Recent Applications of Percutaneous US-guided Radiofrequency Ablation in Treatment of Breast Cancer

Essay

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List of Abbreviations

AJCC	American Joint Committee on Cancer.
BCT	Breast conserving treatment.
BI-RAD	Breast imaging Reporting And Data system.
CC	Craniocaudal.
DCIS	Duct carcinoma in situ.
FDG	Fluorodeoxyglucose
H&E	Hematoxylin-eosin.
LCIS	Lobular carcinoma in situ.
MLO	Mediolateral oblique.
NOS	Not otherwise specified.
RF	Radiofrequency.
RFA	Radiofrequency Ablation.
SLN	Sentinel lymph node.
TDLU	Terminal ductolobular units.

INTRODUCTION
&
AIM OF WORK

Breast cancer is the most common cancer in women and the most common cause of death in women between the ages of 35 and 55y. The incidence of breast cancer is rising but mortality has not risen, probably as a result of earlier detection and improved treatment. ***(Burkitt and Quick, 2002).***

There has been a tremendous change in the surgical management of small breast cancer involving conversion from total mastectomy to breast conserving treatment (BCT), and from axillary lymph node dissection to sentinel lymph node (SLN) biopsy. Thus, treatment for early breast cancer has evolved toward less invasive approaches. However, BCT is still invasive and cosmetically undesirable in some patients, although it is not a major procedure. The cosmetic disadvantages of conventional BCT include the risk of prominent scarring and breast deformity. Recently, screening mammography and image-guided needle biopsy have been widely used for detecting larger numbers of women with early small breast cancer. Thereby, there is increasing demand for minimally invasive treatment methods with better cosmetic outcomes for patients with small breast cancer.

So-called minimally invasive techniques make percutaneous eradication of breast tumor possible, thus leading to BCT without surgery. Methods of minimally invasive therapy have been developed for the breast cancer, including interstitial laser photocoagulation therapy, radiofrequency (RF) ablation therapy, focused microwave therapy, high intensity focused ultrasound therapy, and cryotherapy.

Of these experimental options, RF ablation seems the most promising non-surgical ablation technique for the treatment of breast cancer. ***(Noguchi, 2007).***

Radiofrequency (RF) ablation is a minimally invasive therapeutic strategy for the local treatment of solid malignancies that has received much attention over the past few years. Currently, RF ablation has been successfully used to treat liver, kidney, prostate, lung, and bone neoplasms. The procedure is well tolerated, and the complication rates are low in most studies. ***(Manenti et al., 2009).***

RF ablation for small breast cancer has been a subject of investigation in USA, Italy, and Japan . These studies commonly indicated that RF ablation has the potential to replace surgical resection for the treatment of small breast cancer. Several pilot studies of RF ablation therapy are now in progress in Japan as well as USA***. (Noguchi, 2007).***

Because of the high variability of normal breast tissue composition among individuals (dense or fatty breasts), breast masses are not always surrounded by tissues with homogeneous conductivity; therefore, it is of primary importance to have an RF generator, a needle electrode, and a procedure protocol suitable for the variable composition of breast tissue. Two types of RF ablation needle are mainly used for breast RF ablation: expandable needles and internally cooled single-needle electrodes. Also, several energy delivery schemes have been proposed.

As yet, there is no consensus regarding which type of electrode or RF ablation protocol should be used. Recently, a dedicated breast cool-tip RF ablation system, which has shown better performance ex vivo in terms of temperature distribution and duration of the procedure with respect to multiprobe breast RF ablation, has been proposed. ***(Manenti et al., 2009).***

The aim of this work is:

To evaluate in vivo the efficacy of a newly developed breast RF ablation system in human small invasive breast carcinomas in terms of complete tumor necrosis, reproducibility of ablation lesion size and shape, and cosmetic outcome.

