NANOROBOTICS CONTROL SYSTEM DESIGN – A NEW LOOK TO BREAST CANCER DIAGNOSIS AND THERAPEUTIC

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Abstract: Metastatic Breast Cancer (MBC) is a major cause of cancer-related death among women in developed countries and it offers a diagnostic and therapeutic challenge due to tumor heterogeneity and to various physiological barriers that hinder drug delivery to the metastatic sites. To overcome these limitations, targeted nanoparticles exploited for surface fictionalization, directed toward tumor markers and tissue-specific metastases, may provide effective devices in case of low-vascularised and small-sized metastases. We discuss the method of special autonomous nano-robotic systems that can be used for bio-medical and bio-mechanical purposes. A fuzzy shaped based approach is described in context of recognizing a single malignant cell along with its stage, as a target for medical treatment. The synthesis and imaging of magnetic nanoparticles, that can be functionally bind with the medicine and reached the effected regions for targeted drug delivery, such as in cancer treatment is also presented specially to metastatic breast cancer diagnosis and treatment. The result shows its potential to an upcoming translation of this research into clinical practice for an effective management of the disease in the near future.

Index Terms **- Breast Cancer, Histology, Prognosis, Fuzzy Logic, Nano-Robot**

I. INTRODUCTION

Breast cancer is the most common cancer diagnosed, after skin cancer especially in the developed country. On analyzing the risk model, based on population averages each woman's breast cancer risk may be higher or lower, depending upon a several factors, including family history, genetics, age of menstruation, and other factors that have not yet been identified as shown in Fig. 1(a). Breast Cancer Survival Rates is also very alarming like Five years after diagnosis- 89%, Ten years after diagnosis-82%, Fifteen years after diagnosis-77% and as per Race/Ethnicity, Non-Hispanic White-88.8%, Black-77.5%, American Indian/Alaska Native-85.6 %, Asian-90.7%, Pacific Islander-85.4%, Hispanic-83.8% . The five-year survival rate for breast cancer is calculated based on averages along with Each patient's individual tumor characteristics, state of health, genetic background, etc. will impact her survival. In addition, levels of stress, immune function, will to live, and other immeasurable factors also play a significant role in a patient's survival as shown in Fig 1 (b). (Data source: American Cancer Society Breast Cancer Facts & Figures, 2011-2012).

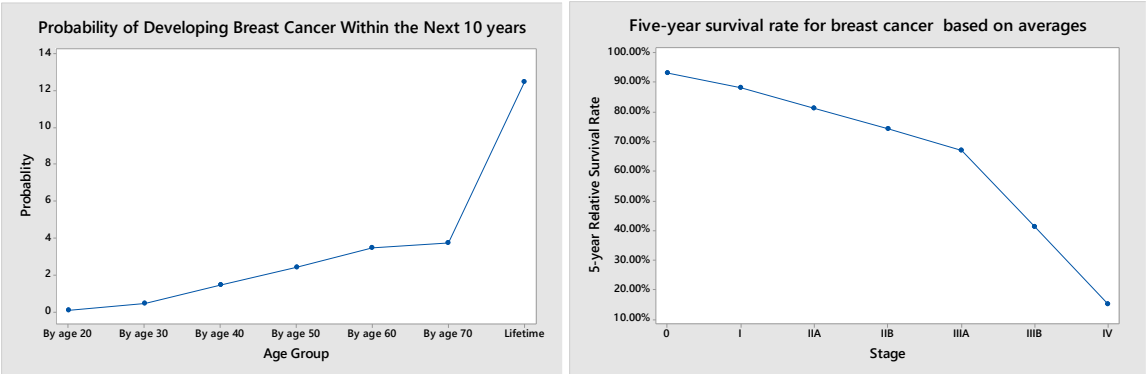

Fig. 1 (a) Probability of developing Breast Cancer within next 10 years among different age group
(b) 5 years survival rate cancer with different stage (based on average)

II. MATERIALS AND METHODS

Histological descriptions of invasive breast cancers

The breast is made up of lobules (glands that produce milk), ducts (tiny tubes that carry lobules to the nipple), and stroma (connective and fatty tissue that surrounds the lobules and ducts, including blood and lymph vessels). Most of the lymph vessels in the breast lead to lymph nodes under the arm (axillary nodes) as shown in **Fig. 2(a)**. Breast cancer normally arises in the epithelial cells that line the ducts and lobes of the breast, which are in constant turnover. These cells are generated continuously by a basal membrane and normally divide, migrate, and differentiate in a tightly controlled process. Cancer forms when internal (genetic alterations) or external (e.g., environmental and hormonal) factors interfere and the cells undergo an abnormal spectrum of changes, from hyperplasia to preinvasive to invasive and metastatic cancer. If the cancerous cells are confined to the ducts or lobules, the cancer is called noninvasive or in situ as shown in **Fig. 2(b)**. Breast cancer that has spread through the walls of the ducts or lobules into the surrounding fatty and connective tissue is referred to as invasive or infiltrating.

