Ultrasonographic Findings in Symptomatic Knee Osteoarthritis in Relation to Pain

Medhat M. Refaat, Ahmed S. Mohammed Ali, Mostafa A. Nassef

Department of Radiology, Benha faculty of medicine, Benha University, Egypt.

Correspondence to: Mostafa A. Nassef, Department of Radiology, Benha faculty of medicine, Benha University, Egypt.

Email:

mostafanassef13@gmail.com

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Abstract:

Background: Osteoarthritis (OA) is the most common form of arthritis and one of the leading causes of disability. OA affects around 250 million people worldwide. Musculoskeletal ultrasound (MSUS) has become important and primary diagnostic tool in visualization of inflammatory and degenerative conditions of joints, ligaments, cartilage and muscles. **Aims:** To study the cross-sectional association between ultrasonographic findings and pain in knee osteoarthritis. **Patients and methods:** Fifty patients fulfilling the clinical criteria for knee OA had undergone US examination of the most symptomatic knee and pain assessment; studies were performed at Benha teaching hospital. **Statistical analysis:** The statistical analysis and presentation of data was conducted using the mean, slandered deviation, t-test and Pearson's correlation by SPSS version 20. **Results:** After data acquisition and statistical analysis no association between US findings and the level of knee pain was found. **Conclusion:**In this cohort, no association between US features and the degree of knee pain was found. Despite the attractiveness of US (easy accessible, inexpensive and no radiation involvement), it remains uncertain which part of pain in knee OA is explained by pathology in soft tissue structures and whether US of the knee is the imaging tool of choice to visualize this pathology. **Key message:**No association between US features and the degree of knee pain, was found.

Key words:

Osteoarthritis, knee, pain, ultrasonography.

List of abbreviations:
BC : Baker's cyst
KOOS: Knee injury and Osteoarthritis Outcome Score
KOOS-PS: Knee injury and Osteoarthritis Outcome Score-pain subscale
LS : Longitudinal section
MSUS : Musculoskeletal ultrasound
NRS : Numeric Pain Rating Scale
OA : Osteoarthritis
TS : Transverse section
US : Ultrasound

Introduction

Osteoarthritis (OA) is the most common form of arthritis and one of the leading causes of disability. This degenerative and progressive joint disease affects around 250 million people worldwide [(1)]. Substantial evidence indicates that knee OA is proximately caused by the breakdown of joint tissues from mechanical loading e.g. repetitive micro-trauma and joint over load as well as metabolic factors and obesity, but the deeper underlying causes of knee remain unclear and poorly tested, hindering efforts to prevent and treat the disease [(2)].

OA is a disease of the entire joint that is characterized by cartilage breakdown, subchondral bone alterations and formation of osteophytes, as well as soft tissue abnormalities including meniscal degeneration and protrusion, bursitis, tendinitis, Baker's cyst and synovial inflammation [(3)]. Pain and other symptoms of OA may have a profound effect on quality of life affecting both physical function and psychological parameters [(4)]. Current evidence suggests that OA joint damage predisposes to pain, but that little correlation between pain severity and the extent of joint damage exists [(5)].

Ultrasound has become the primary diagnostic tool in traumatic, inflammatory and degenerative soft tissue conditions. It is also used to monitor the condition of joints, ligaments, cartilage and muscles [(6)]. In comparison with advanced imaging modalities such as CT and MRI, advantages of ultrasound include non-invasiveness, the readily available bedside ultrasound equipment, and the relatively low cost of the exam procedure, the use of non-ionizing radiation [(7)].

MSUS examination allows multi-planar and dynamic evaluation of the musculoskeletal system and can show the soft tissues e.g. cartilage and meniscal tissue in great anatomical details as well as inflammatory properties e.g. synovial proliferation and effusion [(8)]. US also has advantages from the clinician's point of view, as it allows contralateral examination for comparison and does not pose limitations due to metal

artifacts, which can be problematic in magnetic resonance imaging (MRI) [9].

Patients and methods

In this observational study, fifty patients of the age group more than 50 years were diagnosed with knee osteoarthritis according to the following criteria: knee pain plus at least 3 of 6 : age > 50 years, stiffness < 30 minutes, crepitus, bony tenderness, bony enlargement and non-palpable warmth. It was conducted in Benha teaching hospital Radiology department between September 2018 and February 2019 on cases referred from rheumatology and orthopedic departments. All included patients were informed about the idea of the study and gave consent to participate in the study. The study was approved by the research ethical committee of Benha faculty of medicine.

