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Role of 3T multiparametric-MRI with BOLD hypoxia imaging for diagnosis and post therapy response evaluation of postoperative recurrent cervical cancers

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ABSTRACT

Objectives: To assess the diagnostic value of multiparametric-MRI (MPMRI) with hypoxia imaging as a functional marker for characterizing and detecting vaginal vault/local recurrence following primary surgery for cervical cancer.
Methods: With institutional review board approval and written informed consent 30 women (median age: 45 years) from October 2009 to March 2010 with previous operated carcinoma cervix and suspected clinical vaginal vault/local recurrence were examined with 3.0T-MRI. MRI imaging included conventional and MPMRI sequences [dynamic contrast enhanced (DCE), diffusion weighted (DW), 1H-MR spectroscopy (1HMRS), blood oxygen level dependent hypoxia imaging (BOLD)]. Two radiologists, blinded to pathologic findings, independently assessed the pretherapy MRI findings and then correlated it with histopathology findings. Sensitivity, specificity, positive predictive value, negative predictive value and their confidence intervals were calculated. The pre and post therapy conventional and MPMRI parameters were analyzed and correlated with response to therapy.
Results: Of the 30 patients, there were 24 recurrent tumors and 6 benign lesions. The accuracy of diagnosing recurrent vault lesions was highest at combined MPMRI and conventional MRI (100%) than at conventional-MRI (70%) or MPMRI (96.7%) alone. Significant correlation was seen between percentage tumor regression and pre-treatment parameters such as negative enhancement integral (NEI) ($p = 0.02$), the maximum slope ($p = 0.04$), mADC value ($p = 0.001$) and amount of hypoxic fraction on the pretherapy MRI ($p = 0.01$).
Conclusion: Conventional-MR with MPMRI significantly increases the diagnostic accuracy for suspected vaginal vault/local recurrence. Post therapy serial MPMRI with hypoxia imaging follow-up objectively documents the response. MPMRI and BOLD hypoxia imaging provide information regarding tumor biology at the molecular, subcellular, cellular and tissue levels and this information may be used as an appropriate and reliable biologic target for radiation dose painting to optimize therapy in future.

1. Introduction

Cervical carcinoma is the third most common gynecologic malignancy. Approximately 85% of the global burden is from developing countries, where it accounts for 13% of all female cancers [1]. Even though there have been significant advances in surgical techniques, radiotherapy, and chemotherapy, still approximately 30% of patients with invasive cervical carcinoma die as a result of residual or recurrent disease [2].

Survival has improved with advances in the management of these patients with additional radiation therapy or chemotherapy,

Abbreviations: MPMRI, multiparametric-MRI; DCE, dynamic contrast enhanced; DWI, diffusion weighted imaging; 1HMRS, proton magnetic resonance spectroscopy; BOLD, blood oxygen level dependent; NEI, negative enhancement integral; ADC, apparent diffusion coefficient; PD-IDEAL, proton density iterative decomposition of water and fat with echo asymmetric and least-squares estimation.

