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*Research article*

# Correlations Between Imaging and Clinical, Functional and Biological Features in Knee Osteoarthritis

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**Abstract:** Background: For knee osteoarthritis (OA) pathogeny, cartilage damage is important, and ultrasonography (US) is helpful in assessing specific joint issues. Objectives: We intend to find correlations between functionality, pain level, serum glucose, cholesterol, triglycer-ides, uric acid, systemic inflammation and US findings for patients with knee OA. Meth-ods: For 50 consecutive subjects with symptomatic bilateral knee OA staged according to the scale Kellgren-Laurence(K-L) noted anamnestic data, Body Mass Index (BMI), func-tionality evaluated by Western Ontario and McMaster University Osteoarthritis Index (WOMAC) and pain' intensity through Visual Analogue Scale (VAS). Using the US, the cartilage, meniscal and tendon changes, osteophytes, and fluid collections were assessed for 100 knee joints. SPSS 29.0.2.0 was used for statistical analysis. Results: In our group, with an average age of 60.54 years, there was observed a weak direct correlation between WOMAC and K-L grading (r=0.34) and a negative correlation between BMI and the carti-lage size on the external femoral condyle (r=-0.28). Its thickness on this site was directly correlated with lateral osteophyte severity. Smokers' injuries on the intercondylar groove were increased. Conclusion: Lateral femoral condyle cartilage thickness is inversely asso-ciated with BMI, and K-L grading directly correlates with dysfunctionality. The smokers had higher intercondylar cartilage injuries.

**Keywords:** Knee, osteoarthritis, pain, cartilage, ultrasonography.

## 1. Introduction

Knee osteoarthritis (OA) remains one of the most prevalent conditions and an important source of disability in those over the age of 50, with significant economic consequences which cause patients to require medical rehabilitation and rheumatological and orthopaedic services. Patients complain about pain, stiffness, dysfunctionality and sometimes unnoticed walking changes from the beginning, affecting their daily activity and quality of life. Therefore, with the help of the described investigations, early identification of structural and functional changes is essential to establish appropriate therapeutic strategies. Cartilage's changes represent a main part of knee OA pathogeny, caused by increased pressure applied on this structure, its low resistance and the lack of elasticity of the subchondral bone. All the structures inside or surrounding the joint are involved in the evolution of the disease [1-6].

The knee OA is usually diagnosed after clinical examination. Even if it does not visualise soft periarticular structures and cartilage and only gives us indirect data, the radiological examination remains the standard exploration of osteoarthritis, and it helps stage this disease, according to the Kellgren-Laurance (K-L) grading [2]. Although, symptoms don't always correlate with the severity of the identified radiological changes [7]. In the last 15 years, musculoskeletal ultrasound (MSUS) has gained its place in joint pathology investigations, including degenerative diseases. It has proved to be a non-invasive, sensitive, accessible, easy-to-perform imaging technique [8].

OMERACT Outcome Measures in Rheumatology (OMERACT) establish scores for ultrasound (US) joint pathological changes, including OA. They assess and count issues like synovitis, effusion, synovial hypertrophy, Power Doppler signal presence, the osteophytes, meniscal extrusions and cartilage damages to standardise the method and make it more reproducible [8]. For the knee, specific US findings are intra/periarticular collections, synovial proliferation, synovitis, hyaline cartilage changes [9], osteophytes, meniscal protrusions, extrusions or degeneracy, Baker or other popliteal cysts, tendinopathies and bursitis. Moreover, using MSUS, we can conduct ultrasound-guided proceedings, monitoring the evolution of the disease and the effect of the local or systemic therapy [8,10,11,12].

Even since 2009, European researchers in the MSUS field have performed studies to evaluate the method for knee OA, and the results have shown that it is reliable for different structures even if the operator has less experience [11,13,14].

The American specialists found the same reliability when discussing synovitis, synovial hypertrophy, and effusion: lower for meniscus changes and higher for osteophytes and cartilage disorders [15].

