The Role of Diffusion-Weighted MRI in the Characterization of Musculoskeletal Soft Tissue Tumors

Thesis

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بسم الله الرحمن الرحيم

قالوا

سبحانك لا علم لنا
إلا ما علمتنا إنك أنت
العليم الحكيم

صدق الله العظيم

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List of Abbreviations

Abbrev.	Full-term
ADC...............	Apparent Diffusion Coefficient
CEHs.............	Chronic Expanding Hematomas
DCE-MR.......	diffuse contrast enhanced –magnetic resonance
DWI...............	Diffusion Weighted Imaging
ECM..............	Extracellular matrix
EPI.................	Echo Planer Imaging
FOV...............	Field of view
FS...................	Fat saturated
FSE................	Fast Spin Echo
IM	Intramuscular myxoma
IV...................	Intravascular
LBC...............	lamellar body count
LPS................	Liposarcoma
MFH..............	Malignant Fibrous Histiocytoma
mm^2................	Square millimeter
MPG..............	Motion Probing Gradient
MR.................	Magnetic Resonance
MRI...............	Magnetic Resonance Imaging
MSK..............	Musculoskeletal
NSRBC..........	Non Small Round Blue Cell
PIDC..............	Perfusion Insensitive Diffusion Coefficient

PNET.............	Primitive Neuroectodermal Tumor
RMS...............	Rhabdomyosarcoma
ROC...............	Receiver operating characteristic
ROI................	Region of Interest
S......................	Second
SD...................	Standard Deviation
SI....................	Signal intensity
SNR................	Signal-to-Noise Ratio
SPSS..............	Statistical Program for Social Science
SRBCTs........	Small Round Blue Cell tumors
STIR..............	Short Tau Inversion Recovery
STM...............	soft tissue mass
STMs.............	Musculoskeletal soft tissue masses
T.....................	Tesla
T1 WI............	T1 Weighted Image
T2 WI............	T2 Weighted Image
TE..................	Echo Time
TR..................	Repetition Time
TSE................	Turbo Spin Echo
WHO.............	World Health Organization

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Abstract

Background: Magnetic resonance imaging (MRI) imaging has an important role in characterization of soft tissue tumors, yet, it lacks specificity for differentiation between benign and malignant lesions. **Aim of the Work:** The aim of this work is to evaluate the ability of DW MRI in detection and characterization of the musculoskeletal soft tissue tumors. **Patients and methods:** This prospective study included 30 patients (20 females and 10 males) referred to MRI unit Ain Shams University hospital for MRI evaluation of musculoskeletal soft tissue tumors. **Results:** From 30 cases, 12 cases were benign (40%), 18 cases malignant (60%). From 12 cases of the benign, 8 cases were ≤ 40 years and 4 cases were > 40. From 18 cases of the malignant, 7 cases were ≤ 40 and 11 cases > 40. Ranging of ADC value of benign tumors (1.72-2.58); mean ADC (2.21 $\times 10^{-3}$ mm^2/sec). Ranging of ADC value of malignant tumors was (0.52-1.82). Mean ADC value (0.90 $\times 10^{-3}$ mm^2/sec). Cut-off ADC value ≤ 1.14. Less than 1.14 was benign and more than 1.14 was malignant; sensitivity 94.4% and specificity 91.7%. **Conclusion:** DWI with ADC mapping and measurement of ADC value proved to be a valuable non –invasive tool in differentiating benign and malignant musculoskeletal soft tissue tumors. **Recommendations:** A larger population for future studies with more varieties of musculoskeletal soft tissue histologies.

Key words: diffusion-weighted MRI, musculoskeletal, soft issue, tumor

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Introduction

Musculoskeletal soft-tissue tumors are arising from ectodermal and mesodermal layers ***(David et al., 2011).*** They can generally be classified into two main categories, that is, soft-tissue sarcomas and benign tumors, and these tumors can occur at any age and present at any site ***(Pencavel et al., 2010).***

MRI is indispensable in the evaluation of soft tissue tumors and become modality of choice. It offers improved soft tissue contrast when compared to other modalities ***(Goldblum et al., 2013).***

