



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكرو فيلم

بسم الله الرحمن الرحيم



MONA MAGHRABY



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم



شبكة المعلومات الجامعية التوثيق الإلكتروني والميكروفيلم



MONA MAGHRABY



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات



يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار



MONA MAGHRABY



Comparison of a routine magnetic resonance imaging & T2* mapping of articular cartilage in knee osteoarthritis

Thesis

Submitted for partial fulfillment of M.D. degree in
Radiodiagnosis

BY

Shaimaa Shawky Mohamed Mousa

M.B., B., Ch, M. SC Radio-diagnosis
Ain Shams University

Supervised by

Prof. Dr. Mohsen Gomaa Hassan Ismail

Professor of Radio-diagnosis
Faculty of Medicine, Ain Shams University

Prof. Dr. Hossam Moussa Sakr

Professor of Radio diagnosis
Faculty of Medicine, Ain Shams University

**Ass. Prof. Dr. Mohamed Gamal Al-Din
Abdel-Motaleb**

Ass.Professor of Radio diagnosis
Faculty of Medicine, Ain Shams University

**Faculty of Medicine
Ain Shams University**

2020

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

قالوا

سبحانك يا معلم لنا
إلا ما علمتنا إنك أنت
العليم العظيم

صدق الله العظيم

سورة البقرة الآية: ٣٢

ACKNOWLEDGEMENT

*First and foremost, I feel always indebted to **Allah** for giving me the chance and power to be what I am.*

*I would like to express my deepest appreciation and gratitude to **Prof Dr. Mohsen Gomaa Hassan Ismail**, Professor of Radiodiagnosis Faculty of Medicine, Ain shams University, who is under his kind supervision this work was produced.*

*I am extremely indebted to **Prof Dr. Hossam Moussa Sakr**, Professor of Radiodiagnosis Faculty of Medicine, Ain shams University, for his close precious help, continous supervision, and fruitful guidance.*

*I am deeply thankful to **Ass.Prof Dr. Mohamed Gamal El-Din Mansour**, Assistant Professor of Radiodiagnosis Faculty of Medicine - Ain Shams University, for his kind care, constant help and great assistance throughout this work.*

Last but not least, this thesis is dedicated to the soul of my father, and my beloved family as a whole, I'm so thankful for their continuous love and support.

Dr. Shaimaa Shawky

List of Contents

Title	Page No.
List of Figures.....	i
List of Abbreviations	iii
Introduction.....	1
Aim of the Work	3
Review of Literature	
Anatomy	4
Pathology	29
Patients and Methodology	48
Results.....	51
Illustrative Cases.....	65
Discussion.....	90
Summary & Conclusion	94
References.....	96
Arabic Summary	1

List of Figures

Fig. No.	Title	Page No.
Fig. (1):	Right knee deep structures posterior view	6
Fig. (2):	Anatomy of the patella.....	7
Fig. (3):	Right tibial, femoral and patellar articular surfaces	9
Fig. (4):	Anterior and posterior surfaces of te right patella.....	10
Fig. (5):	superior surface of the tibia shows menisci.....	12
Fig. (6):	Capsular ligaments of the knee.....	15
Fig. (7):	The attachment of the knee joint	17
Fig. (8):	Synovial membrane of the knee joint.....	19
Fig. (9):	Arterial supply of the knee.....	22
Fig. (10):	Anatomy of the knee joint in MRI sagittal image.....	24
Fig. (11):	Coronal PD MR image in a young male with arthroscopically normal patellar articular cartilage	24
Fig. (12):	Sagittal sections show normal Cruciate Ligaments	27
Fig. (13):	Normal MRI appearance of quadriceps & patellar tendons ...	29
Fig. (14):	Pathogenesis of osteoarthritis with risk factors.....	35
Fig. (15):	Schematic draw of the knee joint depicting tissues affected in OA	38
Fig. (16):	Chodrocytes synthesize collagen fibrils & proteoglycans.....	40
Fig. (17):	Negative ions attract positive counter ions and water molecule in articular cartilage.....	41
Fig. (18):	The Articular cartilage zones and the collagen fibrils orientations	42
Fig. (19):	The Pathogenesis of osteoarthritis	43
Fig. (20):	Illustrate articular cartilage in the left knee tibio-femoral articulation in healthy and OA patients	45
Fig. (21):	Pie-charts representing the Sex, lateralization & c/o distribution in study population	46
Fig. (22):	Illustrative charts representing the distribution of the cartilage lesions detected at the medial tibio-femoral compartment	52
Fig. (23):	Illustrative charts representing the distribution of the cartilage lesions detected at the lateral tibio-femoral compartment	54
Fig. (24):	Illustrative charts representing the distribution of the cartilage lesions detected at the patello-femoral compartment.....	56