Other studies checked and confirmed the reproducibility of the method for detecting and quantifying specific changes in patients with knee OA [16,17].

A systematic literature review and meta-analysis concluded that reliability is moderate for knee US findings [18].

Another multicentric study published in 2023 by 164 US examiners showed accuracy and reliability regarding suprapatellar joint effusion, especially when discussing medium and large amounts of fluid [19].

It has been observed that the presence of Baker cyst, intraarticular effusions and meniscal protrusion have been associated with increased pain and dysfunction [20]. A 2020 study found that the association of Baker's cyst increases the risk of knee pain by 2.94 times [21]. Other researchers identified that the pain level was correlated with the severity of cartilage lesions, with osteophytes in the internal compartment and medial meniscal protrusion in patients with bilateral knee OA [22]. Another recent study published in 2023 concludes that the cartilage layer's thickness in the femoral condyle and the intercondylar groove in these patients is reduced compared to a control group [23]. Knee OA raises the risk of falling (RF), and these events are accompanied by increased morbidity and mortality in older people [24]. Two recent studies concluded that maximal medial meniscal extrusion occurs during adduction, and walking with the fingers outward reduces this structure shift [25]. Other authors have tried to identify correlations between cartilage changes in the femoral condyle, muscle strength of the femoral quadriceps and gait parameters using computerise quantification [26]. Several studies have also observed different sizes of hyaline cartilage thickness at the femoral level depending on the number of steps the patient takes [27]. Regarding the muscle strength of the quadriceps, a study published in 2022 observed that the vastus lateralis force was inversely proportional to the pain level in a group of women with knee OA. Simultaneously, the force index for the medial and lateral vastus muscle was directly correlated with the cartilage's thickness. Because of these findings, we consider it essential to check if there is a link between common and uncommon ultrasound changes in knee OA and joint symptomatology and functionality [28]. Meniscal pathology was linked to the structural progression and severity of knee OA, as well as to the risk of total knee

replacement. Internal and external meniscal tears were associated with cartilage degradation when the lesion is located on the body and posterior horns but not in the anterior ones. A weak association was observed between the meniscal lesion grade and knee OA pain level [29]. Regarding the symptoms of knee OA, a study from 2022 concluded that persistent local pain is associated with moderate-to-severe synovitis [30]. Another study published in 2020 showed that the OMERACT US OA score was correlated with clinical, radiological and MRI changes for knee OA. It showed that K-L is associated with meniscal displacement but not cartilage thinness [31].

Therefore, we aim to evaluate the joint by ultrasound and to note whether there are correlations between these changes and the clinical features, the intensity of pain and different degrees of dysfunction quantified by specific tools.

## 2. Material and methods

### *2.1. Study Design and Participants*

We performed a cross-section observational study that included patients with bilateral knee OA consecutively admitted to the Balneal and Rehabilitation Sanatorium of Techirghiol (B.R.S.T.) for two months. Before the actual start of the study, approval was given by the Ethical Council of the unit where the research was conducted, B.R.S.T. (approval no. 56/03.11.2022). All patients received clear explanations about the clinical exam, the questionnaires they had to answer, the blood tests they had to be subject to, and the ultrasound assessment procedure. Each of them had signed a written consent form before enrolment in the study.

Inclusion criteria were bilateral knee OA diagnosis according to the criteria of the American College of Rheumatology (ACR), formulated by relying on the clinical examination and staged according to the K-L classification and grading [2] based on the radiological examination of the joint from two perspectives: anterior-posterior and lateral-medial. We excluded the patients with other causes of knee arthritis (inflammatory autoimmune rheumatological diseases, crystal arthropathies, infectious arthritis), lower limb surgical history, trauma or congenital illnesses and association of neurological pathology. The reason for that was their potential influence of this type of pathology on biomechanics, followed by the occurrence of structural changes in the knee. [32,33].

