The role of high resolution ultrasound in the assessment of knee osteoarthritis

Thesis

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By

Samar Mohamed Ibrahim Shaaban

M.B.B.CH

Under Supervision of

Prof. Dr. Marwa Ibrahim Fahmy

Professor of Radiodiagnosis

Faculty of Medicine - Ain Shams University

Dr. Tarek Wahby Hemada

Lecturer of Radiodiagnosis

Faculty of Medicine - Ain Shams University

Ain Shams University

Faculty of Medicine

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تحت إشراف

الدكتورة/ مروة إبراهيم فهمي

أستاذ الأشعة التشخيصية

كلية الطب - جامعة عين شمس

الدكتور/ طارق وهبي حميدة

مدرس الأشعة التشخيصية

كلية الطب - جامعة عين شمس

جامعة عين شمس

كلية الطب

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List of Abbreviations

Abb.	Full term
ACL	Anterior cruciate ligament
AHLM	Anterior horn of lateral meniscus
AHMM	Anterior horn of medial meniscus
AP	Antero posterior
BME	Bone marrow edema
FCL	Fibular collateral ligament
FN	False negative
FP	False positive
HS	Highly significant
JSN	Joint space narrowing
MCL	Medial collateral ligament
MRI	Magnetic resonance imaging
NPV	Negative predictive value
NS	Non significant
OA	Osteoarthritis
PCL	Posterior cruciate ligament
PHLM	Posterior horn of lateral meniscus
PHMM	Posterior horn of medial meniscus
PPV	Positive predictive value
TN	True negative
TP	True positive
US	Ultrasound

ABSTRACT

Background: Osteoarthritis (OA) is a common musculoskeletal disease with high prevalence worldwide. Knee OA is primary diagnosed using conventional radiography, however, changes of articular cartilage or menisci cannot be directly assessed using conventional radiology. Ultrasound (US) can be used to assess soft tissue degeneration directly.
The Objectives: The aim of this study is to evaluate the efficacy of high resolution ultrasound (HRUS) in the assessment of structural abnormalities found in knee osteoarthritis.
Patients and Methods: The study was conducted upon 20 patients with knee OA (12 F, 8 M;
mean age 53 years), each subject was evaluated for the presence of medial and lateral femoral cartilage thinning, medial and lateral femoral and tibial osteophytes, medial and lateral meniscal degeneration, joint effusion and Baker's cyst using ultrasound and MRI, considering MRI as a reference standard.
Results: The overall sensitivity of the ultrasound in the detection of knee OA parameters was good (89.3%), the overall accuracy was excellent (90%), the overall specificity was excellent (93.1%). The positive predictive value (PPV) and the negative predictive value (NPV) were 98.3 and 65.9 respectively. The P value was highly significant (<0.01) when comparing assessment of knee osteoarthritis parameters between ultrasound and MRI.

Conclusion: Ultrasound assessment of the knee joint is an accurate imaging method for detection of knee osteoarthritis parameters including medial and lateral femoral articular cartilage thinning, medial and lateral osteophytes, medial and lateral meniscal degeneration, joint effusion and Baker's cyst. Thus, Knee ultrasound can be used as a complementary imaging technique to radiography, especially when MRI is not available, to assess tissue-specific structural OA degeneration not detected by conventional radiographs

INTRODUCTION

Osteoarthritis (OA) is a common musculoskeletal degenerative disease. Prevalence of knee OA in aging populations is increasing worldwide leading to reduced quality of life and working disability which has major implications for healthcare and overall economy. OA is no longer seen as a disease of "wear and tear" but rather conceptualized as a whole-organ disorder. Besides articular cartilage degeneration, formation of osteophytes, bone erosion, meniscus atrophy, effusion and synovial inflammation are structural and compositional hallmarks of the disease ***(Podlipská et al., 2016).***

The epidemiology of the disorder is complex and multifactorial, with genetic, biological, and biomechanical components. Etiological factors are also joint specific. Joint replacement is an effective treatment for symptomatic end-stage disease, although functional outcomes can be poor and the lifespan of prostheses is limited. Consequently, the focus is shifting to disease prevention and the treatment of early osteoarthritis. This task is challenging since conventional imaging techniques can detect only quite advanced disease and the relation between pain and structural degeneration is not close ***(Agricola et al., 2015).***

A diagnosis of knee OA is mainly based on symptoms. Recommendations for the diagnosis of knee OA were published in 2010. They include three main symptoms: knee pain, short-lived morning stiffness, and functional limitation in combination with three signs on physical examination (crepitus, restricted movement and bony enlargement) ***(Jain and Johar,2018).***

In clinical practice, severity of knee OA is primarily assessed using conventional radiography especially by evaluation of joint space narrowing (JSN) and to some extent by the Kellgren-Lawrence (KL) grading. However, Structural alterations visible on radiographs such as bone abnormalities and JSN are known to appear only at relatively late stages of the disease. It is also known that JSN is a surrogate of both cartilage thinning and meniscal extrusion, and there are no means to directly evaluate cartilage and meniscus morphological damage from radiographs ***(Podlipská et al., 2016).***

To date, magnetic resonance imaging (MRI) is considered the most accurate imaging modality in the assessment of knee OA. It is used to evaluate the different roles of structural disorders in incident knee osteoarthritis, to compare predictability of individual features of semi quantitative scores for knee replacement and to formulate different disease progression models ***(Hunter et al., 2017).***

Despite its best sensitivity, MRI is expensive and sometimes not practical. For some patients MRI is difficult to be used because of the presence of a pacemaker or other absolute or relative contraindication to MRI ***(Sadeghian and Niya, 2018).***

Recently, Ultrasonography (US) is considered a promising technique for assessing soft tissue abnormalities such as joint effusion, synovial hypertrophy, Baker cyst, and other structural changes including the decrease in cartilage thickness, meniscus bulging, and formation of osteophytes ***(Oo and Bo, 2016).***

Ultrasonography is relatively easy to perform and is a non-invasive imaging technique that produces minimal discomfort. It can assess intra-articular abnormalities in knee OA reliably and is helpful in its diagnosis. Furthermore, US can be used under various conditions such as joint flexion and loading that cannot be evaluated by other modalities ***(Niwa et al., 2018).***

Advantages of ultrasound include its easy availability and multiplanar capability, as well as economic advantages. Also its ability to compress, dynamically assess structures and compare easily with the contralateral side. A great advantage of knee ultrasound is the assessment of para-articular disease. With ultrasound, the patient's point of clinical tenderness can be correlated with the underlying anatomical structures and associated pathology ***(Friedman et al., 2001)***.

AIM OF WORK

The aim of this study is to evaluate the efficacy of high resolution ultrasound in the assessment of structural abnormalities found in knee osteoarthritis compared to MRI as a reference standard.

Chapter 1

ANATOMY OF THE KNEE JOINT

The knee is the largest joint in the body. It is a compound synovial joint that consists of the tibiofemoral joint and the patellofemoral joint. It primarily serves as a hinge joint which allows flexion and extension, as well as various other movements. It joins the lower leg and thigh bilaterally and is an essential component of efficient bipedal movements such as walking, running, and jumping. The anatomical function and stability of the knee depend on muscles, bones, ligaments, cartilage, synovial tissue, synovial fluid, and other connective tissues ***(Gupton and Terreberry, 2018).***

Bones

Femur

The lower end of the femur is expanded into two prominent condyles united anteriorly, but separated posteriorly by a deep intercondylar notch. The most prominent parts of each condyle are called the medial and lateral epicondyles. Above the articular surface on the lateral side is a small depression that marks the origin of the popliteus muscle ***(Ryan et al., 2011).***