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The Role of Imaging Modalities in Lung Cancer Treatment

Research Scholar V.Juliet Rani
Manonmaniam Sundaranar University,
Tirunelveli, India.
vjulietrani@gmail.com

Asst. Prof. Dr. K.K.Thanammal
Dept. of Comp. Science and Centre for Research
S.T. Hindu College, Nagercoil
thanaravindran@gmail.com

Abstract- Lung cancer is the most deadly disease in the world. This paper overviews one of the most important and challenging problems in oncology, the problem of lung cancer diagnosis using computer information system. Lung cancer is the dangerous disease that is being spread all over the world. Developing an effective computer-aided diagnosis (CAD) system for lung cancer is of great clinical importance. An effective CAD system can diagnose the lung cancer in an accurate manner. CAD systems for lung cancer have been explored in a huge number of research studies. A typical CAD system for lung cancer diagnosis is composed of four main processing steps: segmentation of the lung fields, detection of nodules inside the lung fields, segmentation of the detected nodules, and diagnosis of the nodules as benign or malignant. In order to accomplish the above four steps we must have the appropriate imaging modalities.

Keywords- Oncology, CAD, benign, malignant, segmentation, Nodule.

I. INTRODUCTION

Lung cancer is one of the leading causes of cancer related death. Lung cancer is caused due to the division of cells in the lungs uncontrollably. This causes the growth of tumours that reduce a person's ability to breathe. The two types of lung cancer are: Small cell lung cancer and Non-small cell lung cancer. Small cell lung cancer occurs almost exclusively in heavy smokers. Non-small cell lung cancer is any type of epithelial lung cancer other than small cell lung cancer about 85% of lung cancers are Non-small cell lung cancer [1].

Non-small cell lung cancer has three subtypes: Carcinoma, Aden carcinoma and Squamous cell carcinomas [15].Hence an agile technique is required in order to detect the lung cancer in its early stage.

Initially Lung cancer also can be detected through some observed symptoms of patients. The common symptoms of lung cancer includes cough, weight loss, loss of appetite, shortness of breath, pain in the chest, cough up blood or blood in the sputum, fatigue and pain in the bone [17]. The stages of lung cancer are assigned as stage from I to IV, according to the severity of the disease [3] [12]. Staging is based on tumor size and tumor and lymph node location [13].

II. COMPUTER AIDED DIAGNOSIS

A person can survive only when cancer is diagnosed at the early stage .The computer aided diagnosis system can be improved with the implementation of image processing techniques. Even though a number of image processing techniques are available, the chance of early stage detection of cancer is not greatly improved. Neural network plays an important role in the process of recognition of the cancer cells among the normal tissues. The cancer treatment will be effective only when the tumor cells are accurately separated from the normal cell [4].

Computer Aided Detection (CADe) and Computer Aided Diagnosis (CADx) systems are two types of CAD systems. A wealth of known publications has investigated the development of computer-aided diagnosis (CAD) systems for lung cancer from a host of different image modalities.

The success of a particular CAD system can be measured in terms of accuracy of diagnosis, speed, and automation level. A schematic diagram of a

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typical CAD system for lung cancer is shown in Figure 1. The segmentation of lung tissues on chest images is a preprocessing step in developing the CAD system in order to reduce the search space for lung nodules. Next, detection and segmentation of lung nodules from the available search space are mandatory steps.

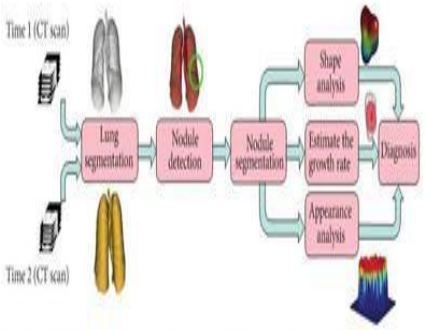


FIGURE 1: Typical computer-aided diagnosis (CAD) system for lung cancer. The input of a CAD system is the medical images obtained using an appropriate modality. A lung segmentation step is used to reduce the search space for lung nodules. Nodule detection is used to identify the locations of lung nodules. The detected nodules are segmented. Then, a candidate set of features, such as volume, shape, and/or appearance features, are extracted and used for diagnosis.

