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Breast Cancer Detection Techniques: A Review

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Abstract:- Every year an increasing number of women are being diagnosed with breast cancer. Breast Cancer Detection and Screening has become an extremely important part of health care. Through this paper, an attempt has been made to comprehensively compare the engineering techniques behind breast cancer detection. Each technique has its own risks and benefits. The paper lists the various techniques prevalent in different part of the world and compares their various aspects.

Keywords*:-* Breast Cancer, Cancer screening, Emerging Technologies, Detection, Mammography

I. INTRODUCTION

Breast cancer is one of the most common cancers. In the year 2012, 144937 women were diagnosed with breast cancer in India and this number is only increasing year after year.[1] The alarming rise in the number of breast cancer cases demands that we develop better preventive oncology techniques. With an early detection of breast cancer, the patient stands a high chance of being cured of the cancer. Thus imaging techniques are extremely important when it comes to preventive oncology. Through this paper we aim to compare the various techniques used for breast imaging and their efficiencies.

II. CURRENT TECHNIQUES

The most widely used technique today for breast imaging is mammography. Mammography essentially uses low energy X-rays to create 2d breast images. Radiologists examine these images for tumors mainly based on difference in the tissue density. Although mammography is convenient and inexpensive, it has numerous drawbacks. This technique fails to distinguish between two tissues with a small density difference thereby often causing false negatives. Not only this, it gives false positives about 25-30% of the times. This causes unwarranted anxiety to the patient. The effect of X-rays on cell DNA is known. Thus it is vital to have alternative technologies that can overcome these inefficiencies.
Digital mammography uses X-rays to get a clearer picture. The X-rays are converted into electrical signal and analyzed.

III. ALTERNATE METHODS

Although mammography serves as an inexpensive monitoring tool, its lack of efficiency (in terms of the rate of false positives and false negatives) and harm caused by the radiation have led to the invention of more precise, safe and efficient methods of diagnosis [2].

A. PET Scans

The basic mechanism in a PET scan is that the cancerous cells tend to be more active than normal cells. Such cancer cells absorb more sugar. The radioactive sugar which is injected into the person is picked up with the help of a special camera and analyzed. The high cost of the procedure along with the difficulty in procuring the radioisotope is a major deterrent.
PET scan is not only used for primary diagnosis but is also used to detect secondary spreading of cancer to adjacent.

B. MRI

Magnetic Resonance Imaging is a technology that uses magnets and radio waves to produce detailed cross sectional images of the body. MRI does not use X-rays. Thus MRI involves no exposure to radiation. It's often used to detect breast cancer in cases like[4],

a. High risk women (with a family history of breast cancer or a gene abnormality)
b. Gathering more information of an area found to be suspicious on the mammogram.
c. Monitoring for recurrence after treatment.

C. Thermography

Thermal imaging/ Thermography uses a special camera to measure the temperature of the skin on the breast surface. It's completely noninvasive and involves no radiation at all which makes it a good screening tool. The basis of this test is cancer cells grow and multiply fast making the blood flow and metabolic rate higher in these cells leading to an increased skin temperature.

Women are recommended to have a thermography done every year. Each patient has a characteristic thermography response to a thermography test. The tumors can be detected whenever a change in this pattern is observes. Thus it is recommended that women get it done every year.[8]

Although thermal imaging is capable of detecting advanced abnormalities, deep hidden tumors are occasionally missed. Thus this is not a good screening and cannot replace mammography.

D. Ultrasound imaging

Ultrasound imaging is based on creating an image with the help of sound waves reflected from the tissues. Although ultrasound (sonography) is not used as a screening tool, it is used complementary to mammography.[4] Ultrasound is the best way to find out if an abnormality is a solid or fluid based, however it cannot determine whether a solid lump is malignant or benign. Several modifications to the ultrasound techniques have given rise to techniques that are efficient in their own particular ways[2]:

a. High frequency Sonography
b. Vascular imaging
c. Contrast imaging
d. Sonoelasticity imaging
e. Guided Biopsy

E. Electrical Impedance Tomography

Different tissues in our body have different characteristic conductivities and permittivities. Thus they offer different resistance to an electric current when passed through it. This property is used in the method of electrical impedance tomography.