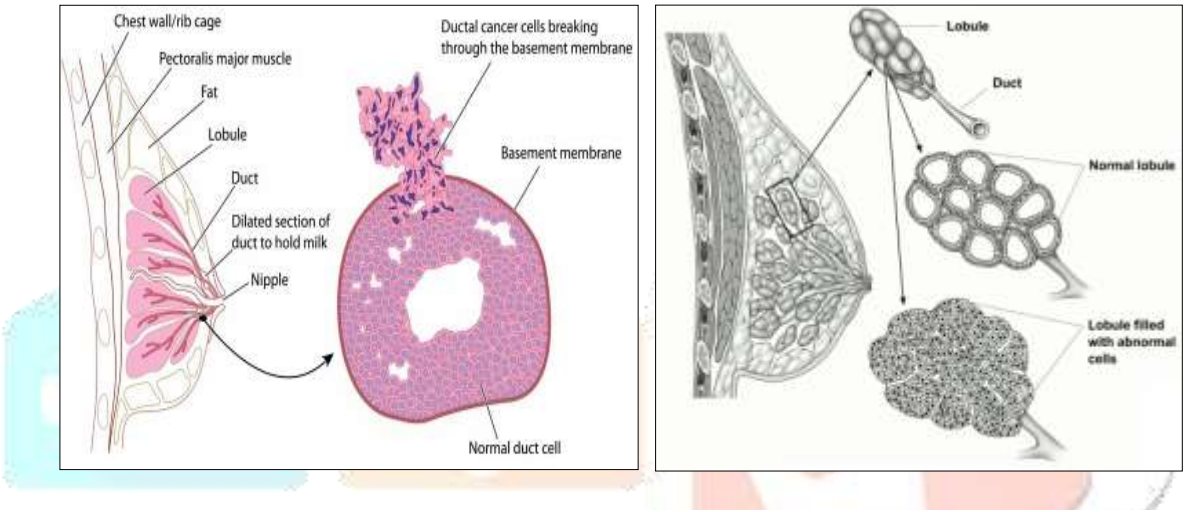

Fig. 2 (a) Female Breast Anatomy profile **(b)** lobular Carcinoma in situ

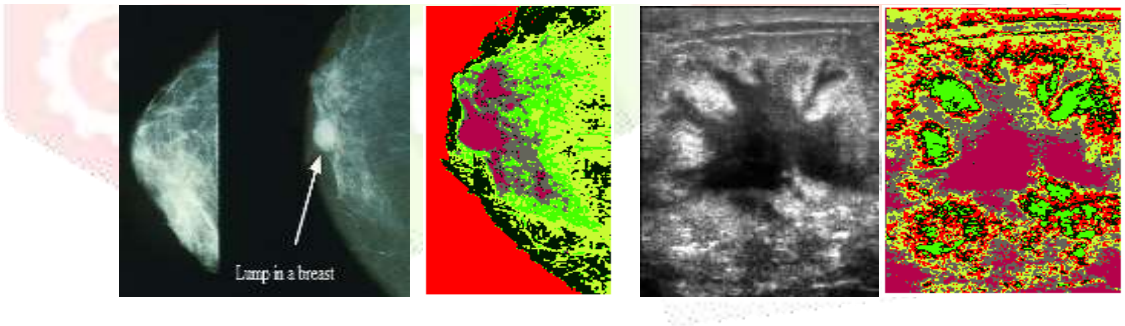

Fig. 3 (a) Mammograms showing a normal breast (left) and a breast with cancer (right, white arrows)
(b) Ultrasound image shows irregularly shaped mass of breast cancer along with colour coding

Biopsy is the only way to find out. During a biopsy, a surgeon will remove cells from the suspicious area so they can be studied in the lab to see if cancer cells are present. Mammograms and Ultrasound images can often show a breast lump before it can be felt shown in **Fig 3. (a) & (b)**.

There are a great number of different types of breast cancer, and quite frequently one encounters a combination of different types of breast cancer within the same patient. Most common type of breast cancer would probably, **mucinous breast carcinoma**, **medullary breast carcinoma**. The most common sign of breast cancer is a painless, hard lump with irregular edges.

