THE ROLE OF MR SPECTROSCOPY IN EVALUATION OF BREAST MASSES

Essay

Submitted for Partial Fulfillment of Master Degree in Radiodiagnosis

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ꕥ Acknowledgement ꕥ

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List of Abbreviations

^{1}H	: Proton
^{1}H MRS	: Proton magnetic resonance spectroscopy
2D	: Two dimensional
^{31}P	: Phosphorous
^{31}P MRS	: Phosphorous magnetic resonance spectroscopy
3D	: Three dimensional
ANDI	: Aberrations of normal development and involution
Bo	: Magnetic field.
CHESS	: Chemical shift selected
Cho	: Choline
CM	: Contrast media
CSI	: Chemical shift imaging
FFE	: Fast field echo
FID	: Free induction decay
FISP	: Fast imaging with steady-state progression
FLASH	: Fast low-angle shot
FNAB	: Fine needle aspiration biopsy
FOV	: Field of view
Gd-DTPA	: Gadolinium diethylene triamine penta acetate
GE	: Gradient echo
GPcho	: Glycerophosphocholine
GRASS	: Gradient-refocused acquisition in steady state
Hz	: Hertz
MRI	: Magnetic resonance imaging
MRS	: Magnetic resonance spectroscopy
MRSI	: Magnetic resonance spectroscopy imaging
NMR	: Nuclear magnetic resonance
NOS	: Not otherwise specified
Pcho	: Phosphocholine
pH	: Phosphorus
ppm	: Part per million

List of Abbreviations (Cont.)

PRESS	: Point-resolved spectroscopy
RF	: Radio frequency
SE	: Spin echo
SNR	: Signal-to-noise ratio
STIR	: Short T1 inversion recovery
T	: Tesla
T1	: Relaxation time
T1 W1	:T1-weighted image
T2	: Longitudinal relaxation time
T2 W1	: T2-weighted image
TE	: Time of echo
TR	: Repetition time
VOF	: Volume of interest

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Introduction

In previous studies, researchers have demonstrated that magnetic resonance (MR) imaging can be used to detect otherwise occult breast cancers and that MR imaging is playing an increasingly important role in the clinical setting, including a possible role in the screening of women who are at high risk for breast cancer ***(Liberman, 2004; Robson & Offit, 2004 and Morris et al., 2003)***.

Because of the lack of standardization in technique and interpretation, the specificity of MR imaging has been variable from center to center; however, overall specificity has been relatively low, resulting in a considerable number of benign biopsy results ***(Boetes and Stoutjesdijk, 2001)***.

Methods to improve the positive predictive value of MR imaging with regard to biopsy recommendations would improve the acceptability and cost-effectiveness of this imaging technique. MR spectroscopy provides biochemical information about the investigated tissue. ***(Bartella et al., 2006)***.

The diagnostic value of ^{1}H MR spectroscopy is typically based on the detection of elevated levels of choline compounds, which are a marker of active tumor ***(Negendank, 1992)***.

The results of several *ex vivo* MR spectroscopy studies have shown elevated levels of choline, such as phosphocholine and glycerophosphocholine ***(Mackinnon et al., 1997 and Aboagye & Bhujwalla, 1999)***, in cancerous human mammary cells. It has been suggested that choline levels may not be as greatly elevated in some breast cancers as they are in others, determined by the biologic aggressiveness; thus, the ability of MR spectroscopy to demonstrate abnormal choline levels in breast cancer has been variable ***(Yeung et al., 2002)***.

Multiple in vivo ^{1}H MR spectroscopy studies aimed at improving discrimination between benign and malignant breast lesions have been performed at several centers ***(Jacobs et al., 2004)***.

In addition to being used for breast cancer diagnosis, in vivo ^{1}H MR spectroscopy has also been used to monitor breast cancer response to chemotherapy ***(Jagannathan et al., 2001 and Meisamy et al., 2004)***.

Aim Of Work

Our aim of work is to evaluate the diagnostic performance of magnetic resonance spectroscopy in patient with suspicious breast mass.