Inclusion criteria:

- Patients with symptomatic knee osteoarthritis.
- If patients have bilateral knee osteoarthritis, the most symptomatic knee will be selected.

Exclusion criteria:

- Patients with other rheumatic or orthopedic diseases leading to inflammatory arthritis or secondary osteoarthritis.
- Patients with cognitive or sensorimotor problems that interfered with filling in questionnaires.

All patients were subjected at the same day to:

- History taking.
- Pain assessment.
- Clinical examination of the affected knee.
- Real time high resolution static and dynamic ultrasonography of the most symptomatic knee.

History taking:

- **Personal history:** it included age, sex, BMI.
- **Past history:** previous trauma or operations.

Pain was assessed by: -

1- Numerical pain rating scale (NRS)

- It assesses the pain severity at the day of U/S examination.
- Being 0 score represent no pain and 10 represent maximum pain.

2- Knee injury and osteoarthritis outcome score (KOOS)-pain subscale

- It reflects the pain severity in the last two weeks.

- Being 100 score represent no pain and 0 represent maximum pain.

Ultrasound examination:

- All patients underwent ultrasound examination of their knee with using excess gel.
- High frequency probe (7-11 MHz) is used.
- The routine US examination of the knee starts with its anterior aspect, followed by the medial, lateral and posterior aspects in both longitudinal and transverse planes.

U/S findings protocol includes the following items: -

1- **Effusion:** 4mm or more hypoechoic or anechoic intra-articular material that is displaceable and compressible in the suprapatellar recess, evaluated using a longitudinal scan with the leg in passive full extension.

2- **Synovial hypertrophy**: abnormal hypoechoic intra-articular tissue that is non-displaceable and poorly compressible of 2mm or more in the supra-patellar recess, measured with the leg in full extension with a longitudinal scan.

3- **Meniscal protrusion**: protrusion of meniscal tissue out of the joint space >3mm from the joint line, evaluated at the medial joint space with the knee in full extension with a longitudinal scan.

4- **Infra-patellar bursitis**: an enlarged infra-patellar bursa (>2 mm) on both longitudinal and transverse scans with the knee in 45 degree flexion.

5- **Baker's cyst:** a hypo-anechoic area between the semimembranosus and medial gastrocnemius tendon examined with the patient in a prone position on the dorsal/medial side of the fully extended knee applying a transverse and longitudinal scan.

6- **Cartilage thickness**: an anechoic band with sharp hyper-echoic margins, measured perpendicular to the surface at the inter-condylar notch and at the medial and lateral condyle (5mm just medial or lateral from the top of the condyle), with the transducer immediately above the patella in a transverse plane and with the knee in maximum flexion.

Statistical analysis:

The collected were inserted into Statistical Package for the Social Sciences (SPSS version 20.0) software for statistical analysis (Chicago, Ill, USA). According to the type of data qualitative represented as number and percentage, quantitative data represented by mean and SD. The following tests were used

to test differences for significance; Differences between quantitative independent groups by t test, correlation by Pearson's correlation to test the association between quantitative variables. P value was always 2 tailed and set at <0.05 value for significant results.

Results

Study population:

A total of 50 patients were included in this study, of which 31(62%) were female. The mean age was 57.1 years. The majority of the patients were overweight. The mean NRS was 6.5±0.62 indicating moderate to high pain levels and the mean KOOS-PS was 43.35±2.07 indicating moderate pain levels.

Prevalence of U/S findings:

Joint effusion was found in 66% of included patients, being the most frequent finding. Medial meniscus protrusion found in 60% of patients. Baker's cyst (BC) was found in 30% of patients. Synovial hypertrophy was found in 22% of patients. Infra-patellar bursitis was only found in 6% of patients, being the least frequent finding.

As regarding cartilage thickness:

All included patients in the study showed variable degrees of decreased cartilage thickness along different areas of the femur. At medial epicondyle mean cartilage thickness was1.64±0.24 mm and ranging from (1.4 to 1.96 mm) and at the inter-condylar notch; mean cartilage thickness was 2.14±0.20 and ranging from (1.8 to 2.5), while at the lateral epicondyle mean cartilage thickness was1.8±0.3 and ranging from (1.2 to 2).

