THE ROLE OF DIFFUSION-WEIGHTED MRI IN THE CHARACTERIZATION OF MUSCULOSKELETAL SOFT-TISSUE TUMORS

Essay

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بسم الله الرحمن الرحيم
وأنزل الله
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والحكمة
وعَلَّمَكَ مَا لَمْ
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Mohamed Ismail Deghedy

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List of Abbreviations

ADC ..... Apparent Diffusion Coefficient

AFIP..... Armed Forces Institutes of Pathology

AFX..... Atypical fibroxanthoma

AP..... Antero-posterior

ARMS ..... Alveolar Rhabdomyosarcoma

ASPS ..... Alveolar soft part sarcoma

CC ..... Cephalocaudal

CEHs..... Chronic Expanding Hematomas

CNS..... Central nervous system

CPMG..... Carr–Purcell–Meiboom–Gill

CSF ..... Cerebrospinal Fluid

DFSP ..... Dermatofibrosarcoma Protuberans

DSRCT ..... Desmoplastic small rounded cell tumor

DTI..... Diffusion Tensor Imaging

DWI..... Diffusion Weighted Imaging

EMC..... Extraskeletal mesenchymal chondrosarcoma

EPI ..... Echo Planer Imaging

ERMS ..... Embryonal Rhabdomyosarcoma

ETL..... Echo Train Length

FHT..... Fibrohistiocytic tumors

fMRI..... functional Magnetic Resonance Imaging

FOV..... Field Of View

FSE..... Fast Spin Echo

GIST..... Gastrointestinal stromal tumors

List of Abbreviations (Cont…)

GU ..... Genito-Urinary

IMT ..... Inflammatory myofibroblastic tumor

IV ..... Intravenous

LGMFS ..... Low grade malignant myofibroblastic sarcoma

MFH ..... Malignant Fibrous Histiocytoma

MIFS ..... Myxo-inflammatory fibroblastic sarcoma

mm2 ..... Square millimeter

MPG ..... Motion Probing Gradient

MPNST ..... Malignant Peripheral Nerve Sheath Tumor

MPR ..... Multi-planar Reconstruction

MR ..... Magnetic Resonance

MRI ..... Magnetic Resonance Imaging

MSK ..... Musculoskeletal

NOS ..... Not otherwise specified

NSRBC ..... Non Small Round Blue Cell

OFMT ..... Ossifying fibromyxoid tumor

PFHT ..... Plexiform fibrohistiocytic tumor

PHAT ..... Pleomorphic hyalinizing angiectatic tumor

PIDC ..... Perfusion Insensitive Diffusion Coefficient

PNET ..... Primitive Neuroectodermal Tumor

PWI ..... Perfusion Weighted Imaging

RARE ..... Rapid Acquisition With Relaxation enhancement

RF ..... Radio Frequency pulse

RMS ..... Rhabdomyosarcoma

List of Abbreviations (Cont…)

