CODEN [USA]: IAJPBB ISSN: 2349-7750

INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES

http://doi.org/10.5281/zenodo.1483455

Available online at: http://www.iajps.com *Review Article*

IMAGING IN CANCER

Ahmed Sulaiman Aljuhani[1], Zyad Mansour Mohammed Almutlaq[2], Aseel Abdu Aljahdali[1], Moayad Khalid Almaimani[1], Maha Hamed Rabea Altowairqi[3], Adhwaa Saud Damith Alruwaili[4], Tasleem Khoudier Alabdullatif[4]

[1] King Abdulaziz University
[2] King Saud Bin Abdulaziz University For Health Sciences
[3] Ohud Hospital
[4] Northern Border University

Abstract:

Introduction: *Imaging modalities are mainly used to achieve the goals screening for tumor existence, detection of all tumor cells in the body and metastasis, and monitoring response of a treatment. Recently the use of angiogenic modalities has also played a significant role. , there are six imaging modalities that physicians usually use. These six modalities are: ultrasound, x-ray (plain film and computed tomography), magnetic resonance imaging, positron emission tomography, single-photon emission computed tomography, and optical imaging.*

Aim of the work: *In this study we aimed to understand the different types imaging modalities that are used in managing cancer.*

Methodology: *we conducted this review using a comprehensive search of MEDLINE, PubMed, and EMBASE from January 1987 to March 2017. The following search terms were used: cancer imaging, ultrasound, cancer screening, cancer diagnosis, PET scan, SPECT*

Conclusion: *Although new technologies have massively helped in cancer management, detection of small cancers in the body continues to be challenging. However, it is still essential to detect smaller and earlier malignancies as this is a main prognostic factor in determining the survival of patients. Newer imaging modalities like optic imaging are very likely to impact clinical practice.*

Keywords: *cancer imaging, ultrasound, cancer screening, cancer diagnosis, PET scan, SPECT*

Corresponding author:
Ahmed Sulaiman Aljuhani,
King Abdulaziz University

QR code

Please cite this article in press Ahmed Sulaiman Aljuhani et al., ***Imaging in Cancer.,*** *Indo Am. J. P. Sci, 2018; 05(11).*

INTRODUCTION:

When it comes to diagnosing, staging, and treating cancers, there are six imaging modalities that physicians usually use. These six modalities are: ultrasound, x-ray (plain film and computed tomography [CT]), magnetic resonance imaging (MRI), positron emission tomography (PET), single-photon emission computed tomography (SPECT), and optical imaging. Only four modalities of these are effective in detecting any cancer in the body in a three-dimensional method. These are: MRI, CT, PET, and SPECT **[1]**.

Imaging modalities are mainly used to achieve the following targets: screening for tumor existence, detection of all tumor cells in the body and metastasis, and monitoring response of a treatment. However, recently the use of angiogenic modalities has also played a significant role in this **[2]**. The terms 'detection' and 'imaging' are close and distinguishing one from the other may be difficult; it is mainly based on the volume element (i.e., voxel) size. For example, when dealing with a subvoxel aggregation of tumor cells, a proper 3D imaging may not be successful, but this aggregation can still be detected. Regardless of the terms used, it is essential to know the detection threshold. The current used threshold that is used for the detection of solid tumors is about 109 cells (1 g = 1 cm3). This, on the other hand, can mean the when we say 'remission', we are saying that there may be anywhere in the body, malignant cell that are between 0 and 109. However, this level is considered to be accepted universally **[3]**.

METHODOLOGY:

- **Data Sources and search terms**

We conducted this review using a comprehensive search of MEDLINE, PubMed and EMBASE from January 1987 to March 2017. The following search items were used in the process: cancer imaging, ultrasound, cancer screening, cancer diagnosis, PET scan, SPECT

- **Data extraction**

Two reviewers have independently reviewed the studies, abstracted data and disagreements were resolved by consensus. Studies were evaluated for quality and a review protocol was followed throughout.

The study was done after the approval of ethical board of King Abdulaziz University.

DISCUSSION

Imaging Modalities

Each of the previously mentioned modalities has its limitations that is due to its physical and chemical characteristics. This will affect the sensitivity and resolution of the results.

US

Ultrasound techniques use 1 to 10 MHz waves in order to observe soft tissues. However, many body parts are not accessible with US, due to the high scattering of waves at bony and air surfaces. In general, the depth that can be effectively reached with ultrasound is about 10 cm in most body organs **[4]**.