Associations between ultrasonographic features and pain:

Effusion found not to be indicator for pain severity as there is no significant difference between mean NRS scores in patients with and without effusion (**p=0.6** as well as KOOS pain subscale **(p=0.7).**

Medial meniscus protrusion found not to be an indicator for pain severity as there is no significant difference between mean NRS scores in patients with and without medial meniscus protrusion (**p=0.5)** as well as KOOS-PS **(p=0.56).**

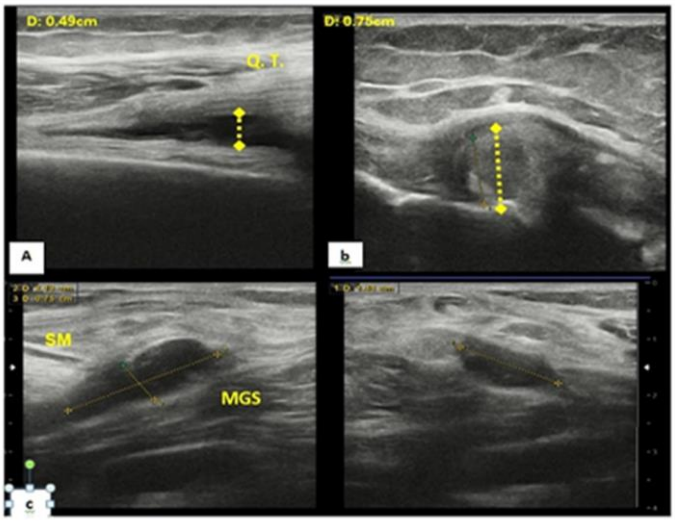
BC formation was found not to be related to pain severity as there is no significant difference between mean NRS score in patients with and without BC formation **(p=0.07)** as well as KOOS pain subscale **(p=0.14).**

Synovial hypertrophy was found to be not an indicator for pain severity as there is no

significant difference between mean NRS in patients with and without synovial hypertrophy **(p=0.18)** as well as KOOS-PS (**p=0.12).**

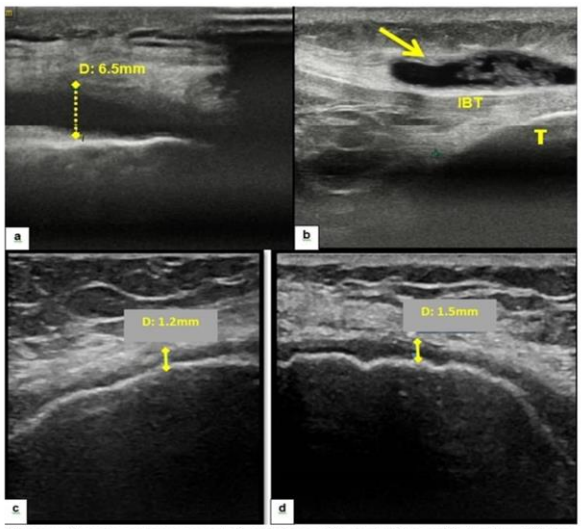
Infra-patellar bursitis, also was found to be not an indicator for pain severity as there is no significant difference between mean NRS in patients with and without synovial hypertrophy **(p=0.8)** as well as KOOS-PS (**p=0.3).**

As regard cartilage thickness; it was found that there is no significant correlation between cartilage thickness and pain scores as values of cartilage thickness at medial epicondyle were not correlated with NRS and KOOS-PS **(p= 0.68 & 0.31)** respectively. Also, values of cartilage thickness at inter-condylar notch were not correlated with NRS and KOOS-PS **(P=0.12 & 0.2)** respectively. Values of cartilage thickness at lateral epicondyle were not correlated with NRS and KOOS-PS as well **(p=0.48 & 0.5)** respectively.