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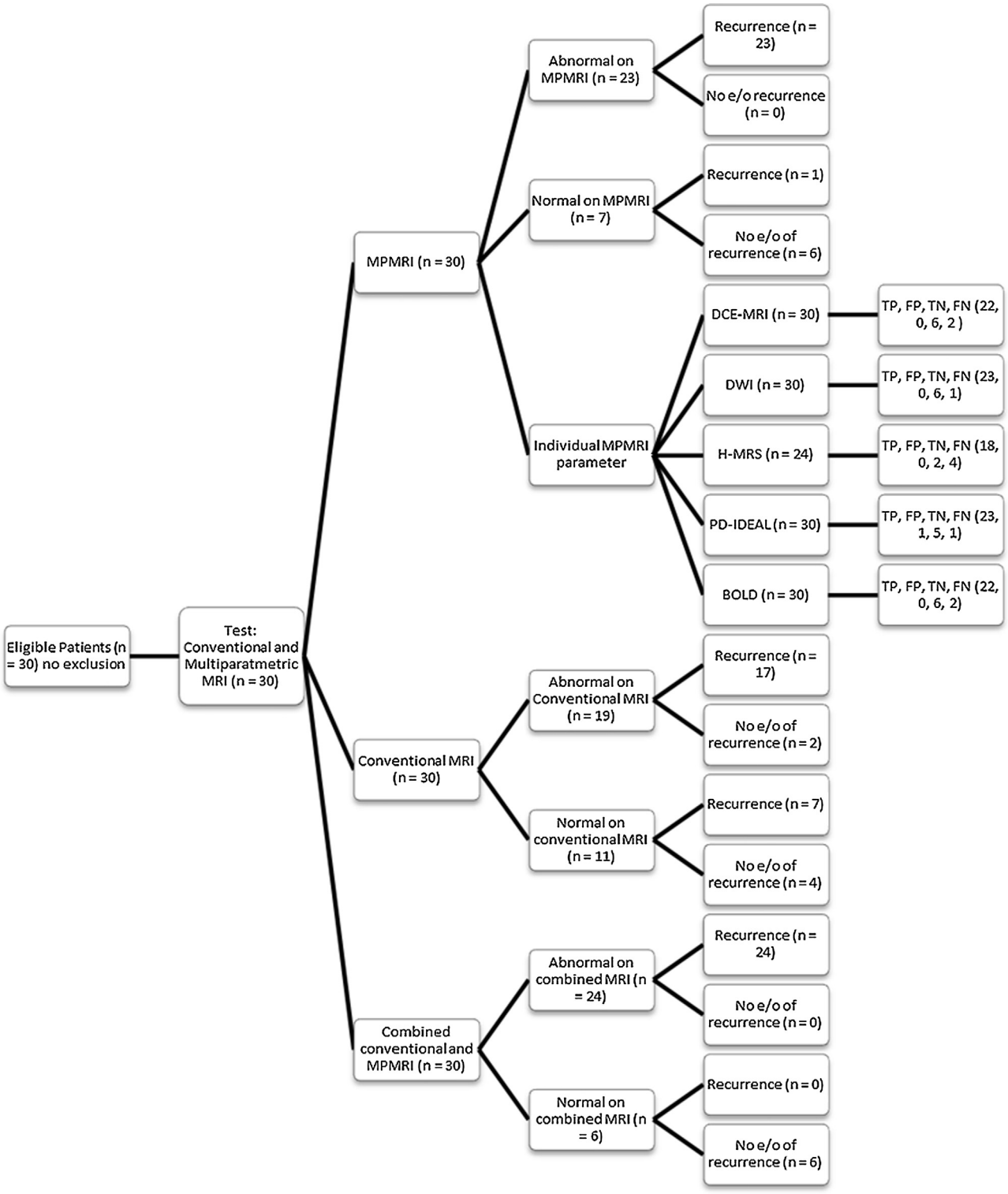

Fig. 1. Diagnostic flowchart of patient population.

still early detection of recurrent cervical carcinoma is imperative. The follow-up after primary therapy is usually performed with clinical examination and imaging {computed tomography (CT) or magnetic resonance imaging (MRI)} [3,4]. Because of the wide availability and certain advantages, such as rapid acquisition time, lack of bowel motion artifact, and fewer contraindications than MRI, CT is most widely used for follow up and is a diagnostic tool for detection of recurrence [3]. However, the value of CT in differentiating recurrence from postoperative changes/post radiation fibrosis is limited [3,4]. Fewer studies exist in literature to confirm the usefulness of MRI over CT for diagnosis of recurrent cervical carcinoma and differentiating it from radiation fibrosis [3,4,5].

Combined anatomic and physiologic information at multiparametric MRI (MPMRI) with BOLD hypoxia imaging makes it an interesting tool for detection and grading of tumors. MPMRI has been extensively used in diagnosing and characterizing pro-