical findings and advances in instrumentation such as endoscopes and microcatheters suggest that these molecular imaging modalities have numerous clinical applications and will be translated into clinical use in the near future.

Molecular imaging is defined as the ability to visualize and quantitatively measure the function of biological and cellular processes in vivo.[1,2] As the anatomical imaging is well established imaging modality and plays a major role in medical imaging for the diagnosis, surgical guidance/follow-up, and monitoring response to the treatment, the field of molecular imaging is evolving and promises the significant improvement in the specificity, sensitivity, and quantitation not only for the screening and the early diagnosis, which is focused and having the personalized management and therapy, but also for the earlier treatment follow-up. The biggest advantage of in vivo molecular imaging is its ability to evaluate and characterize the pathologies of various diseases at the tissue level without any invasive techniques like biopsies or surgical procedures. This information will be able to help in the concept of the personalized treatment and planning. The one of the classical recent advances is the treatment of breast cancer by the combinations of various chemotherapeutic drugs that will be targeting the epidermal growth factor receptor types I and 2 (EGFR and HER2/neu), mammalian target of rapamycin, estrogen receptor, and/or histone deacetylase, and here the best strategy is dependent on the molecular profile of the tumor (e.g., HER2/neu-targeted therapy is only effective in HER2-positive breast cancers).[3] Thus, the in vivo molecular imaging is being used for the identification and quantification of the various molecular markers profile (e.g., EGFR, HER2) of the tumor. This is possible by noninvasive techniques where the need of the

DOI https://doi.org/10.1055/s-0043-1761166.
ISSN 0971-5851.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

biopsy and time associated with pathological characterization are different. This concept of the personalized medicine will be used for the best care for patients having the advanced stage of the cancers and with poor prognosis. The risk of exposure to various side effects of therapy will be impacting the quality of the life.

The various preclinical applications in the advances in molecular imaging contrast agents will have the capability for the different multiplex nano- and/or microparticles with several entities: (1) Here, the use of the molecule for the different targeting to the specific tissues/the different disease marker like the binding ligands; (2) the different molecules will be used for the detection of the agent having the different imaging modalities; and, (3) the direct attachment of the various systems like the Doxel, is the liposome encapsulation of doxorubicin, which is the cytotoxic drug used for the inhibition of the DNA replication and for the targeted delivery of a therapeutic drug in the region of the interest. For example, Blanco et al[4] showed the direct attachment of the chemotherapy drug, Doxorubicin, to a superparamagnetic iron oxide nanoparticle, which is then encapsulated in liposomes coated with RGD peptides; and these particles have the property to attach to the tumor angiogenic vessels which have the high levels of $\alpha_V\beta_3$-integrins like the protein receptors that help in binding the different RGD peptides. These will be of help for the better localization of these magnetic particles by using magnetic resonance imaging (MRI).

In addition, the molecular imaging can measure the response to therapy more precisely and early. The tumor response to chemotherapy is being done by response evaluation criteria in solid tumors criteria, where the different anatomical imaging methods like computed tomography or MRI by using the tumor size, tumor volume in post-therapy settings, and time lapse after the management reflect the total tumor volumetric changes for the accurate reflection of therapeutic efficacy for various treatment options.[5] Thus, the molecular imaging can improve the therapeutic monitoring by direct effect of a drug at an earlier time point before the various morphological–anatomical changes that can become visible on imaging. The different modalities of the molecular imaging are having different protocols based on the systems, techniques, and the combined modalities.

Molecular Imaging has revolutionized the imaging concepts at the molecular level with better, faster, and more precise evaluation in the concept of the precision medicine.

Conflict of Interest
None declared.

References

1 Mankoff DA. A definition of molecular imaging. J Nucl Med 2007; 48(06):18N–21N [PubMed] [Google Scholar]
2 Peterson TE, Manning HC. Molecular imaging: 18F-FDG PET and a whole lot more. J Nucl Med Technol 2009;37(03):151–161 [PMC free article] [PubMed] [Google Scholar]
3 Wong ST. Emerging treatment combinations: integrating therapy into clinical practice. Am J Health Syst Pharm 2009;66(23, Suppl 6):S9–S14 [PubMe d] [Google Scholar]
4 Blanco E, Kessinger CW, Sumer BD, Gao J. Multifunctional micellar nanomedicine for cancer therapy. Exp Biol Med (Maywood) 2009; 234(02):123–131 [PMC free article] [PubMed] [Google Scholar]
5 Desar IM, van Herpen CM, van Laarhoven HW, Barentsz JO, Oyen WJ, van der Graaf WT. Beyond RECIST: molecular and functional imaging techniques for evaluation of response to targeted therapy. Cancer Treat Rev 2009;35(04):309–321 [PubMed] [Google Scholar]