Anatomy Of The Female Breast

The breast is a modified, differentiated apocrine sweat gland with a functional purpose of secreting milk during lactation. It is located in the superficial tissues of the anterior chest wall. The surface of the breast is dominated by the nipple and the surrounding areola ***(Glenn, 2001)***.

The mature breast has an eccentric configuration, with the long axis diagonally placed on the chest wall largely over the pectoralis major muscle and extending into the axilla. The peripheral anatomic boundaries of the breast are not precisely defined, except at the deep surface where the gland overlies the pectoralis fascia. Superficially, the breast extends over portions of the serratus anterior muscle, laterally, inferiorly over the external oblique muscle and superior rectus sheath, and medically to sternum ***(Rosen, 2001)***.

The protuberant part of the human breast is generally described as overlying the 2^{nd} to the 6^{th} ribs, and extending from the lateral border of the sternum to the anterior axillary line. Actually, a thin layer of mammary tissue extends considerable farther from the clavicle above to the 7^{th} or 8^{th} ribs below, and from the midline to the edge of latissimus dorsi muscle posteriorly ***(Russell et al., 2000)***.

The Axillary Tail:

The axillary tail of the breast (tail of Spence) is a breast extension towards the lateral margin of the chest and into the axilla. It has a duct which drains into the ductal system of the major gland. In some normal cases it is palpable, and in a few it can be seen premenstrually or during lacation. A well-developed axillary tail is sometimes mistaken for a mass of enlarged lymph nodes or a lipoma ***(Russell et al., 2000 and Hendriks et al., 2002)***.

The Internal Structure Of The Mammary Gland:

The normal adult female breast (Fig.1) is composed of a mixture of epithelial and stromal elements with variable adipose tissue typically present in the interlobular stroma, and not amongst the lobules. The epithelial elements are glandular tissue or tubulo-alveolar type consisting of a series of branching ducts which connects the structural and functional units of the breast, the lobules, to the nipple. The stroma is composed of variable amounts of adipose tissue and fibrous tissue, and comprise the majority of the breast volume in the non lactational state. The relative abundance of parenchyma and stroma varies according to age, parity and other factors ***(Hayes, 2000)***.

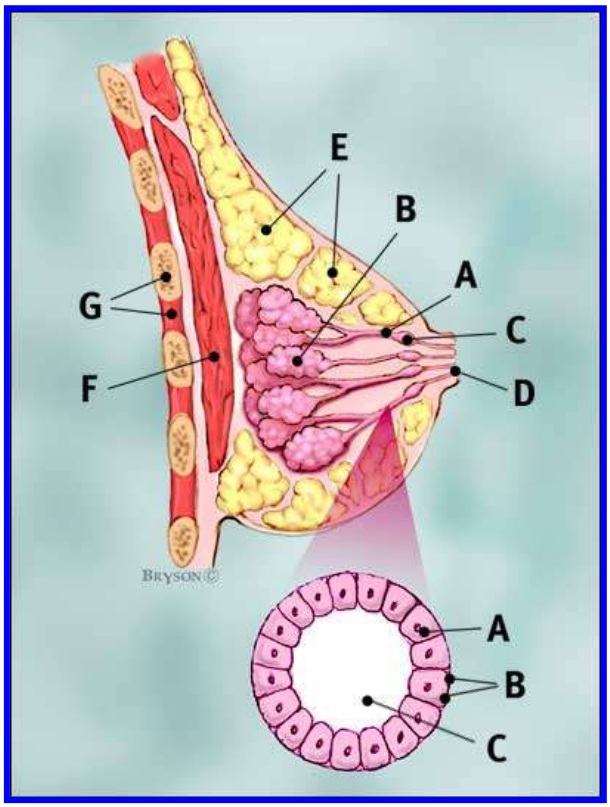

Figure 1: Sagittal section of the breast and anterior thoracic wall showing the basic anatomy of the breast ***(Quoted from Moore et al., 1999)***.