ROI ..... Region Of Interest

S..... second

SD..... Standard Deviation

SE ..... Spin Echo

SFT..... Solitary fibrous tumor

SI ..... Signal Intensity

SNR..... Signal-to-Noise Ratio

SPAIR..... Spectral Presaturation Attenuated Inversion recovery

SRBC ..... Small Round Blue Cell

SSCRG..... Site Specific Clinical Reference Group

SSFP..... Steady State Free Precession

STIR..... Short Tau Inversion Recovery

T ..... Tesla

T1 WI..... T1 Weighted Image

T2 WI..... T2 Weighted Image

TE..... Echo Time

TR ..... Repetition Time

TSE ..... Turbo Spin Echo

Vs..... Versus

WHO..... World Health Organization

ɣ ..... Proton Gyromagnetic Ratio

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ABSTRACT

Diffusion-weighted (DW) imaging is a functional magnetic resonance (MR) imaging technique that can readily be incorporated into a routine non–contrast material–enhanced MR imaging protocol with little additional scanning time. DW imaging is based on changes in the Brownian motion of water molecules caused by tissue microstructure. The apparent diffusion coefficient (ADC) is a quantitative measure of Brownian movement: Low ADC values typically reflect highly cellular microenvironments in which diffusion is restricted by the presence of cell membranes, whereas acellular regions allow free diffusion and result in elevated ADC values. Thus, with ADC mapping, one may derive useful quantitative information regarding the cellularity of a musculoskeletal lesion using a nonenhanced technique. The role of localized DW imaging in differentiating malignant from benign osseous and soft-tissue lesions is still evolving; when carefully applied, however, this modality has proved helpful in a subset of tumor types, such as nonmyxoid soft-tissue tumors. Successful application of DW imaging in the evaluation of musculoskeletal lesions requires familiarity with potential diagnostic pitfalls that stem from technical artifacts and confounding factors unrelated to lesion cellularity. Further investigation is needed to evaluate the impact of DW imaging–ADC mapping on management and outcome in patients with musculoskeletal lesions.

Keywords: Diffusion Magnetic Resonance Imaging; Soft Tissue Neoplasms; Differential Diagnosis.

INTRODUCTION

Soft tissue tumors usually present with unspecific clinical findings, such as palpable mass, tenderness and pain and sometimes with motion impairment and are therefore easily detected on clinical examination. However, the characterization of such masses remains a challenge for the clinician, because malignancies and benign tumors as well as non-neoplastic masses following inflammation or trauma, have a similar presentation ***(Andreas et al., 2007)***.

MRI is the modality of choice to evaluate such masses, because of its excellent soft tissue contrast. Although there are some findings on MRI which are indicative for malignancy, such as infiltration of adjacent tissues, destruction of bones and tendons, and the size of the mass, there are no criteria available to clearly distinguish benign masses from malignancies. On the contrary some very aggressive tumors present as an encapsulated mass without surrounding edema and only minimal contrast enhancement, findings, which are in general indicative for benign processes. Thus, histopathologic work up is required for reliable characterization of soft tissue masses ***(Andreas et al., 2007).***

Benign lesions are much more common than malignant lesions in daily practice. Therefore, we need diagnostic tools that

improve our diagnostic confidence and prevent unnecessary biopsies or surgeries. Diffusion-weighted imaging (DWI) is a noninvasive method for investigation of tumor histological content **(Pekcevik et al., 2015).**

DWI is an invaluable tool for identifying benign and malignant lesions in the body. It is generally hard to differentiate between benign and malignant soft tissue tumors from their signal intensities except for some soft tissue tumors that have unique MR imaging signal and localization such as lipoma, ganglion cyst etc. DWI MR has been applied to some soft tissue tumors and reported to be useful**. (Pekcevik et al., 2015).**

The tissue contrast attained using diffusion-weighted imaging (DWI) is different from that attained using conventional MR techniques. The DWI technique involves the diffusion motion of water protons in tissue, which produces different contrasts in different kinds of tissue and because of this, the procedure provides different information about diseased tissue. Recently, DWI was applied to characterize soft tissue tumors, differentiate between benign and malignant tumors, and determine treatment success in patients with sarcoma. The potential clinical application of DWI in musculoskeletal radiology is thought to be high ***(Nagata et al., 2008).***

It has been reported that DWI has the potential to differentiate benign and malignant soft-tissue tumors because

malignant tumors have greater cellularity and therefore have more restricted diffusion than benign tumors ***(Maeda et al., 2007)***.

Characterization with MR imaging is feasible in the typical manifestations (imaging and clinical) of some pseudotumors and benign neoplastic lesions, such as lipomas, hemangiomas, lymphatic malformations, peri-articular cysts, benign neural tumors, abscesses, and hematomas **(Navarro et al., 2009)**.

Conventional MR imaging is unable to offer information about the extent of tumoral necrosis and the presence of viable cells. Therefore, advanced MR imaging techniques, such as diffusion-weighted imaging (DWI), are now used in association with conventional MR imaging with the objective of improving diagnostic accuracy. DWI allows quantitative and qualitative analyses of tissue cellularity and cell membrane integrity and has been widely used for tumor detection and characterization ***(Koh and Collins, 2007).***

AIM OF WORK

The aim of this work is to evaluate the ability of Diffusion-Weighted MRI in the detection and characterization of the musculoskeletal soft tissue tumors.