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Medical Image Modalities in Lung Cancer Detection

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ABSTRACT: Challenging disease in healthcare community is a cancer. Out of control growth of abnormal cells is a cancer. Among all the cancer, lung cancer mortality rate is very high all over the world both in men and women. Early detection of lung cancer saves the life of patients. Medical imaging modalities like Low Dose Computed Tomography, FluoroDeoxyGlucose Positron Emission Tomography and Diffusion Weight MRI a special type of MRI are effective technologies for detection of lung cancer at its early stage and TNM staging of detected tumors. Accurate T stage, N stage and M stage of detected lung tumors decides the efficient treatment plans and classification of tumors as benign or malignant.

KEYWORDS: Computed Tomography, Diffusion Weighted MRI, FluoroDeoxyGlucose, and Low Dose Computed Tomography.

I. INTRODUCTION

Cancer is not a single disease it is group of diseases. In human body as new cells generate by cell mutation, the old and DNA damaged cells are removed by process known as Apoptosis. In case of unhealthy condition Apoptosis fails to remove the damaged cells or abnormal cells. Deposited abnormal cells mutates further to form cancer tumors. Cancer is life threaten disease with high mortality rate. Among all type of cancer death rate due to lung cancer is very high. Lung cancer starts in one or both the lungs typically in the tissue cells that line the air passages. Smoking, family history, Age, toxins in environment such as radon, asbestos and others are major risk factors for development of lung cancer. About 85 to 90% lung cancer is of type Non Small Cell Lung Cancer (NSCLC) mainly due to smoking[1]. 15 to 20% lung cancer is of type Small Cell Lung Cancer (SCLC). Early detection of lung cancer prevents loss of life thus increases survival rate. Imaging modalities like X-ray, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Diffusion Weight MRI(DW-MRI), Fluorodeoxyglucose Positron Emission Tomography(FDG PET/CT) are valuable technologies for lung cancer detection and diagnosis. CT has been GOLD STANDARD for lung cancer detection [10][11][12]. The study by National Lung Screening Trail(NLST) showed that reduction of lung cancer mortality all over the world by Low Dose CT(LDCT) is very appreciable. Computer Aided Detection(CADe) and Computer Aided Diagnosis(CADx) system performs analysis of medical image using various image processing algorithms to detect lung cancer.

II. TNM STAGING

Cancer treatment selection and its planning depend on staging of cancer disease. Staging also determines prognosis of the disease. TNM staging (T-Tumor, N-Number of lymph nodes affected, M-Metastasis) is standard cancer staging tool developed by American Joint Committee on Cancer (AJCC) [1][2][3]. Like for other type of cancer TNM staging is recommended tool for lung cancer. TNM score of the lung tumors decides the possible stage (I-IV) of disease. Table I shows the TNM staging of lung cancer.

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Table I: Lung cancer TNM staging

TNM Staging	T-Staging	N-Staging	M-Staging
Stage-0	Tis-Carcinoma in site	N0-No metastases of cancer to regional lymph nodes.	M0-No metastases of cancer
	T1a: Tumor<=2mm	N0	M0
	T1b:3mm> Tumor>=2mm		
Stage-IB	T2a:5mm>Tumor>=3mm	N0	M0
	T2b:7mm>Tumor>=5mm	N0	
Stage-IIA	T1a	N1-Spread of cancer to ipsilateral peribronchial,ipsilateral hilar lymph node, intrapulmonary nodes.	M0
	T1b	N1	
	T2a	N1	
Stage-IIB	T2b	N1	
	T3:Tumor>7mm and invades to chest wall, diaphragm, mediastinal pleural etc	N0	M0
Stage IIIA	T1a	N2-Spread of cancer in ipsilateral mediastinal and subcarinal lymph nodes	M0
	T1b	N2	
	T2a	N1	
	T2b	N2	
	T3	N1	
	T3	N2	
	T4: Tumor of any size, invades to heart, mediastinum,trachea, carina etc	N0	
	T4	N1	
Stage	T1a, T1b, T2a, T2b and T3	N3	M0
	T4	N2	
	T4	N3	
Stage IV	Any T Any T	Any N Any N	M1a- Spread of cancer to contralateral lobes, tumor with pleural nodules M1b-Spread of cancer to extrathoracic organs

III. COMPUTED TOMOGRAPHY

Computed Tomography is diagnostic medical imaging modality uses special type of X-rays to generate multiple cross sectional images of part of body where abnormalities to be identified. Computer reconstructs these images into 3D images [9]. Study by National Lung Screening Trail (NLST) had proved that CT screening for lung cancer is effective modality to detect early stage lung cancer [10][13][14]. Standard CT screening of lung uses 7mSv radiation dose (radiation dose of absorption is measured in millisieverts). Newer type of CT known as Low Dose Spiral CT (LDCT) is advanced technology for lung cancer detection. LDCT uses less radiation dose (approximately 1.5mSv) and without use of contrast agent, it generates images with higher spatial resolution to detect very minute size lung abnormalities. National Comprehensive Cancer Networks (NCCN) prefers LDCT for lung cancer screening for patients with NSCLC.

