Appreciable Challenges in Breast Imaging

SY22-1

Perfusion MRI

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1) Conventional contrast enhanced MRI analysis

- subjective evaluation of signal enhancement curves

- characterized by high spatial and low temporal resolution of 90–120 sec

- no quantifiable measurements

2) Perfusion MRI

- high temporal resolution : about less than 10 seconds

- quantitative analyses ; pharmacokinetic parameters that directly reflect the physiological properties of tissues, including vessel permeability, perfusion and the volume of extravascular/extracellular space (EES):

- several parameters

; K^{trans} (min^{-1}, volume transfer constant from blood plasma to EES) – composite measure of permeability, capillary surface area and flow

; k_{ep} (min^{-1}, rate constant from EES to plasma)

; v_e (ml/100ml of tissue; %, volume of EES per unit volume of tissue)

; iAUC (mM.s, initial area under the concentration curve in 60 seconds) – similar measure to K^{trans} but also influenced by v_e

; v_p (blood plasma volume) – relatively poor reproducibility

3) Clilnical Researches

- Differentiation of Benign and Malignant Tumors

- Correlation with Prognostic Factors

- Clinical trials of antivascular therapies

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Keywords : Dynamic Contrast Enhanced MRI

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SY22-2

Diffusion MRI

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The concept of diffusion magnetic resonance (MR) imaging came out in the mid-1980s and it had been used in neurologic images for many years. However, diffusion MR imaging has rapidly expanded its application in oncology as it is usually useful to investigate the detection of malignant lesions or metastasis. Now diffusion MR is routinely recommended in the breast cancer staging MR and there have been many papers about it. When I searched the articles about "breast diffusion MR" in the PubMed site from Jan 1 2010 to Dec 31 2016, I found total 217 articles. Among them, 54 out of 217 were published in 2016.

In this session, I'd like to firstly introduce the recent common themes of diffusion study for breast imaging;

* *Clinical applications of diffusion MR in the breast imaging,*

* *Intravoxel incoherent motion (IVIM) diffusion,*

* *Diffusion kurtosis MR*

* *Diffusion tensor imaging (DTI).*

However, most of studies were associated with apparent diffusion coefficient (ADC) values or fusion with other imaging findings such as the ^{18}F-fluorodeoxyglucose-positron emission tomography (^{18}F-FDG-PET) or dynamic contrast-enhanced (DCE) breast MR. Among these many researches, I'll show some "Appreciable challenges in breast imaging" were selected from the core clinical journals arranged by PubMed for last three years.

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Keywords : Diffusion, Breast, Intravoxel incoherent motion, Diffusion kurtosis

Appreciable Challenges in Breast Imaging

SY22-3

Magnetic resonance electric properties tomography (MREPT)

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Conductivity reflects the amount of current induced by an applied electric field and exhibits frequency-dependent behavior since tissues are heterogeneous substances consisting of insulating cell membranes and conducting electrolytes (1-3). Magnetic resonance electric properties tomography (MREPT), a method of imaging conductivity using a MRI system was recently demonstrated that conductivity measures can be used to differentiate breast cancer from benign tissue and to differentiate invasive breast cancer from ductal carcinoma in situ (4,5). In addition, conductivity showed an independent negative correlation with the human epidermal growth factor receptor 2 (HER2) overexpression subtype (6). These prior studies formed the initial basis for evaluating the clinical application of conductivity in the field of breast cancer imaging. In this talk, the brief review of the basic idea of MREPT and recent two studies where MREPT was used to correlate with the characteristics of breast cancer will be covered.

The correlation between electric conductivity and traditional biomarkers for prognostic factors would noninvasively provide helpful information for understanding tumor biology and predicting prognoses in patients with breast cancer. Moreover, the correlation between electric conductivity and other known MR characteristics of breast cancer such as diffusion weighted imaging would be also helpful for understanding tumor characteristics.

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Keywords : Conductivity, Electric property, Breast Cancer, MR

Appreciable Challenges in Breast Imaging

SY22-4

MR Spectroscopy vs. PET/CT: Prediction of Response to NAC in Breast Cancer

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Neoadjuvant chemotherapy (NAC) prior to surgery is not only the recommended standard treatment for locally advanced breast cancer [1], but is also used in patients with operable breast cancers in order to increase breast-conservation rates [2]. In this regard, it has previously been shown that achieving pathologic complete response (pCR) after NAC is significantly associated with favorable disease free survival outcomes [3]. However, as 20% of patients are resistant to NAC, prediction of its response at the initial cycles, which would allow the treatment to be modified in non-responders, would be of great clinical significance [4]. Indeed, a recent study has reported that the survival rates of non-responders to initial NAC who responded to a different regimen, was similar to that of responders to the initial regimen [5].

For the prediction of pCR at the early cycles of NAC, tumor size or volume change measured on contrast-enhanced magnetic resonance imaging (MRI) has been demonstrated to be superior to clinical assessment [6]. However, as the changes of tumor size after treatment usually occur after the 2nd cycle of NAC [7], earlier predictors reflecting angiogenesis, metabolic activity, or tumor cellularity, which may show change before tumor shrinkage, have been explored. 18F-fluoro-deoxy-glucose (FDG)-positron emission tomography (PET) has been reported to show 65-88% accuracy in the prediction of pathologic response after the first or second cycle of NAC [8, 9]. In addition, greater total choline-containing compounds (tCho) signal changes of the tumor at in vivo 1H MR spectroscopy (MRS) has been observed in patients with pCR than with non-pCR also after only the first or second cycle of NAC [10-12]. Furthermore, Tozaki et al. reported that the changes in the integral value of the tCho peak at MRS were correlated with those of peak standardized uptake values (SUVs) at FDG-PET, both during and following NAC cycles (13).

In this lecture, I will present results of our prospective study to compare MRS and FDG-PET/CT in the prediction of response to NAC and review the results of ACRIN 6657 trial.

Keywords : Breast neoplasm; Magnetic resonance imaging; Magnetic Resonance Spectroscopy; Positron-Emission Tomography; Neoadjuvant chemotherapy