There are some finding on MRI which are indicative for malignancy, such as infiltration of adjacent tissue destruction of bones and tendons and the size of mass, there are no criteria available to clearly distinguish benign mass from malignant, some very aggressive tumors present as encapsulated mass without surrounding edema and only minimal enhancement which are in general indicative for benign process. Thus, histopathologic work up is required for reliable characterization of soft tissue tumors ***(Andreas et al., 2007).***

The DWI now used in association with conventional MRI with the objective of improving diagnostic accuracy and treatment evaluation. DWI allow quantitative and qualitative analysis of tissue cellularity and cell membrane integrity and has been widely used for tumor detection and characterization to monitor treatment response ***(Koh and Collins, 2007).*** The tissue contrast using diffusion weighted image (DWI) is different from that attained using conventional MR technique.

The DWI involves the diffusion motion of water protons in tissue, which produces different contrast in different kinds of tissue, because of this procedure provide different information about diseased tissue ***(Nagata et al., 2008).***

DWI has the potential to differentiate benign from malignant soft tissue tumors because malignant tumors have greater cellularity with more restricted diffusion than benign tumors ***(Maeda et al., 2007).***

Aim of the Work

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

Pathology of Musculoskeletal Soft Tissue Tumors

Soft tissue can defined as non epithelial extra skeletal tissue of the exclusive of the reticuloendothelial system, glia and supporting tissue of various parenchymal organs. It is represented by the voluntary muscles, fat and fibrous tissue, along with the vessels serving these tissue.

Soft tissue tumors are highly heterogeneous group of tumors that are classified by the line of differentiation, according to the adult tissue they resample, lipoma and liposacromas for example are tumors that recapitulate to varying degree normal fatty tissue. Hemangioma and angiosarcomas contain cell resembling vascular endothelium.

Soft tissue tumors are usually divided into benign and malignant (Table 1).

-Benign tumors:

Which more closely resemble normal tissue have a limited capacity for autonomous growth. They exhibit little tendency to invade locally and are characterized by low rate of local recurrence following conservative therapy.

-Malignant tumors (sarcoma):

Are locally aggressive and are capable of invasive or distructive growth, recurrence and distant metastasis. Radical surgery is required to ensure the total removal of these tumors ***(Goldblum et al, 2013).***

Table (1): Classification of soft tissue tumors ***(Campanacci, 2013).***

Differentiation or histogenesis	Benign	Low-grade malignancy	High- grade Malignancy
Fibrous	Fibromatosis (subdermic, Digital, aponeurotic, congenital) Desmoid tumor	Grades1, 2 Fidrosarcoma Infantinal fibrosarcoma	Grades3, 4 fibrosarcoma
Fibrohistiocystic	Benign fibrous histiocytoma	Dermatofibrosarcoma protuberans Atypical fibroxanthoma	Malignant fibrous histiocytoma (pleomorphic storform, myxoid, giant cell, angiomatoid, histiocytic
Adipose	Lipoma (angiolipoma, Spindle-cell, pleomorphic, lipoblastomatosis, intrnervous, lipomatosis, hibernoma)	Liposarcoma (well differentiated, myxoid)	Liposarcoma (pleo-morphic, round cell, dedifferentiated)
Smooth muscular	Leiomoyma (vascular, deep)	Grade1, 2 leiomyosarcoma	Grade3, 4 Liomyosarcoma
Striated muscular	Rhabdomyoma (adult, fet al., genital, cardiac)		Rhabdomyosarcoma (embryonal, alveolar, pleomorphic)
Vascular	Angiomas and angiodysplasias Glomus tumor Epithelioid hemangioma Hemangiopericytoma	Low-grade hemangioendoth-elioma Kaposi's sarcoma Hemangiopericy-toma	High-grade hemangiomaendothelioma - Kaposi's sarcoma Hemangiopericytoma
Synovial			Synovial sarcoma
Nervous	Schwannoma Neurinofibroma		Malignant neurinoma Peripheral neuroepithelioma
Cartilaginous		Myxoid chondrosarcoma Synovial chondrosarcoma	Mesenchymal chondrosarcoma
Osseous			Osteosarcoma
Uncertain	Intramuscular Myxoma, Granular cell tumor		Malignant granular cell tumor Ewing sarcoma Alveolar sarcoma Epitheliod sarcoma Clear cell sarcoma of the tendons and aponeurosis