Fig. (25):	The distribution of the cartilage lesions detected at the medial tibio-femoral, lateral tibio-femoral and patello-femoral compartments	58
Fig. (26):	The number and character of the cartilage lesions detected in conventional MRI and T2* mapping	60
Fig. (27):	Distribution of depth of the cartilage lesions	61
Fig. (28):	Illustrating diagrams representing the T2 relaxation time levels of cartilage lesions detected at both MRI & T2* mapping	62
Fig. (29):	Illustrating diagrams represent the T2 relaxation time levels of cartilage lesions detected only by T2* mapping.....	63
Fig. (30-33):	Case I illustrative images	65
Fig. (34):	Case II illustrative images.....	70
Fig. (35-39):	Case III illustartive images	73
Fig. (40-44):	Case IV illustrative images	80
Fig. (45-48):	Case V illustrative images	85

List of Abbreviations

Abb.	Full term
OA	Osteoarthritis
MRI	Magnetic resonance imaging
3.0T	3 Tesla
3 D	Three dimensional
PXR	Plain x-ray
ROI	Regions of interest
PD	Proton density
FSE	fast spin-echo
SPGR	spoiled gradient-echo sequence
ACL.....	Anterior cruciate ligament
PCL	Posterior cruciate ligament
PG	Proteoglycan
GAG.....	Glycosaminoglycan
ECM.....	Extra-cellular matrix
TIM	Total image matrix
d-GEMERIC.....	Delayed Gadolinium enhanced MRI of cartilage

INTRODUCTION

Osteoarthritis (OA) is multi-tissue, multi-factorial disease and a worldwide major cause of disability resulting from reduced joint mobility and function. Progressive loss of articular hyaline cartilage is one of the hallmark features of OA, initiated by loss of proteoglycans and an increase in water contents, followed by loss of type II collagen and a change in collagen fiber orientation (*Apprich et al., 2012*).

OA progression is usually graded based on plain radiographs, using joint space width, continuity of bony contours, and the presence and size of osteophytes as criteria. However these criteria do not help for detection of early cartilage changes. As articular cartilage has only limited capability of self-repair, an early diagnosis of cartilage degeneration and a sensitive non-invasive diagnostic tool are highly desirable (*Apprich et al., 2012*).

With advances in joint preservation surgery that are intended to alter the course of osteoarthritis by early intervention, accurate and reliable assessment of the articular cartilage status is critical (*Hesper et al., 2014*).

Magnetic resonance (MR) imaging has evolved rapidly owing to technical advances and the application of these to the field of clinical research. Cartilage imaging certainly is at the forefront of these developments (*Roemer et al., 2011*).

The development of magnetic resonance imaging has revolutionized the ability of physicians to directly assess the articular cartilage with a non-invasive modality. Despite this advancement, cartilage lesions, such as thin fissures, cartilage flaps, and shallow defects, remain difficult to be accurately evaluated with standard MRI (*Reed et al., 2013*).

T2* mapping is a good alternative because it combines the benefits of biochemical cartilage evaluation with remarkable features including short imaging time and the ability of high-resolution three-dimensional cartilage evaluation without the need for contrast media administration or special hardware (*Hesper et al., 2014*).

Aim of the work

To evaluate the detection and the size of the cartilage lesions in T2* mapping as compared to standard magnetic resonance imaging in knee osteoarthritis.

Anatomy of the knee joint

The knee joint is the largest and most complex joint in the human body; it can be conceptualized as two joints; tibio-femoral and patello-femoral articulations, stabilized by a combination of static ligaments, dynamic muscular forces, joint load, bony topography, and meniscocapsular aponeurosis **(Flandry & Hommel, 2011)**.

Gross Anatomy

The complex synovial knee joint plays an important role as it provides a range of movements (flexion, extension, and small degree of medial and lateral rotation) while supporting the body's weight. To do so, it is composed of different tissues such as bones (femur, tibia, and patella), strong ligaments, joint capsule, bursae, and articular fat pads **(Oliveira et al., 2016)**.

The structures in the knee joint will be discussed under the following sections:

- Osseous structures.
- Articular surfaces.
- Soft tissue structures including: menisci, ligaments, joint capsule, synovial membrane, muscles, bursae, and neuro-vascular structures.

Osseous anatomy:

The knee is consists of four bones: the femur, tibia, fibula, and patella. All of them are functional in the knee joint, except for the fibula.

- The Femur is the longest and strongest bone in the human body, its proximal end forms the head of the femur, which projects antero-supero-medially to articulate with the acetabulum, the distal end is wider and forms a double condyle that articulates with the tibia and patella.

The tibia articulates with the lateral and medial femoral condyles, while the patella articulates anteriorly in the inter-condylar fossa (trochlear groove) (**Kishner, 2017**).

- The Tibia which lies distal to the femur and medial to the fibula, the primary function of it is to transfer the body weight across the knee and to the ankle. Its proximal end consists of medial, lateral condyles, and intercondylar area, that articulates with the medial and lateral condyles of the femur. Distally, the tibia articulates with the ankle. The distal and proximal ends of the tibia articulate with the fibula. In addition, also the shaft of the tibia and fibula are connected with an interosseous membrane to form a syndesmosis joint (**Kishner, 2017**).