Role of Susceptibility Weighted Imaging in Evaluation of Gynecological Diseases

Thesis

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List of Abbreviations

Abb.	Full term
ADC	*Apparent Diffusion Coefficient*
DWI	*Diffusion Weighted Images*
EPI	*Echo-Planar Imaging*
HASTE	*Half-Fourier Acquisition Single-Shot Turbo Spin-Echo*
MRI	*Magnetic Resonance Imaging*
MS	*Multi-Shot*
RF	*Radio-Frequency*
SNR	*Signal to Noise Ratio*
SS	*Single Shot*
SWI	*Susceptibility Weighted Imaging*
TM	*Trademark*
TSE	*Turbo Spin Echo*

INTRODUCTION

Magnetic resonance imaging (MRI) is a rapidly evolving imaging modality, which over the last decade with the development of increasingly faster sequences and methods of image processing was used in the evaluation of gynecological diseases. Newer techniques introduced in the pelvic MRI such as susceptibility-weighted imaging (SWI), spectroscopy, diffusion-weighted imaging, and functional imaging have future applications ***(Reston, et al., 2006).***

Susceptibility-weighted imaging (SWI) is an MRI sequence which is particularly sensitive to compounds which distort the local magnetic field and as such make it useful in detecting blood products, calcium etc. It has been used in imaging of central nervous system and recently in body and pelvis imaging too ***(Wu et al., 2009).***

SWI uses a fully flow compensated, long echo, gradient recalled echo (GRE) pulse sequence to acquire images. This method exploits the susceptibility differences between tissues and uses the phase image to detect these differences. The magnitude and phase data are combined to produce an enhanced contrast magnitude image which is exquisitely sensitive to venous blood, hemorrhage and iron storage (***Deistung et al., 2008).***

The magnetic susceptibility effects generated by local inhomogeneity of the magnetic field are visualized as signal voids. SWI not only detects subacute blood products like methemoglobin, but also acute and chronic blood products such as deoxyhemoglobin and hemosiderin ***(Krishnan et al., 2015).***

SWI is sensitive for the presence of hemorrhage within various gynecologic pathologies and helpful for the differential diagnosis such as: Hemorrhagic ovarian cysts, Endometriosis, Ectopic pregnancy, Hemorrhagic Uterine pathologies (Adenomyosis with hemorrhagic foci, Leiomyomas with red degeneration, with hemorrhagic necrosis, and Placental polyp with hemorrhagic foci) ***(Krishnan et al., 2015)***.

Hemorrhagic ovarian cysts show high signal intensity on T1WI and high signal intensity on SWI (water-like pattern). No flow voids along the cyst wall is observed on SWI. Acute intra-cystic hemorrhage may show low intensity both on T1WI (no methemoglobin) and SWI (due to deoxyhemoglobin). Because SWI is sensitive to a small amount of hemorrhagic contents, SWI may be able to differentiate mucinous cysts from hemorrhagic cysts both exhibiting high signal intensity on T1WI ***(Rajkotia et al., 2006).***

Endometriosisis a common chronic disease affecting young women, repeated cyclic bleeding and rupture of endometriomas can cause severe pelvic adhesions and infertility, so early diagnosis is important for the adequate

treatment. Definite MR criteria are as follows: 1) Multiple T1-high cysts (multiplicity) and/or 2) T1-high /T2-low cyst (shading). However, some endometriomas do not meet the criteria, and it may be difficult to differentiate from other ovarian cystic masses ***(Takeuchi et al., 2015).***

Demonstration of hemosiderin deposition reflecting repeated cyclic hemorrhage is also useful for the diagnosis of extra-ovarian endometriosis such as urinary bladder, abdominal wall, etc. as tumor-like masses containing signal voids due to hemosiderin deposition on SWI. Peritoneal implants of endometriosis may appear as small hemosiderin depositions, which are well visualized by the presence of peritoneal fluid collection ***(Cimsit et al., 2016).***

Ectopic pregnancy may appear as complicated heterogeneous mass, which may contain acute, subacute, and chronic hemorrhage exhibiting marked low intensity on SWI. Acute peritoneal hemorrhage may also show low intensity on SWI ***(Yoshigi et al., 2006).***

Adenomyosis with hemorrhagic foci show punctate signal voids due to hemosiderin deposition scattered within adenomyosis. SWI is more sensitive for hemorrhagic foci than fsT1WI, and is useful in differentiating focal adenomyosis from physiologic contraction ***(Takeuchi et al., 2015).***

Red degeneration of uterine leiomyomas is hemorrhagic infarction due to venous obstruction, associated with pregnancy, or oral contraceptives is characterized by high intense rim on T1WI corresponding to strongly paramagnetic methemoglobin within obstructed veins which may appear at late phase of red degeneration. At early phase high intense rim on T1WI does not appear yet, however, low intense rim on T2WI/SWI corresponding to deoxyhemoglobin within obstructed veins may be observed. This low intense rim due to T2*-shortening effect by deoxyhemoglobin is more prominent on SWI ***(Byams et al., 2012)***.

AIM OF THE STUDY

The aim of study is to evaluate the role of susceptibility-weighted images in diagnosis of various gynecologic pathologies by the detection of the presence of internal hemorrhage at any stage.

Chapter 1

ANATOMY OF FEMALE REPRODUCTIVE SYSTEM

The uterus is a pear-shaped muscular organ. It is the site of menstruation, implantation of a fertilized ovum, development of the fetus during pregnancy, and labor. Before the first pregnancy, it measures approximately 3 inches long, 2 inches wide, and 1 inch thick **(Fig. 1)**. After a pregnancy, the uterus remains larger than before the pregnancy. After menopause, it becomes smaller and atrophies ***(Blackburn et al., 2011).***

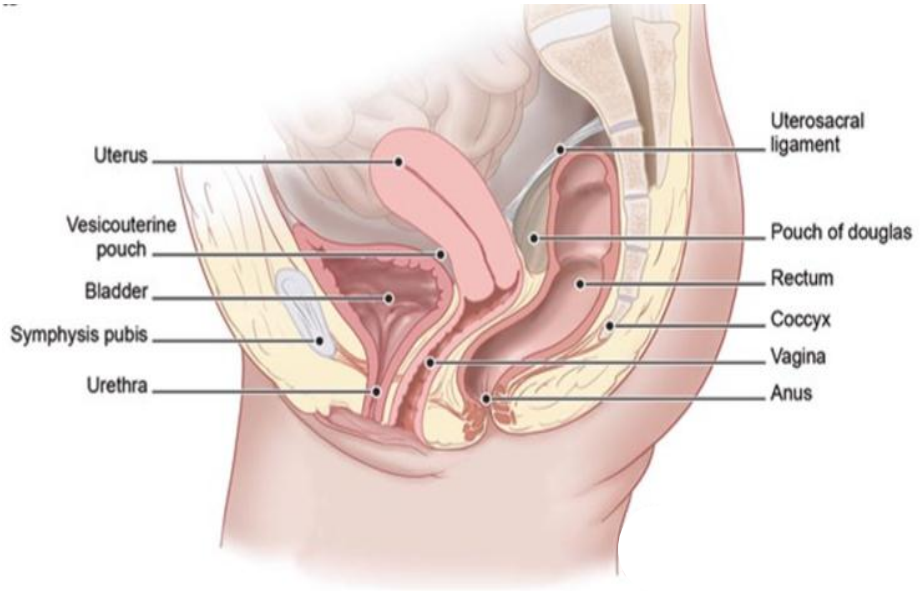

Fig. (1): Female reproductive organs ***(Blackburn et al., 2011).***