Anatomy

The breasts form a secondary sexual feature of females and are the source of nutrition for the neonate. They are also present in a rudimentary form in males. The breasts are the site of malignant change in as many as one in ten women.***(Johnson et al., 2008).***

Shape & extent:

In young adult females, each breast is a rounded eminence lying within the superficial fascia, largely anterior to the upper thorax but spreading laterally to a variable extent. Breast shape and size depend upon genetic, racial and dietary factors, and the age, parity and menopausal status of the individual. Breasts may be hemispherical, conical, variably pendulous, piriform or thin and flattened. In the adult female the base of the breast-its attached surface-extends vertically from the second or third to the sixth rib, and from the sternal edge, medially, almost to the midaxillary line laterally in the transverse plane. The superolateral quadrant is prolonged towards the axilla along the inferolateral edge of pectoralis major, from which it projects a little, and may extend through the deep fascia up to the apex of the axilla (the axillary tail). ***(Johnson et al., 2008).***

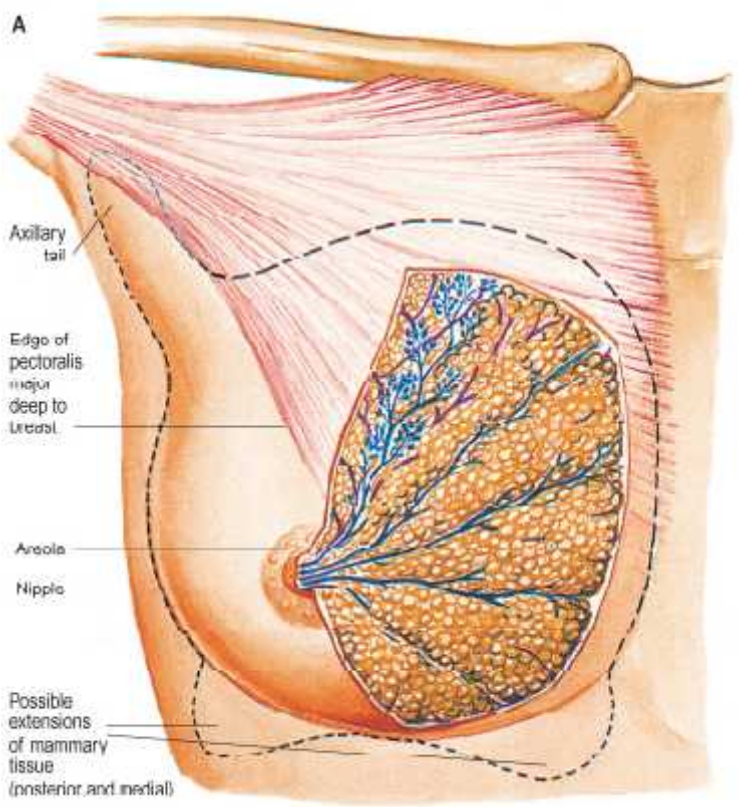


Fig.1 A: The macroscopic structure of the breast. ***(Quoted from Johnson et al., 2008).***

Structure:

The resting (non lactating) breast consists mainly of fibrous tissue, glandular tissue is very sparse and consists almost entirely of ducts while alveoli are difficult to find in a histological section of a resting breast which is made up of 15 – 20 lobules of glandular tissue embedded in fat, the later accounts for its smooth contour and most of its bulk. These lobules are separated by fibrous septa running from the subcutaneous tissue to fascia of the chest wall (ligament of cooper).

Each lobule drains by its lactiferous duct on to the nipple, which is surrounded by the pigmented areola, these ducts open separately on the summit of the nipple, the area is lubricated by the areoler gland of Montgomery, These are large modified sebaceous glands.***(Ellis, 1992).***