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Small nodules with less changes of metastasis provide more treatment options for radiologist. The main advantages of LDCT are it is noninvasive, fast (scanning less than 15 seconds with single breath hold) and painless.

LDCT image quality impacts the radiologist performance. It generates higher level spatial resolution images. Using this modality radiologist strives to identify all the nodules that are possibly cause to lung cancer. According to recent guidelines for LDCT image acquirement with thick sections such as 1mm not greater than 2.5mm is capable to detect the nodules that are as small as 1mm in diameter. Current guidelines says that solid nodules<4mm in diameter and ground glass nodules greater the 20mm in diameter need to be for follow up procedure.

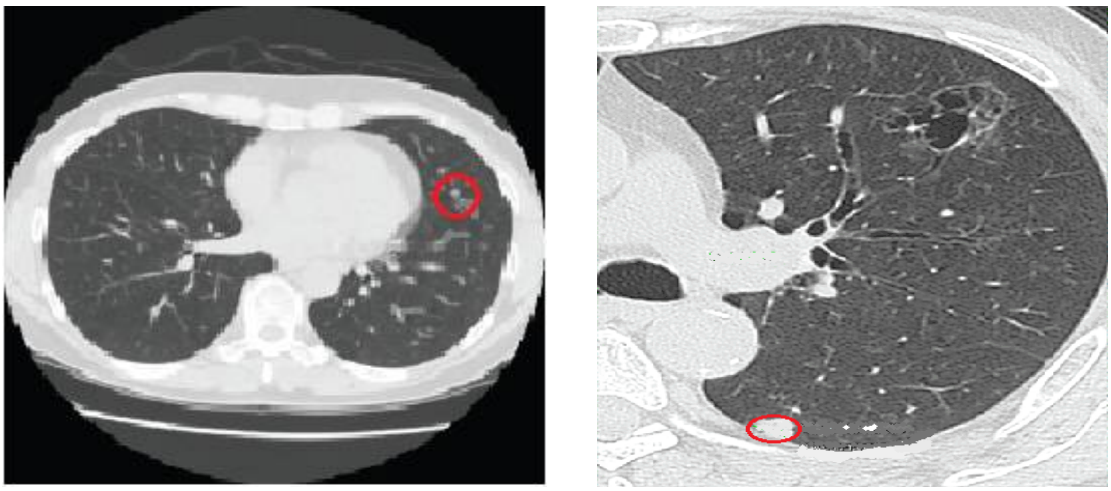

Fig.1 a. Low Dose CT scan showing 3mm nodule b. LDCT scan of 62 years old man showing 10mm nodule

Lung screening provides valuable growth information of tumors. A 3-D image allows the radiologist to make out changes in the volume of the lung tumor.

NCCN is multicenter study center sponsored by National Cancer Institute (NCI). This trail was conducted by American College of Radiology Imaging Network (ACRIN) and involved 53454 men and women former, current heavy smokers of age 55-54 with 30 pack years of history. Study proved that mortality rate due to lung cancer is reduced by usage of CT lung screening in lung cancer detection. The trail was mainly performed to compare LDCT and chest X-ray to find a possibility of presence of lung cancer in of age 55-74. It proved that LDCT is modality choice in lung cancer detection since it generates anatomical high special resolution images of lung and assist radiologist to perform accurate T staging of the identified cancer while treatment plan. The main limitation of LDCT is that it shows a limitation in soft tissue invasion.

IV. PET/CT IMAGING FOR LUNG CANCER

Lung cancer affecting rate both in men and women is almost same. Day by day it is becoming challenge for both healthcare communities and nation economy. 90% of lung cancer is NSCLC and its mortality is very high compared to SCLC. Using LDCT scan T staging of NSCLC can be effectively achieved. Successful treatment plan for NSCLC also needs its proper N staging and M staging[1][2].

Studies from various healthcare communities have proven that integrated FDG PET/CT is effective modality choice for detection of NSCLC [4][8]. This combined modality produces images that provide functional and anatomical information used for characterization of tumors, TNM staging (metastases stage), to find and stage metastasis tumors,

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follow up screening (NSCLC patients) after a treatment to determine changes in the nodule, guiding the biopsy and therapy. It is effective combined modality for a radiologist to study the lung cancer [4][5].