Lastly, the classification of the detected nodules into benign and malignant is the final step. Classification of the detected nodules is a major component in CAD systems for detection and diagnosis of lung nodules in CT. In CAD systems for detection (often abbreviated as CADe), a classification component categorizes the nodule candidates identified in the previous step into nodules or nonnodules (i.e., normal anatomic structures), whereas a CAD system for diagnosis (often abbreviated as CADx) classifies detected nodules (either by a computer or a radiologist) into benign or malignant nodules. Figure 2 elucidates the various imaging techniques.

III. IMAGING MODALITIES

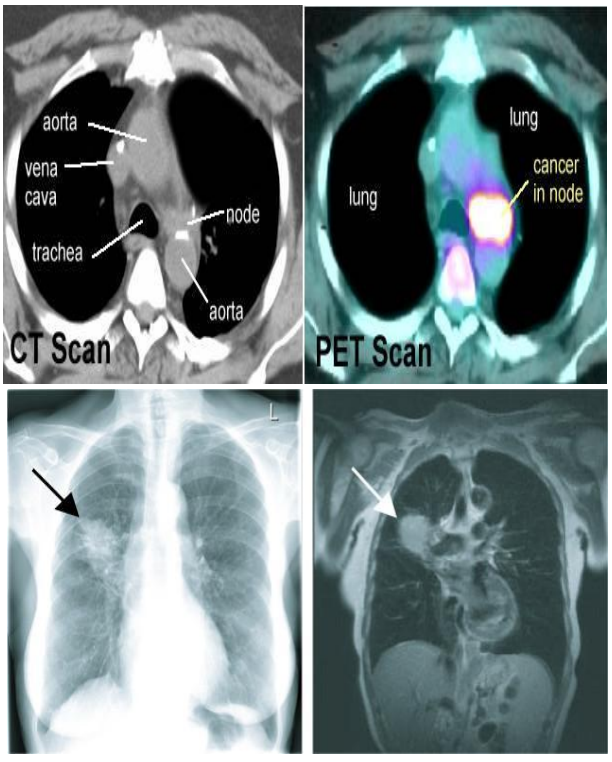
In order to diagnose the lung cancer, physician may recommend tests such as imaging tests, sputum cytology and tissue sample tests [5]. Different types of imaging tests that are used to diagnose lung cancer. The X-ray, MRI, Positron emission tomography (PET), Single-photon emission computed tomography (SPECT), computed tomography (CT), Low-dose computed tomography (LDCT), and Contrast-enhanced computed tomography (CE-CT) are the most common noninvasive imaging modalities for detecting and diagnosing lung nodules.

1. Chest X-ray:

A chest x-ray is considered as the first test by most physicians to diagnose lung cancer. The appearance of lung cancer on the chest x-ray will be like a white grey mass. Chest x-ray cannot distinguish between lung cancer and other abscess [6].

2. Computed Tomography (CT) scan:

A CT scan takes many images of our body using x-rays; hence it is easy to diagnose Lung Cancer using CT scans. It can also predict the size, shape and position of any lung tumors. The enlarged lymph node can also be found using CT scan. The development of computer-aided diagnostic (CAD) system helps the physician and radiologist to accurately analyze the CT images to increase the accuracy of the cancerous nodule detection. Commonly, nodules are the tiny mass inside the lung, which are the indicator for lung cancer. The nodules are classified into different types based on their location inside the lungs. They are juxta-pleural, well-circumscribed, pleural tail and vascularised [3]. The cancerous nodule growth rate is rapid. So the growth can only be analyzed by a sequence of CT scans taken over a period of time [10].



X-ray MRI

Fig 2. Sample images for different modalities.

