

Breast MRI: Malignant Cystosarcoma Phyllodes Tumor Exhibits Unique Anisotropic Diffusion

Noam Nissan MD PhD¹, Uriel Ben-Aharon MD² and Ady Yosepovich MD³

¹Department of Chemical Physics, Weizmann Institute of Science, Rehovot, Israel

²Breast Surgery Unit, Meuhedet Clinic, Ashdod, Israel

³Breast Pathology Service, Sheba Medical Center, Tel Hashomer, Israel

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Malignant cystosarcoma phyllodes is a rare type of breast tumor that shares histopathological similarities with fibroadenoma, notably the dual constitution of glandular and stromal components. However, in contrast to fibroadenoma, phyllodes tumors have the capability for rapid growth and metastatic potential. Therefore, complete surgical excision with wide margins is the treatment of choice for both the benign and malignant variants of phyllodes breast tumor [1]. However, precisely differentiating between phyllodes breast tumors and fibroadenoma based on needle biopsy or conventional magnetic resonance imaging (MRI) features can be challenging [2].

Diffusion tensor imaging (DTI) is a non-invasive MRI approach that has been utilized for breast imaging in recent years, showing high efficacy for cancer diagnosis [3] as well as insensitivity to common hormone-regulated drawbacks of dynamic contrast-enhanced (DCE) MRI [4]. By measuring the diffusion in multiple well-defined directions, DTI can extend the averaged information acquired by diffusion-weighted imaging (DWI) to reveal an anisotropic (direction dependence) diffusion process in accordance with the underlying microstructural architecture. Indeed, DTI enables mapping of the three-dimensional anisotropic diffusion

process within a voxel, determining the diffusion coefficients in the free direction – λ_1 (parallel to neuronal tract or breast duct) and in the orthogonal directions – λ_2 and λ_3 (perpendicular to the neuronal tract or breast duct) where the diffusion is restricted by the microstructural boundaries. Moreover, based on the measured diffusion coefficients, the fractional and maximal anisotropy (λ_1 - λ_3) indices (FA and MA, respectively), which quantify the level of anisotropy, can be calculated and mapped [5].

Thus far, reports on the diffusion properties of phyllodes tumors were limited to DWI studies. We present here the case of a patient with malignant cystosarcoma phyllodes, scanned with DTI sequence to reveal the unique anisotropic diffusion properties of this tumor.

PATIENT DESCRIPTION

A 62 year old woman presented to the breast clinic complaining of a large hard lump in the right breast that was evident on palpation. A radiological workup including mammography and ultrasound examinations was conducted, followed by a biopsy that confirmed the diagnosis of malignant cystosarcoma phyllodes with a high mitotic index. A preoperative MRI examination was required for surgical planning. The patient was offered and agreed to participate in our institutional breast DTI study which was approved by Meir Hospital's ethics committee, and she signed an informed consent.

MRI was performed on a 3 Tesla scanner equipped with breast coil (Siemens, Germany). Protocol included conven-

tional non-fat-suppressed anatomical T2-weighted and DCE sequences [5] and DTI protocol (scan duration 6:04 min) using fat suppression, applying the diffusion gradients (b values of 0 and 700 s/mm²) in 30 directions, with resolution 1.9 x 1.9 x 2.5 mm³. Image analysis was performed using the 3TP method (for DCE dataset) and DTI property software. DCE MRI revealed a 53 mm enhancing lesion in a central posterior aspect of the right breast, without further findings. Images and parametric maps are presented in Figure 1.

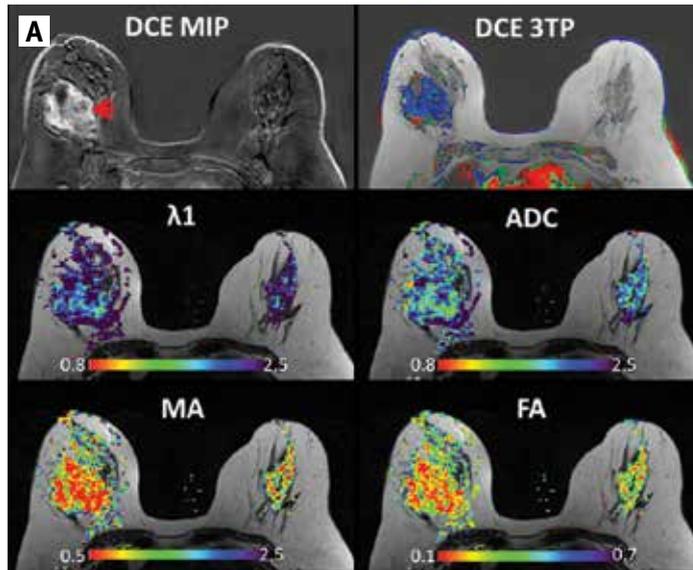
The patient underwent wide lumpectomy followed by oncoplastic reconstructive surgery using fat autologous grafting. According to our latest clinical and radiological follow-up one year later, she remains disease-free.