CT is choice of modality for T staging and N staging of NSCLC, but differentiation of benign and malignant tumors is challenging in CT. FDG PET/CT improves the T staging of cancer since PET uses radioactive agent FDG. For T staging of NSCLC, FDG PET/CT image provides information such chest invasion of cancer and for N staging it shows greater sensitivity.

Specification of FDG PET/CT while producing lung images to detect lung cancer are FDG quantity used is 0.15mCi/kg. Standard CT specifications for imaging of lung cancer are slice thickness: 5mm, 120kv (kilovoltage), exposure time per rotation is 108 Ma sec (milli ampere). 15% to 20% of lung cancer is SCLC. It is more aggressive form of lung cancer that recurrence in most of patients. Two types of SCLC are limited disease and extensive disease. In Most of cases the SCLC is extensive type [7]. FDG PET/CT is effective modality for staging of SCLC. Fig. 2a and b shows the CT image and PET image of lung cancer of patient.

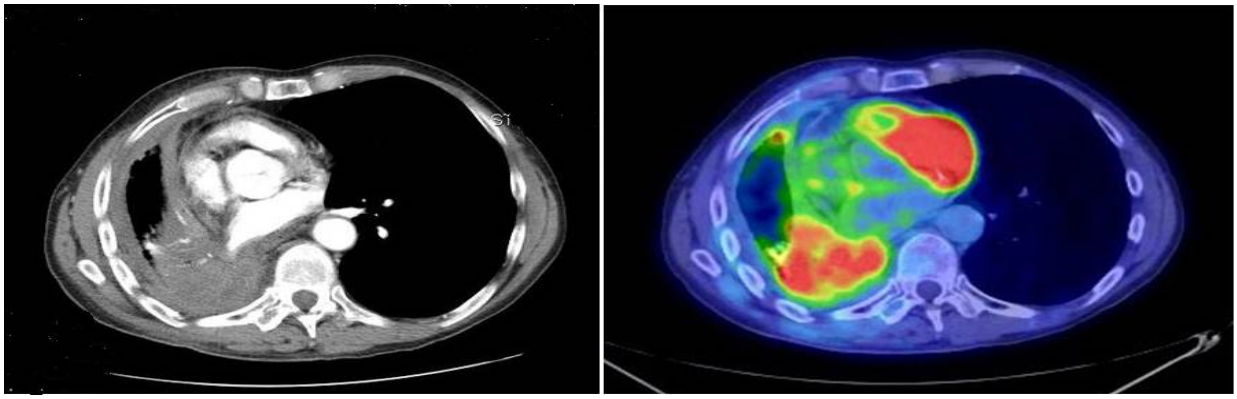

Fig. 2 a CT image of lung cancer b. PET image of lung cancer

Main disadvantages of FDG PET/CT are low spatial resolution of images, with false-positive and false-negative values.

V. DIFFUSION WEIGHTED MRI

Various healthcares all over the world have proven that new medical modality DW-MRI is another effective, useful, accurate or even better than CT and FDG PET/CT in detection, investigation, N-staging and M-staging of lung cancer. DW-MRI is more accurate for NSCLC staging and mediastinum staging of lung cancer. Like FDG PET/CT, DWMRI can also be used to determine the survival rate and assessment of NSCLC and SCLC.

The main advantages of DW-MRI are it does not use any contrast agent unlike FDG PET, no exposure to radiation and produces images with high spatial resolution very quickly [6]. Specification of DW-MRI to capture the lung images to detect the cancer is echo time 75msec, repetition time 7,400 msec, slice thickness 5mm, image size 128*86.
Apparent Diffusion Coefficient (ADC) value for detected tumors is good compared to Standardized Uptake Value (SUV) of FDG PET/CT for same patient tumors.

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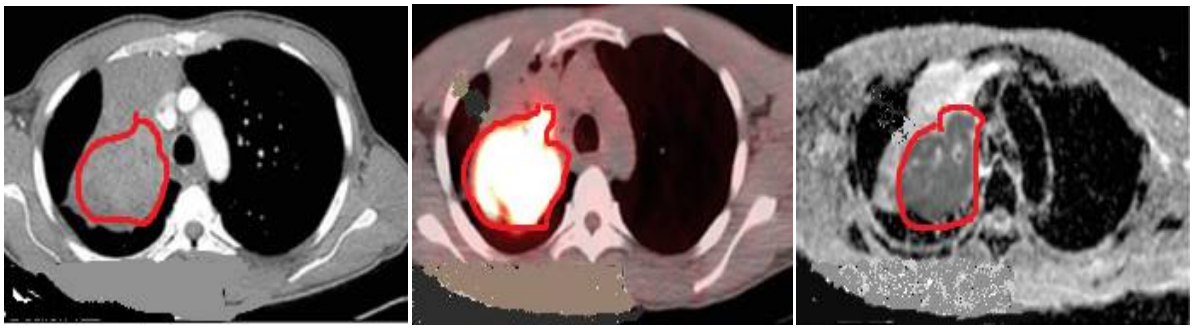

Fig. 3 a. CT Image of lung cancer b. PET/CT Image of lung cancer c. DW-MRI Image of lung cancer

Fig. 3a, b and c show the lung cancer image of same patient in CT, FDG PET/CT and DW-MRI screening.