The two categories are: low-dose computed tomography (LDCT), and contrast-enhanced

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computed tomography (CE-CT). Low-dose computed tomography (LDCT) has been used as a screening tool for lung cancer and recent results from the National Lung Screening Trial (NLST) predicts that lung cancer mortality has been reduced by 20% when compared to chest radiograph [9]. In Contrast Enhanced Computed Tomography (CECT), contrast agents are used during contrast enhancement. It examines the highlighted tissues and parts of the body. Bones can be clearly seen on x-ray images, but the visualization of some other organs and soft tissues is more difficult. Hence x-rays are replaced by CT scan.

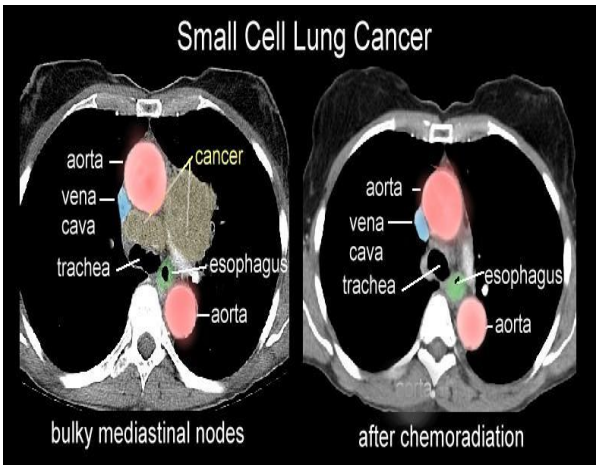
3. Magnetic resonance imaging (MRI) scan:
MRI Scan shows detailed images of soft tissues in the body .It also produces images that allow doctors to see the location of a lung tumour and measure the tumour's size .An MRI uses magnetic fields , to produce detailed images of the body. A special dye called a contrast medium is given before the scan to create a clearer picture. This dye is injected into patient's vein or given as a pill or liquid to swallow.MRI scanning does not work well to take pictures of parts of the body that are moving, like the lungs, which move with each breath you take. Due to this reason MRI scan is rarely used for lung cancer diagnosis.

4. Positron emission tomography (PET) scan:
In PET scan, a slightly radioactive form of sugar is used (known as FDG). FDG means fluorodeoxy glucose [14]. FDG is the radiotracer that is most commonly used today. It is injected into the blood and collects mainly in cancer cells. In PET/CT scan a PET scan is combined with a CT scan using a special machine that can do both at the same time. This allows the doctor to compare areas of higher radioactivity on the PET scan with a more detailed picture on the CT scan. This is the type of PET scan most often used in patients with lung cancer. This type of scan is opted when the doctor thinks the lung cancer has spread to other parts of the body. PET scan can be combined with MRI scan also to produce multidimensional colour images of the inside working of the human body [16].

5. Single photon emission computed tomography (spect):
This type of scan is used in nuclear medicine. This imaging technique uses gamma rays [10]. A medical specialty that uses radioactive tracers (radio pharmaceuticals) is used to assess bodily functions and to diagnose and treat disease. Diagnostic nuclear medicine relies heavily on imaging techniques. Single Photon Emission Computed Tomography or SPECT and Positron Emission Tomography or PET scans are the two most common imaging modalities in nuclear medicine.

IV. CHEMO RADIATION

After performing the imaging technique, the lung must be diagnosed using appropriate CAD system. Then we can determine the stage of the lung cancer from that we can conclude about the chemo radiation. The figure 3 elucidates the chemo radiation concept.



V. CONCLUSION

The CAD system plays a major role in lung cancer diagnosis. Designing efficient CAD systems for lung cancer is very important since early diagnosis can improve the effectiveness of treatment and increase the patient's survival rate. Though many methods are available for detecting Lung Cancer, the task of extracting the information from those imaging modalities is of great importance. So new methods can be developed by using digital image processing techniques to extract the information in an effective manner.

Hence researchers must concentrate on developing new algorithms that can diagnose the disease with high accuracy. It makes the better possibility to provide correct treatment to patients. So the mortality rate due to lung cancer can be reduced. Hence an efficient and accurate lung cancer

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diagnosis system is required for the early detection of lung cancer.

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