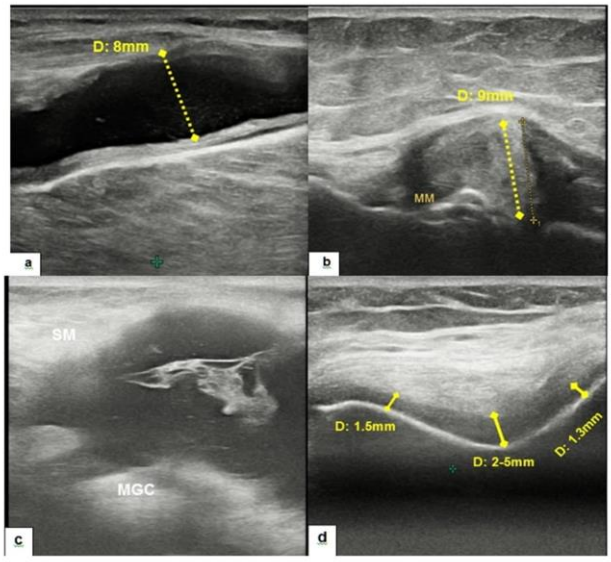
51 years old male patient with knee osteoarthritis, by U/S manifested by effusion, MM protrusion and Baker's cyst. **(a)**Longitudinal section through the suprapatellar pouch, showing effusion in the form of collection of more than 4mm anechoic fluid within it (QT= quadriceps tendon). **(b)** LS through the medial aspect of the knee joint showing medial meniscus protrusion more than 3mm out the joint space. **(c)** Longitudinal and transverse scan through the popliteal fossa showing baker's cyst lies between semimembranosus (SM) and medial head of gastrocnemius (MGS)

Case 1



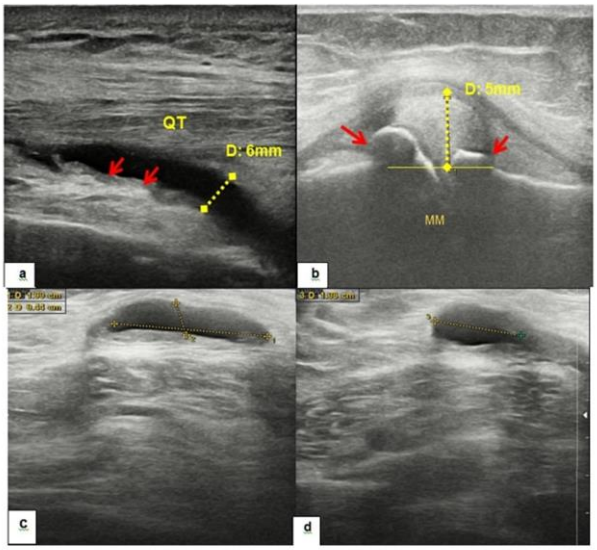
58 years female patient presented with knee OA, by U/S manifested by effusion, superficial infra-patellar bursitis and cartilage affection with subchondral bony erosions.**(a)** LS through the lateral knee aspect showing marked effusion within the lateral pouch. **(b)** LS over the infrapatellar region showing superficial infrapatellar bursitis(arrow) that seen as distension of suprficial infrapatellar bursa by anechoic fluid with internal low level echoes, the bursa seen lies superficial to infrapatellar tendon (IPT) which seen inserted into tibia (T). **(c &d)** TS through the medial and lateral femoral cartilage respectively showing cartilage thinning with underlying bony erosions.

Case 2



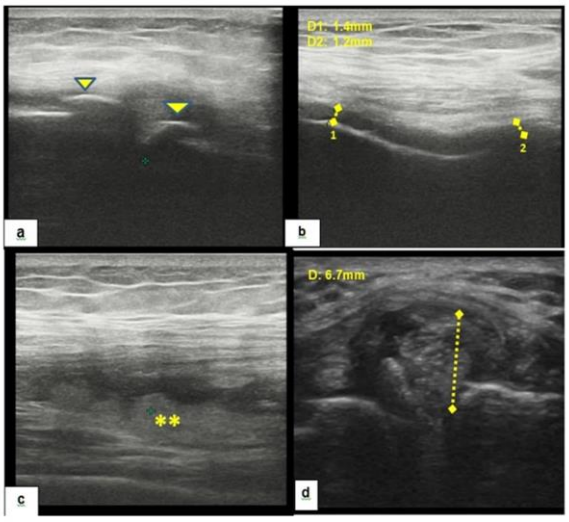
51 years male patient has knee OA, by U/S manifested by effusion, MM protruion, Baker's cyst and cartilage thinning. **(a)** LS through the lateral aspect of the knee showing marked effusion. **(b)** LS through the medial aspect of the knee showing MM protrusion with marginal osteophytes as well**. (c)** LS through the posterior aspect of the knee showing Baker's cysts with internal septations and its neck seen extending between semimembranosus (SM) and medial head of gastrocnemius (MGC). **(d)** TS through the femoral cartilage showing blurring of the cartilage, loss of sharpness of superficial margin and cartilage thinning at the medial and lateral epicondyles.