The group included 50 patients diagnosed with bilateral knee OA, consecutively admitted to our unit for specific rehabilitation treatment between February and March 2023.

### *2.2. Assessments*

The anamnestic data were collected using specific questionnaires designed for our unit. That way, we gathered information about socio-demographic aspects, living and working conditions, level of physical activity, the time elapsed since the onset of symptoms, previously applied treatment (medication, rehabilitation therapy), height, weight, and abdominal circumference.

All the subjects were clinically evaluated. Body mass index (BMI) was noted. Pain was assessed using an analogue visual scale (VAS) [3]. Functionality was appreciated regarding the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) index [4], obtained at the end of the evaluation of the specific questionnaire. The muscle strength of the quadriceps was clinically evaluated using a grade between 0 and 5 according to the medical scale of muscle strength.

At admission, all patients in the group underwent the following blood tests: inflammatory tests like red blood cell sedimentation rate (ESR), C-reactive protein (CRP), glycaemia, cholesterol, and triglyceride serum levels.

The ultrasound assessment of the knees was performed at admittance before any rehabilitation treatment was applied. The procedure was performed using an Essaote My

Lab x6 machine and a ML 4-15 transducer. The appropriate device sets were used to adjust focus, depth and gain corresponding to the structure and the patient's needs. The US was performed systematically, multiplane, dynamic and bilateral, using greyscale and, whenever needed, Doppler. It was selected at the highest frequency, which allowed us to acquire the best image of the structure. Every pathological change was visualised in longitudinal and transversal view [34].

A single operator with 10 years of experience in the field of MSUS carried out the assessment.

Ultrasonographic assessment of the knee joint was made using standard scans according to the EULAR guide [35]:

- Longitudinal and transverse scan of suprapatellar recess and suprapatellar and pre-femoral fat pads; longitudinal scan of the quadricipital tendon; longitudinal scan of the quadriceps enthesis; transverse scan of the quadriceps tendon. For these assessments, the patient was placed in dorsal decubitus with 30º knee flexion.
- Longitudinal scan of the lateral recess with patients positioned the same with a supplementary 15 º internal rotation of the ipsilateral hip.
- Longitudinal medial parapatellar recess. This time, the 15 º hip rotation was on the external side.
- Longitudinal and transverse scan of the prepatellar bursa, longitudinal scan of the proximal and distal patellar enthesis, longitudinal panoramic and transverse scan of the patellar tendon, longitudinal scan of the deep and superficial infrapatellar bursa, longitudinal and transverse scan of the Hoffa's fat pad. The patient was placed in dorsal decubitus with 90 º knee flexion to acquire these images.
- A longitudinal scan of the internal and external tibiofemoral joints and a longitudinal panoramic scan of the medial and lateral collateral ligaments were done with the patient placed in dorsal decubitus and a 15 º knee flexion.
- Longitudinal scan of the proximal tibiofibular joint, longitudinal scanning of the ilio-tibial band insert, longitudinal scan of the biceps femoris tendon, transverse scan of the popliteus tendon in dorsal decubitus with 90 º knee flexion and 45 º internal rotation of the hip.
- Transverse of the Pes Anserinus tendons in dorsal decubitus with 90 º knee flexion and 45 º hip external rotation.
- Longitudinal and transverse scan of the semimembranosus tendon, longitudinal and transverse scan of the semimembranosus-gastrocnemius bursa, transverse scan of the neurovascular popliteal bundle with the patient in ventral decubitus with assessment of the posterior knee compartment.
- Longitudinal and transverse scan of intercondylar femoral cartilage and internal and external femoral condyles, with the patient placed in ventral decubitus with maximal knee flexion.

The pathological findings of the knee joint ultrasound were described according to OMERACT definitions [36].

