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# THE NEW ERA OF BREAST ULTRASONOGRAHPY: HIGH FREQUENCY

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## Abstract

High-Frequency Ultrasonography is a recent advance in Ultrasonography. It allows improving spatial resolution reducing penetration of ultrasound beam. This facility allows studying more accurately cutaneous diseases, blood vessels wall and eyes anatomy. However it could be useful also to evaluate breast superficial lesion, cutaneous involvement in breast cancer and several cutaneous diseases of nipple and breast.

In our experience, HFU allows optimal definition of cutaneous layers of pre-mammary zone, when compared to conventional ultrasonography, offering an optimal tool for better assessing superficial layers diseases of breast and pathologies involving pre-mammary zone.

**Key words:** high frequency ultrasonography, breast cancer

## Introduction

In last years, advances in diagnostic imaging were made possible by developing new technologies first applied on animal models only in preclinical settings [1;2] ; indeed small animals investigations allowed the development of more powerful systems, such as ultra-high-frequency ultrasonography (HFU).

The availability of ultra high-frequency US probes equipped with Color-Doppler permits an easy, advanced and non invasive evaluation of a variety of superficial targets within the first centimeter of the skin surface; HFU has improved spatial resolution although the reduced depth of penetration. Primary application of this new technology is in the evaluation of cutaneous diseases, blood vessel wall and eye [3]. However, an amazing HFU's utility are the study of superficial breast diseases with skin or first order ductal involvement [4], of breast lesions with subcutaneous involvement, the analysis of very superficial structures [5], such as the nipple-areolar complex and very small lesions. So, actually, HFU represents a valid completion of a conventional breast ultrasonography, conducted by an experienced breast radiologist [6], leading to a decrease in errors number during conventional ultrasound examinations. In this way, it could reduce the numbers of invasive procedures like biopsies and fine needle aspirations [7], resulting in lower costs and less anxiety for patients [8].

Moreover, ultra-high-frequency US could be useful as guide to biopsy superficial lesions of the breast [9]. Potential indications of this technique are the measurement of thickness, invasion depth, evaluation of breast and/or skin tumors borders and post-surgery follow-up, skin thickening or retraction assessment, inflammatory carcinoma, papillary lesions, Paget disease or dermatologic diseases of the breast. It could be also useful in monitoring of topical and systemic drugs effects also in hereditary syndromes with breast involvement, such as gynecomastia in Peutz-Jeghers syndrome [10; 11]. In our institution, we conducted experimental studies with the first ultra-high-frequency US system available today for clinical routine (Vevo MD; FUJIFILM VisualSonics, Amsterdam, the Netherlands; with a 48–70-MHz linear-array transducer). Our experience underlined the HFU capability in improving spatial resolution as fine as 30 µm. We analyzed and compare ability of conventional US with respect to HFU in imaging normal ultrasonography anatomy of the breast skin, the axilla, the nipple-areola complex and retro-areolar ducts

HFU allows to highlights the different layers of the skin. Cutaneous and subcutaneous structures are represented by a succession of hypo and hyperechoic bands. Epidermis is a hypoechoic line, the dermis, indeed, a hyperechoic band, less shiny than epidermis and subcutaneous tissue a hypoechoic outer interrupted by hyperechoic longitudinal structures corresponding to fibrous septa. In the axilla, there are also hypoechoic structures arranged obliquely, corresponding to hair follicles; depending on the stage of the hair cycle, these structures might be in the dermis or subcutaneous tissue. The nipple skin is similar to the areola, but without sebaceous glands and subcutaneous tissue. It has 10 to 20 pores corresponding to the output of the main ducts [12; 13; 14]. It appears as a hypoechoic structure at skin surface that occasionally produces an intense acoustic shadow due to the connective tissue; the areolar muscle fibers have two directions: radial (muscle of Meyerholz) and circular (muscle of Sappey) 4]. HFU provides more detailed information concerning the anatomy of the pre-mammary zone (skin and overlying breast fat, in particular breast skin thickness and absence of hair follicles in the areola skin) and of the sub-areolar region [14]. For these reasons, we believe that the use of high-frequency transducers should increase for women with nipple discharge. In addition, ultrasonography showed the superficial layer of superficial fascia in the subcutaneous adipose tissue, and its thick turning point, key structures of the periareolar area. Some authors believe, indeed, that it is important to suture the SLSF securely, and that the suture should include the thick turning point to reduce scar widening and hypertrophy at the periareolar incision [15]. In conclusion, HFU promises for addressing important biomedical applications offering unique advantages over the existing non-invasive imaging modalities such us in other districts [16, 17]; it can be use in the evaluation of benign and malignant neoplasms, inflammatory diseases and infectious diseases [18]. Future goals for US trials need to include further validation studies, studies of diagnostic and therapeutic impact and longer-term outcomes from clinical and therapeutic decisions based on the US examinations.

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