Case 3



57 years male patient has knee OA , by U/S manifested bymarginal osteophyte, effusion, synovial hypertrophy, MM protrusion and Baker's cyst**. (a)** LS throught anterior aspect of the knee showing effusion within suprapatellar pouch with hypoechoic synovial hypertrophy (red arrows). **(b)** LS through the medial aspect of the knee showing MM protrusion with marginal osteophyes (red arrows) as well. **(c & d)** LS and TS through the posterior aspect of the knee showing Baker's cyst.

Case 5



56 years old female presented with primary knee OA, by U/S manifested by marginal osteophytes, effusion, synovial hypertrophy, MM protrusion and femoral cartilage thinning. **(a)** Longitudinal scan through the lateral aspect of knee showing marginal osteophytes (arrow heads) appear as bony projections. **(b)** Transverse section through the femoral cartilage; showing thinning at the medial and lateral epicondyles and loss of sharpness of superficial margin. **(c)** Longitudinal section through suprapatellar pouch showing effusion and synovial hypertrophy (asterisks). **(d)** L.S through the medial aspect of knee showing protrusion of the medial meniscus.

Case 4

Discussion

In this cohort of 50 patients with painful knee OA we were unable to demonstrate any explanation based on ultrasonographic findings for the level of knee pain. Our findings, although perhaps somewhat unexpected, suggest that the level of knee pain in knee OA is not strongly determined by soft tissue abnormalities in the majority of patients and that other mechanisms play a role in this process.

According to our study, joint effusion was the most prevalent finding present among the

included patients; however, there is no significant association between effusion and the severity of pain. In line with this, it was found that moderate or large effusion were more frequent among those with knee pain than those without pain, suggesting these features with the painful knee OA. (10)

In another study, an association between Baker's cyst and supra-patellar effusion and pain in motion was found when comparing patients with pain, and without pain, but they found no association with the severity of pain, which in turn coincide with our study. (11)

Our results also coincide with that of the study done on 180 patients with knee OA; they evaluated the association between US features and pain score. They found that no association was found between US or clinical or demographic features and the level of knee pain. They suggested that the exact origin of the pain in knee OA patients remains uncertain however, US of the knee is the imaging tool of choice to visualize these pathologies. **(12)**

Another study found that no single US finding has been consistently linked to the level of pain in knee OA, which agree with our result. **(13)**

Other study stated that synovial hypertrophy was moderately correlated with radiographic severity but the relationship with pain is less strong and this comes in line with our study's results. **(14)**

In contrast to our study, it was found in another study that bursitis is associated with radiographic and MRI-detected joint structural abnormalities and related to symptomatic knee O.A **(15)**

In another study it was found that US findings impressive of inflammation are higher in included patients with symptomatic knee O.A. especially synovial hypertrophy. Synovial hypertrophy was confirmed as an independent risk factor for knee pain, which in turn disagree with our study. **(16)**

Variations in pain score may be explained by the fact that the cause of pain in knee OA is poorly understood, although articular cartilage is considered the major structure involved in OA, hyaline cartilage has no nervous fibers. Then, pain may arise from other peri-articular and/or intra-articular structures such as the joint capsule, synovium, periosteum, bone, tendons, bursae, ligaments or menisci **(17)**

It was suggested that painful knee O.A may be multifactorial; mechanical, structural,

inflammatory bone-related, neurological and psychological factors. [18]

Conclusion

In our study we were unable to demonstrate an association between US features and pain in a cohort of patients with painful knee OA. Despite the attractiveness of US (easy accessible, inexpensive and no radiation involvement), it remains uncertain which part of pain in knee OA is explained by pathology in soft tissue structures and whether US of the knee is the imaging tool of choice to visualize this pathology.

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