Breast profile:
A) Ducts
B) Lobules
C) Dilated section of duct to hold milk
D) Nipple
E) Fat
F) Pectoralis major muscle
G) Chest wall/rib cage

Enlargement:
A) Normal duct cells
B) Basement membrane
C) Lumen(center of duct)

The mammary gland (mamma = breast) consists of 15-20 lobes or segments, separated by adipose tissue. The amount of adipose tissue, not the amount of milk produced, determines the size of the breast.

Each lobe is drained by one lactiferous duct (lact = milk, ferre = to carry). Lactiferous ducts run dorsally in long axis of the nipple, enveloped in an areolar cuff, and then spread radially. Two or three lactiferous ducts unite to form a total of five to eight lactiferous sinuses which exit at the nipple ***(Hendriks et al., 2002)***.

The lobule is the basic structural unit of the mammary gland. Each lobe contains hundreds of lobules, composed of grape like clusters of milk-secreting glands termed alveoli (alveolus= small cavity) embedded in connective tissue. Surrounding the alveoli are spindle shaped cells called myoepithelial cells, whose contraction helps to propel milk toward the nipple ***(Hendriks et al., 2002)***.

Terminal ductal lobular unit (TDLU) is the basic histological unit. It consists of extra- and intra-lobular terminal ducts and the blind ending acinar ductules. The lobule consists of 25-35acini.

The acini are (milk producing) the glandular component of the breast lobules ***(Hendriks et al., 2002)*.**

The Ligaments Of Cooper:

Anatomically, the breast lies in a space within the superficial fascia. Superiorly this layer is continuous with cervical fascia and inferiorly with the superficial abdominal fascia of Cooper. Fibrous strands extend from the dermis into the breast, forming the suspensory ligaments which attach the skin and nipple to the breast. Cooper's ligaments are more extensive in the upper part of the breast. Cooper's ligaments are hollow conical projections of fibrous tissue filled with breast tissue , the apices of the cones being attached firmly to the superficial fascia and thereby to the skin overlying the breast. They are considered to be the fibrous "skeleton" supporting the breast glandular tissue. Distortion or contraction of the suspensory ligaments by parenchymal lesions may be manifested by skin dimpling or nipple retraction ***(Glenn, 2001)***.

Two-thirds of the breast rests on the deep membranous layer of the superficial fascia of the pectoral fascia overlying the pectoralis major, the other 3rd rests on the fascia covering the serratus anterior muscle. Between the breast and these fasciae is a potential space, the retro-mammary or sub-mammary space (bursa), which contains a loose adipose and connective tissue allowing the breast some degree of movement on the pectoral fascia. Extensions of the membranous superficial fascia that traverse the retro-mammary space act as posterior suspensory ligaments. Neoplastic or inflammatory

infiltration of the retromammary space is associated clinically with fixation of the breast to the chest wall ***(Glenn, 2001)***.

The Nipple:

The nipple is covered by thick skin (stratified squamous epithelium) with corrugations; it is un-pigmented in the pre-pubertal breast. Melanin pigmentation develops after menarche, increasing during pregnancy, and persists to a variable degree thereafter. Near its apex lie the orifices of the lactiferous ducts. The nipple contains smooth muscle fibers arranged concentrically and longitudinally, thus, it is an erectile structure which points outwards. Sebaceous glands are present in the skin of the nipple ***(Glenn, 2001)*.**

The Areola:

The areola (A-RE-O-La = small space) is a ring of skin surrounding the breast nipple that undergoes pigmentary changes similar to the nipple. It contains involuntary muscles arranged in concentric rings as well as radially in the subcutaneous tissue. The areolar epithelium contains numerous sweat glands and sebaceous glands, the latter of which enlarge during pregnancy and serve to lubricate the nipple during lactation (Montgomery's glands). These glands atrophy after menopause. The glands of Montgomery are modified sebaceous glands that open on the surface of the areola via the tubercles of Morgagni. The later structures are visible, especially during pregnancy, around the base of the nipple ***(Glenn, 2001)***.