X-Ray Imaging

CT scanning and plain X-ray films use a simple physics principle. This principle is simply, the measurement of attenuation through calculating the shinning of beam rays through the body. CT images are constructed in a 3D manner due to the rotation of the detector around the patient. X-ray imaging has a main limitation which is the contrast used which has to be in very high concentrations. On the other hand, the new targeted CT techniques in cancer is not well developed yet **[3]**.

MRI

MRI imaging modalities depends on measuring the Boltzmann distribution of spins over the field of imaging. For example, a proton with about 1.5 T will most likely represent millions of the overall number of already present hydrogen nuclei. In most tissues, the overall concentration of protons is about 80 M. when the strength of the field increases from 1.5 T and becomes 3 T, this will cause significant improvement of signal-to-noise ratio in imaging. When the strength is increased to 7 T, this will eventually result in about 4.7 fold improvement. However, this increase in strength on the other hand will lead to the development of other problems. These include high tissue heating **[5]**.

Gadolinium (Gd3+) contrast is injected intravenously, but it is not itself that is being imaged. Instead, it is its effect on the relaxation properties of magnetic resonance on the tissue being imaged, and its protons. This effect of relaxation can only be observed when the concentrations of gadolinium (Gd3+) is more than 50 umol/L **[6]**.

SPECT

SPECT is considered to be a powerful tool that quantifies radioactive compounds distribution in the human body. The mechanism of SPECT is the following: when an isotope is decayed, gamma rays

(like photons) are released randomly. Collimators are important to restrict the angle of photons, due to the inability of focusing photons with high energy. On the other hand, collimators use for SPECT cause to have a sensitivity that is about 0.02%, which is about only one of five thousands events that are measured. Moreover, photons energies are usually attenuated due to the efficacy of the human body tissues. In fact, when using 140 keV technetium 99m (99mTc) photons, only five percent remain after going about 25 cm in the body. It is important to balance between sensitivity and attenuation of tissues. SPECT is only able to detect one of 100,000 of photons from the cancer site. In this case, the resolution is about 12*12*12 mm **[7]**.

PET

Positrons are defined as an antimatters that are opposite in charge, but equal in mass to electrons. Positrons are generally emitted from a nucleus that is rich in protons. The average distance that a positron can travel before having an interaction with another electron depends mainly on its initial energy **[8]**.

Electrons density in tissues (which are not sometimes appreciated) can have significant impact of the distance. For example, a tissue with less density (like the lung) can have a relatively longer distance, which will subsequently result in a lower inherent resolution. When the electron (which represents the matter), interacts with a positron (which represent the antimatter), they will annihilate each other leading to the production of two 511-keV photons that are antiparallel. Subsequently, only these antiparallel 511-keV photons are detected by crystal rings **[9]**.

Clinical PET scanners have an overall sensitivity of about 0.5% with a maximal resolution of about 8*8*8 mm. Similar to isotopes in SPECT, the human tissues can attenuate 511-keV photons, and the result is that only ten percent of photons will remain after going through 25 of a tissue. In conclusion, and after taking attenuation and sensitivity in consideration, PET is generally able to detect about one of each two thousands photon which is generated at the site of cancer. The combination of all these effects of sensitivity and attenuation makes a normal PET scan able to detect solid masses that are larger than 109 cells **[8]**.

On the other hand, isotopes used in PET techniques are expensive, not readily available, difficult to synthesize, and have very short half-lives. This makes them not available on a routine basis. However, fluorine 18 (18F) is considered an exception for this, as it has a long half-life (up to 110 minutes), and is generally available in several chemical forms. In addition, 2-deoxy-2-[18F]fluoro-D-glucose (18FDG), is the most commonly used isotope in PET scans. The reason behind this is ability of being taken by cells that are metabolically active, and the ability of being trapped in the cells when it is phosphorylated by hexokinases. Moreover, it is not metabolized. Kellof et al, found that most (but not all) tumors are avid to 18FDG (13). However, it is still not considered to be the ideal isotope for PET scanning due to its characteristics that lead to a relatively high uptake in some normal tissues **[10]**.

Optical Imaging

The fate of light photons when they meet tissues, is either to scatter, or to be absorbed. Therefore, optical imaging has to main subtypes: scattering based optical imaging, and absorption-based optical imaging. Optical imaging modalities are usually dependent on simple instrumentation to image-reflected excitation light from surfaces **[11]**.