III. MUCINOUS (COLLOID) BREAST CANCER

Mucinous breast cancer, also called colloid breast cancer, is a rare type of **invasive ductal breast cancer** that accounts for less than 2% of all breast cancers. Like other types of invasive ductal cancer, mucinous breast cancer begins in the milk duct of the breast before spreading to the tissues around the duct. Histology image of Mucinous (Colloid) Breast Carcinoma and region marking with image clustering are shown in **Fig. 4**.

When the cells of a mucinous breast cancer are examined under a microscope, there is an unusually large amount of mucous, or *mucin*, which makes up part of the tumor and gives the cancer its name. A tumor may contain both mucinous breast cancer cells and more typical invasive ductal cells and treatment is recommended based on the tumor makeup as a whole.

Local therapy is aimed at preventing the cancer from coming back in the breast. Local therapy includes surgery (lumpectomy or mastectomy), and may include radiation.

Systemic therapy is used to prevent the disease from coming back or spreading to another part of the body. This may include endocrine (hormone) therapy, chemotherapy, and therapy that targets the HER2 protein. Often different types of treatment are used together to achieve the best result.

Your treatment plan will be based on the **features of the tumor** (type of cells, tumor grade, hormone receptor status, and HER2 status) and the **stage of the disease** (tumor size and node status). Your oncology team will recommend a treatment plan based on what is known about mucinous breast cancer in general and tailored to your specific disease.

We know that it can be stressful to receive a diagnosis of breast cancer, and learning that you have a rare form of the disease can add to your anxiety. We hope it will be reassuring to know that our team at the **Center for Rare Breast Tumors** is dedicated to latest research and treatment of mucinous breast cancer, and is here to support patients and their families through diagnosis, treatment, and survivorship.

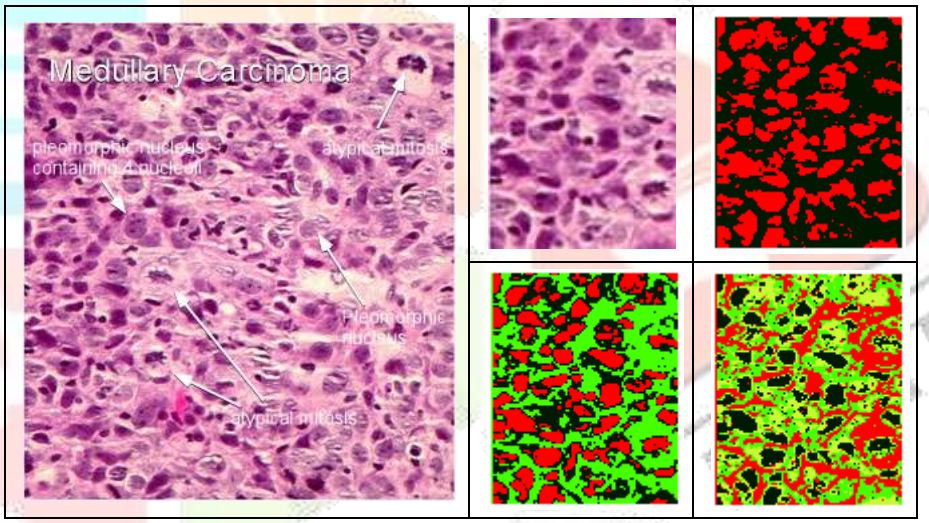

Fig. 4 Medullary Carcinoma and region marking with image clustering

IV. DISCUSSION

Across the globe, breast cancer is one of the leading causes of death among women and, currently many practitioners believe that cancer treatment should be based not only on prognostic factors and chemotherapy, but also on quality of life during and after treatment, knowing that, tolerability, compliance and quality of life will, therefore, could become the most important factors in future therapy of cancer. In our opinion nano-technological therapeutic agents in the clinic represents a great hope for successful cancer therapy through nano-bio-robotics system in future. As an application we describe how a nano-robot able to diagnose and kill the cancer cell [1-3] by controlled drug transfer to particular site. Our method of different type breast cancer diagnosis using image clustering and labelling is a robust one and is very successful in assisting the pathologists in the screening process of breast cancer. The use of fuzzy logic approach [4] to formalize the region detection and labelling in Breast Imaging Lexicon is new one and has a tremendous impact for efficiently and accurately determination of the diseases and its stage [5-7]. The results, we have obtained, are validated with the clinical findings and it proves to be satisfactory with some minor enhancement has to be made. Future work may include addition of a statistical and operational research envelope for evaluating large-scale performance, simulations of new environments and nano-robot designs. We strongly believe that the merging of the new technologies into operational nano-machines will go hand in hand with progressing simulation fidelity. Bottlenecks and open research questions in Nanorobotics are to construct dynamic models at nano-scale, for verification, the right tools or methods to check accuracy and correctness of the modelling and control using cybernetics and general systems theory.

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