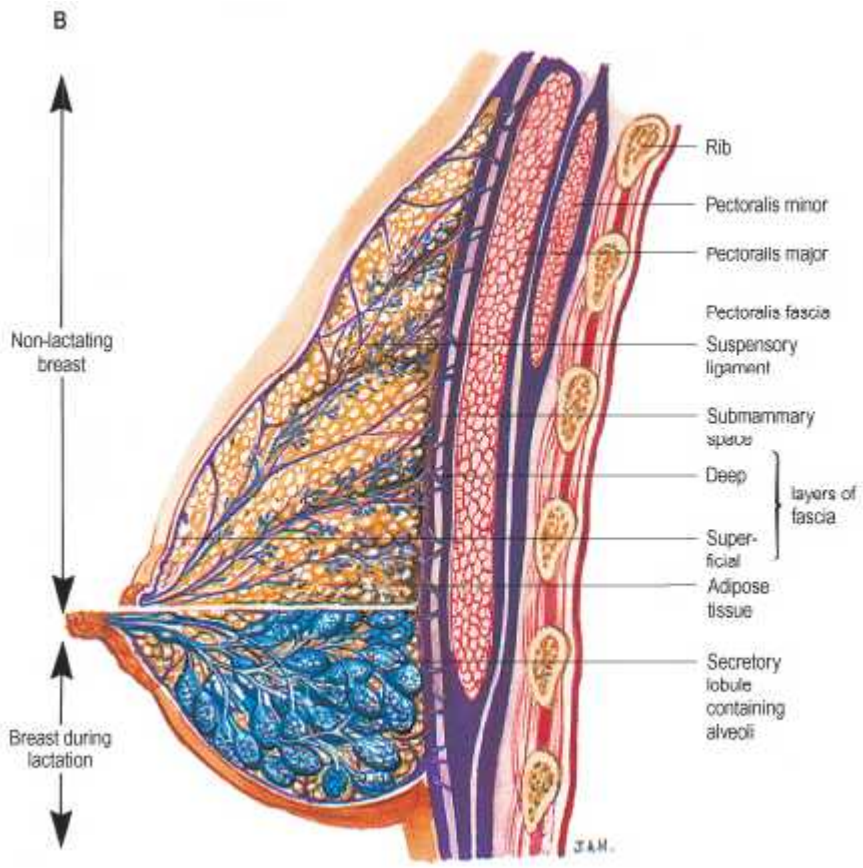


Fig.1 B: Changes during lactation. ***(Quoted from Johnson et al., 2008).***

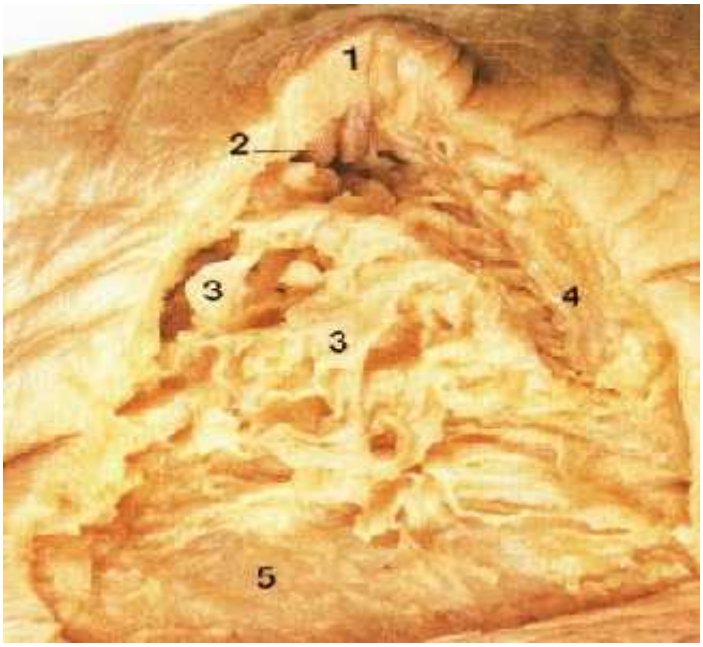
Breast support:

The breast lies upon the deep pectoral fascia, which in turn overlies pectoralis major and serratus anterior, and inferiorly, external oblique and its aponeurosis as the latter forms the

anterior wall of the sheath of rectus abdominis. ***(Johnson et al., 2008).***

In young, breast is protuberant (the older is pendulous) and is supported by the ligaments of cooper which connect the deep fascia with the overlying skin, when these ligaments become atrophic, they allow the organ to drop, and when contracted from the fibrosis they cause skin pitting. Between this fascia and the deep fascia over the pectorals major, there is a sub mammary space in which the lymphatic run and into which the breast prosthesis are inserted, relatively it is bloodless plain.