Limitations in Imaging

Although the previously described imaging modalities are characterized of high, and new technology, many cancers are still hard to detect with imaging. We will discuss these in the following section.

Ovarian Cancer

Ovarian cancer is defined as the proliferation of malignant flat-to-cuboidal cells from the ovarian surface epithelium. This makes early lesions as thin as 10 μm. Therefore, the detection of early ovarian cancer, and sometimes, early small metastases, is very difficult using ordinary imaging modalities **[12]**.

Acute Leukemia

Recently, there have been some evidence pointing to what is called ‘stem-cell niche’. This is present in the bone marrow, and it is thought to be essential to sustain acute leukemia. The fact that bone marrow tissue is well vascularized helps the contrast agents distribute well. However, malignant and normal cells that form the niche are of very small number, making signal amplification required **[13]**.

Pediatric Cancer

It is estimated that an overall twelve thousands cases of cancer are diagnosed each year in patients younger

than 18 years old in the United States. These cases are of several types and subtypes_diagnostic agents that are usually used in clinical practice are not always successful. The reason behind this may be the small market size and the ethical considerations when performing RCTs in this specific population **[14]**.

CONCLUSION:

Despite all the new technologies, detection of small cancers in the body continues to be challenging. However, it is still essential to detect smaller and earlier malignancies as this is a main prognostic factor in determining the survival of patients. Newer imaging modalities like optic imaging are very likely to impact clinical practice. However, clinical oncology field still needs more significant advances in order to be able to detect tumors better.

REFERENCES:

1. Fass L. Imaging and cancer: a review. Mol Oncol 2008; 2: 115-52.
2. Naumov G. N., Akslen L. A., Folkman J. Role of angiogenesis in human tumor dormancy: animal models of the angiogenic switch. Cell Cycle 2006; 5: 1779-87.
3. Frangioni J. V. New technologies for human cancer imaging. J Clin Oncol 2008; 26: 4012-21.
4. Kiessling F., Bzyl J., Fokong S., Siepmann M., Schmitz G., Palmowski M. Targeted ultrasound imaging of cancer: an emerging technology on its way to clinics. Curr Pharm Des 2012; 18: 2184-99.
5. Hoult D. I., Phil D. Sensitivity and power deposition in a high-field imaging experiment. J Magn Reson Imaging 2000; 12: 46-67.
6. Zhou Z., Lu Z. R. Gadolinium-based contrast agents for magnetic resonance cancer imaging. Wiley Interdiscip Rev Nanomed Nanobiotechnol 2013; 5: 1-18.
7. Khalil M. M., Tremoleda J. L., Bayomy T. B., Gsell W. Molecular SPECT Imaging: An Overview. Int J Mol Imaging 2011; 2011: 796025.
8. Berger A. How does it work? Positron emission tomography. BMJ 2003; 326: 1449.
9. Shukla A. K., Kumar U. Positron emission tomography: An overview. J Med Phys 2006; 31: 13-21.
10. Kumar R., Chauhan A., Zhuang H., Chandra P., Schnall M., Alavi A. Standardized uptake values of normal breast tissue with 2-deoxy-2-[F-18]fluoro-D: -glucose positron emission tomography: variations with age, breast density, and menopausal status. Mol Imaging Biol 2006; 8: 355-62.
11. Hadjipanayis C. G., Jiang H., Roberts D. W., Yang L. Current and future clinical applications for optical imaging of cancer: from intraoperative surgical guidance to cancer screening. Semin Oncol 2011; 38: 109-18.
12. Rauh-Hain J. A., Krivak T. C., Del Carmen M. G., Olawaiye A. B. Ovarian cancer screening and early detection in the general population. Rev Obstet Gynecol 2011; 4: 15-21.
13. Reddick W. E., Glass J. O., Helton K. J., Langston J. W., Li C. S., Pui C. H. A quantitative MR imaging assessment of leukoencephalopathy in children treated for acute lymphoblastic leukemia without irradiation. AJNR Am J Neuroradiol 2005; 26: 2371-7.
14. Pashankar F. D., O'Dorisio M. S., Menda Y. MIBG and somatostatin receptor analogs in children: current concepts on diagnostic and therapeutic use. J Nucl Med 2005; 46 Suppl 1: 55S-61S.