COMMENT

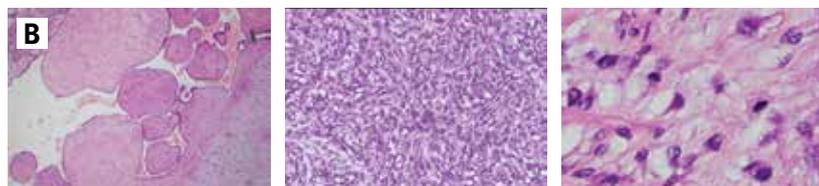
Phyllodes tumor of the breast usually appears as a round well-circumscribed mass that histopathologically resembles the basic structure of intracanalicular fibroadenoma, except for the intracystic projections and a greater degree of cellularity [1]. MRI is not able to efficiently differentiate between phyllodes breast tumors and fibroadenomas by unenhanced T1 and T2 weighted sequences or by DCE [2], and relatively high apparent diffusion coefficient (ADC) values were reported in a study that used strong diffusion gradients (high b values 0 and 1000 s/mm²) as compared to the range of ADC measurements in normal fibroglandular tissue [1].

In our examination the tumor is clearly seen on DCE images, exhibiting a continuous slow uptake of contrast agent without

Figure 1. MR and histopathology images of malignant cystosarcoma phyllodes tumor of the breast



[A] Imaging. Top panel: DCE maximal intensity projection (MIP) and 3-time point (3TP) revealed the tumor in the right breast (arrowhead). On the 3TP map and enhancement curve plot, the tumor exhibits graduated and constant increase in signal intensity (color intensity), without wash-out (hue intensity). Middle panel: λ_1 and ADC maps show relatively high diffusion values in the tumor region, similar to the values in the healthy fibroglandular tissue. Bottom panel: The tumor is clearly shown on MA and FA maps; the tumor region is characterized by markedly lower anisotropy values, as compared to the surrounding and contralateral healthy fibroglandular tissue. DTI maps are overlaid on the corresponding T2-weighted images. λ_1 , ADC and λ_1 - λ_3 are in units of $\times 10^{-3}$ mm²/s.



[B] Pathology. Representative hematoxylin and eosin-stained histopathological images in small, medium and large magnification (from left to right) showing the epithelial, stromal and cystic architecture of the tumor, the high cellularity and increased mitosis.

wash-out, a typical pattern of benign enhancement, such as anticipated for fibroadenoma. On DTI analysis, similar values of λ_1 (2.40 ± 0.58 and 2.47 ± 0.53 mm²/s) and of ADC (1.95 ± 0.46 and 1.85 ± 0.39 mm²/s) were found in the phyllodes and healthy contralateral tissues, respectively.

However, marked differences were found for the anisotropy indices; phyllodes tumor exhibited lower FA (0.23 ± 0.13) and MA values (0.88 ± 0.52 mm²/s) as compared with the healthy fibroglandular tissue (0.32 ± 0.13 and 1.20 ± 0.52 mm²/s, respectively). FA and MA parametric maps [Figure 1]

clearly demonstrate the shape of the tumor in agreement with the DCE images. The fact that the diffusivity of this phyllodes tumor is relatively high in spite of the known high epithelial cellularity suggests a dominant opposing low cellularity contribution of the cystic and stromal tissues, which we assume is close to free diffusion. Moreover, the tumor's lower anisotropy could also be explained by the restriction-free assumed diffusion in the cystic and stromal compartments.

To our knowledge, this is the first report on the DTI properties of phyllodes breast tumor. Uncharacteristic for both benign and malignant breast tumors, the diffusion parameters λ_1 and ADC that usually have the most diagnostic utility failed to detect this tumor, whereas the two anisotropy indices revealed the tumor in agreement with DCE, suggesting a possible adjunct clinical use for anisotropy parameters in the diagnostic workup of suspected phyllodes tumor.

Correspondence

Dr. N. Nissan
 Dept. of Chemical Physics, Weizmann Institute of Science, Rehovot 76100, Israel
Phone: (972-8) 934-2024
email: noamniss@gmail.com

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“A man is a success if he gets up in the morning and gets to bed at night, and in between he does what he wants to do”

Bob Dylan (b. 1941), American singer-songwriter, artist and writer, who influenced popular music and culture for more than five decades. His most celebrated work dates from the 1960s when his songs chronicled social unrest, such as “Blowin’ in the Wind” and “The Times They Are a-Changin’” which became anthems for the American civil rights and anti-war movements