When breast carcinoma invades the retro mammary space and attaches to the deep fascia covering the pectoralis major muscle, contraction of this muscle causes the breast to move superiorly, this is a sign of advanced malignant disease of the breast. It is important to remember that the upper lateral region of the breast can project around the lateral margin of the pectoralis major muscle and into the axilla. This axillary process (axillary tail) may rarely perforate deep fascia and extend as for superiorly as the apex of the axilla. ***(Drake et al., 2005)***.



1-Nipple.
2-Ampulla of lactiferous duct.
3-Fibrous septum.
4-Fat.
5-Fascia over pectoralis major.

Fig2: Cross-sectional (Sagittal) view of the breast and-associated chest wall.
(Quoted from Abrahams et al., 1998).

The areola:

The areolae (the pigmented skin around the nipples) contain numerous glands which enlarge during pregnancy and secrete an oily substance that provide a protective lubricant for both areola and nipple. There is no fat beneath the areola. The size of areolae are variable and its color are pink in white nulliparous women and during the first pregnancy the color changes permanently to brown, the depth of color depends on the woman's complexion. ***(Ellis, 1992).***

The nipple:

Nipples are conical or cylindrical prominences that are located in the center of the areolae ,and resemble the areolae in having no fat in their structure but they are composed mainly of circularly arranged smooth muscle fibers that compress the lactiferous ducts and erect the nipple when they contract. In nulliparous women, the nipples are usually at the level of the fourth intercostal space. The tip of the nipple is fissured and contains the opening of the lactiferous ducts. ***(Johnson et al., 2008)***.

Arterial Supply of the Breast:

The breast is related to the thoracic wall and to structures associated with the upper limb; therefore vascular supply and drainage can occur by multiple routes:

* Laterally: vessels from the axillary artery, superior thoracic, thoracoacromial, lateral thoracic and subscapular arteries.
* Medially: braches from internal thoracic arteries via the perforating branches which pierces the second, third and fourth intercostal spaces. ***(Drake et al., 2005).***

Venous drainage of the breast :

Veins draining the breast parallel to the arteries, drain into the axillary, internal thoracic and intercostal veins, chief venous drainage is to the axillary vein. ***(Drake et al., 2005).***

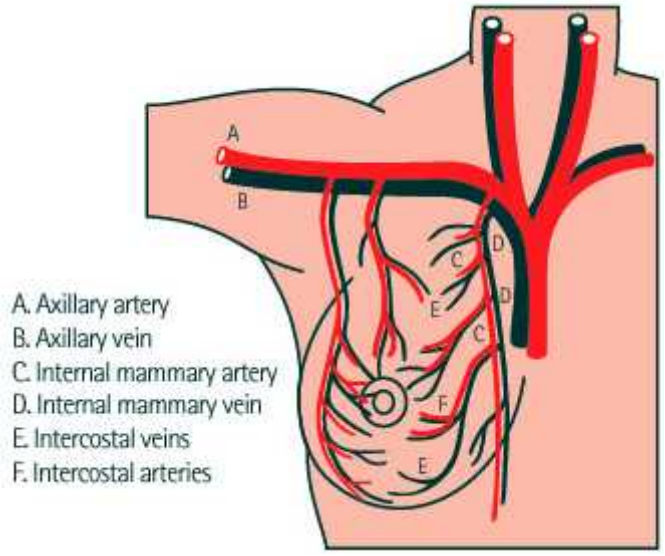


Fig3: Blood supply and venous drainage of the breast. ***(Quoted from Osborne, 2000).***

Innervation of the breast:

The breast is supplied by lateral and anterior cutaneous branches of the second to sixth in intercostal nerves. The nipple is innervated by the fourth intercostal nerve. These nerves include both sensory and sympathetic fibers. ***(Drake et al., 2005).***

Lymphatic drainage of the breast:

Lymphatic drainage of the breast is of considerable importance in the spread of breast tumors. It can be very variable. There are communicating lymphatic plexi in the interlobular connective tissue and the walls of the lactiferous ducts and the subareolar region. There is also a plexus of minute vessels on the subjacent