VI. CONCLUSION

All over the world mortality rate of lung cancer is very high both in men and women. Medical imaging Modalities have been playing vital role in the screening and diagnosis of lung cancer. Studies from various healthcares have shown that Computed Tomography is effective modality in early stage lung cancer detection, localization of tumor, tumor size calculation and T- staging of lung cancer. In most of the patients (85%-90%) lung cancer is of type Non-Small Cell Lung Cancer. For a successful treatment of NSCLC, accurate TNM staging is required. Integrated FDG PET/ CT is valuable modality that provides both functional and anatomical information of lung tumors. This information helps the radiologist in accurate N-staging and M-staging of NSCLC. Diffusion-Weighted MRI is new noninvasive MRI modality for lung cancer detection. Many radiologists have proven that this new modality is very useful in NSCLC screening, staging and classification of nodule as benign and malignant nodules accurately.

REFERENCES

[1] NCCN guidelines for patients-2018 lung cancer Non Small Cell Lung Cancer, guiding cancer, changing lives. Available of online on at NCCN.org/patients.

[2] David S Ettinger, MD; Dauglas E. Wood, MD,FRCSEd; Dara L. Aisner, MD,PhD et.al NCCN "Non-Small Cell Lung Cancer, Version 5.2017, Clinical Practice Guidelines in Oncology", J Nati Compr Canc Netw 2017;15(4):504-535.

[3] American Joint Committee on Cancer, lung cancer staging-7th Edition.

[4] Tasci E, Tezel C, Orki A et.al. "Role of Integrated Positron Emission Tomography and Computer Tomographcy in Assessment nodal spread in cases with Non-Small Cell Lung Cancer Interactive Cardiovasc Thorac Surg 2010;10:200-3.

[5] Wu LM, Xu JR, Gu HY, et. al. Preopeative mediastinal and Hilar Nodal Staging with Diffusion-Weighted Magnetic Resonance Imaging and Fluorodeoxyglucose Positron Emission Tomography/ Computed Tomography in Patients with Non-Small Cell Lung Cancer? Which is better? J-Surg Res 2012;178:304-14.

[6] Pauls S, Schmidt SA, Juchems MS et.al Diffusion-Weighted MR Imaging in Comparison to Integrated [18F] FDG PET/CT for N-staging in Patients with Lung Cancer Eur J Radiol 2012;81:178-82.

[7] Joyce EA, Kavanagh J, Sheehy N, Beddy P, O'Keeffe SA, "Imaging Features of Extrapulmonary Small Cell Carcinoma" Clin Radiol. 2013; 68(9):953-61. http://dx.doi.org/10.1016/J-crad.2013.04.006.

[8] Revel MP, Cerette MF, Torrent M, Tredaniel J,"Diagnosis and Standardized Report for Non-Small Cell Lung Cancer", Diagn Interv Imaging.2014;95(7-8):727-38.http://dx.doi.org/10.2016/j.diii.2014.06.007.

[9] Geoffrey D Rubin, MD,"Lung Nodule and Cancer Detection in CT Screening", J Thorac Imaging, March 2015;30(2):130-138.doi:10.1097/RTI.0000000000000140.

[10] Coply SJ, Bryant TH, Chambers AA, et.al.Observer Accuracy in the Detection of Pulmonary Nodules on CT : effect of Cine Frame Rate. Clinical Radiology. 2010;65(2):133-6.[pubmed 20103435].

[11] MacMohan H, Austin JHM, Gamsu G, et.al. "Guidelines for Management of Small Pulmonary Nodules Detected on CT Scans". A statement from the Fleischner society 1. Radiology 2005;237(2);395-400[PubMed-16244247].

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[12] Wang XH, Durick JE, Lu A, et.al."Compare Display for Lung Nodule CT Screening", Journal of Digital Imaging. 2011;24(3):478-84.[PubMed-20386949]

[13] Seltzer SE, Judy PF, Feldman U, Scarff L, Jacobson SL, "Influence of CT Image Size and Format on Accuracy of Lung Nodule Detection",Radiology 1998;206 (3):617-22.[PubMed-9494475]

[14] Benjamin MS, Drucker EA, McLoud TC, Shepard J-AO "Small Pulmonary Nodules: Detection at Chest CT and Outcome. Radiology 2003;226(3):489-93. [PubMed-12563144]