Typically a malignant tissue shows a variation in the output voltage thereby indicating its presence. This is because a malignant tissue shows much higher conductivity and permittivity than a normal tissue.

A number of electrodes typically 16 are connected to the breast tissue. A current of different frequencies is applied at various times. The results give a general idea of the trends of impedances. Magnitude and phase is calculated at each electrode. Deviation at each electrode for a malignant tissue is calculated. A current is injected using two electrodes which produces a current distribution. The field image is reconstructed using tools like FEMM and EIDORS. Clay and copper used to simulate benign and malignant cells due to their unique conducting properties.[3]

EIT has an advantage of being inexpensive and no safety hazards unlike the MRI and other methods. It can very well detect tumors which are small in size. EIT offers a very low resolution reconstruction of the tissue. This can however be overcome by increasing the number of electrodes.[5]

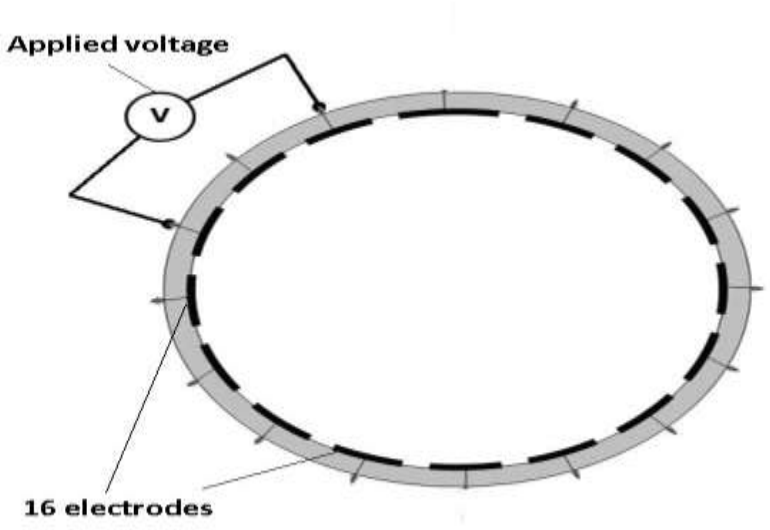

Fig. 1: Set-up for Electrical Impedance Tomography

F. Near Infrared Optical Imaging

This is one of the latest technologies in breast imaging and is still in the development stages. A number of electrodes emitting waves in the infrared range are placed around the breast. A reconstruction is obtained using the reflection pattern. Novel algorithms are used to study these images. The basis of this test is that normal and cancerous tissues have different reflected patterns. However the resolution is poor but penetration is better than mammography as also the discomfort to the patient.[6]

G. Other methods

CAD (Computer Aided Detection) is used along with Mammography which essentially reduces the human element in the detection. The mammography images are analyzed using sophisticated algorithms to detect abnormalities. Latest research has developed algorithms based on artificial neural networks.[7] They can often pick up abnormalities which are difficult to be detected to the human eye.

IV. CONCLUSIONS

A number of promising technologies are constantly being developed in this field. Each technology has been trying to improve on the work already done in the field. In spite of the large amount of the resources in terms of research and funding being put in, it is yet evolving. The conventional mammography, though widely used and inexpensive has its drawbacks. To overcome the shortcomings of mammography, extensive research was carried out in supporting technologies namely CAD and digital mammography. The newer methods like MRI and PET are supportive in the sense that they help in charting the modalities of treatment. Electrical Impedance Tomography helps in early detection of the cancer while Near Infrared Optical Imaging offers better penetration. Current research in this field seems to be advancing towards technologies which can offer more precise and early diagnosis.

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