- The effusion in the medial, lateral parapatellar and suprapatellar recesses was counted if the maximum thickness of the fluid blade exceeded 2 mm.
- The cartilage layer was assessed on the medial and lateral condyle and the intercondylar groove, on transversal view, being noted in mm and quantified according to quantification systems for the severity of cartilage lesions in knee OA patients. O = normal findings, 1 =minimal change (irregularities of the borders and increased echogenicity), 2A= partial thickness (with focal reduction less than 50%), 2B = focal reduction between 50% and 100%, 3= severe changes with 100% focal cartilage loss [11,13, 37].

- The osteophytes were checked on both knees' internal and external compartments and quantified according to a standardised grade scale: 0 = without osteophytes, 1= minimal osteophytes, 2 = medium osteophytes, and 3 = severe osteophytes [38].
- Meniscal protrusion was assessed according to the grading scale established by OMERACT. It is considered when the meniscus exteriorisation is more than 2 mm from the medial femoral tibial joint line and more than 3 mm for the lateral one [14].

*2.2. Statistical analysis*

For statistics, we used SPSS 29.0.2.0. Database program to get:

- Descriptive statistics which show the characteristics of the studied population, helping us to see the homogeneity/heterogeneity of the chosen group,
- Frequencies analysis to see the prevalence of different parameters in our group,
- An independent samples t-test with different variances was used to calculate the difference between the osteophytes and non-osteophytes groups, as the groups had unequal variances and were different. We were able to use the t-test as the groups were small.
- Correlation tests to see how well linked are the variables tested.

Between the linear parameters, we calculated the Pearson coefficient (r) [39].

**2. Results**

*2.1.2. Demographic characteristics of the analysed group of patients*

The group included 50 subjects:

- diagnosed with bilateral knee OA,
- with age between 40 to 81 years old,
- 15 men and 35 women,
- 42 from urban sites and 8 from rural areas.
- 36% older than 65, associating cardiovascular disease (hypertension, ischaemic heart disease).

The ultrasound evaluation identified the following pathological changes:

- 43 (86%) of them had cartilage narrowing (<3mm),
- in 9 cases (18%), we identified intra-articular fluid collection (>2mm),
- 18 (36%) patients associated with patellar or quadricipital tendinopathy,
- 20 (40%) of them, osteophytes,
- 33 (66%) meniscal lesions,
- 5 (10%) – Baker Cyst, 1 patient with bilateral location.

**Table1.** Demographic characteristics of the patients

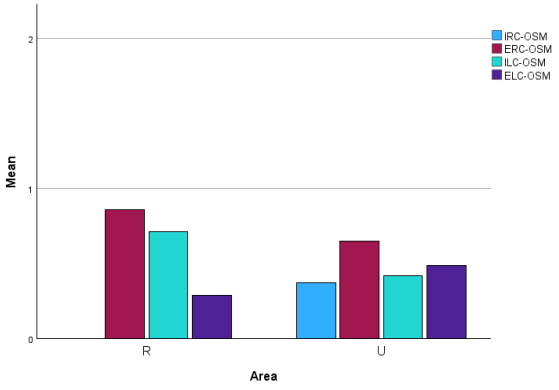
| | *Total* |
|---|---|
| *Age* | M=60.54 |
| *Gender* | |
| • *Female* | 34 (68%) |
| • *Male* | 16 (32%) |
| *Residence* | |
| • *Urban area* | 43 (86%) |
| • *Rural area* | 7 (14%) |

**Table2.** Descriptive statistics of the patient's group

| | N | Minimum | Maximum | Mean | Std. Dev. |
|---|---|---|---|---|---|
| *AGE* | 50 | 40 | 81 | 60.54 | 9.307 |
| *BMI* | 50 | 21.0 | 83.0 | 32.596 | 10.4888 |
| *AC* | 50 | 70 | 127 | 97.58 | 14.590 |
| *TIME OF PAIN ONSET* | 50 | 1 | 6 | 3.00 | .756 |
| *TIME OF THE DIAGNOSIS* | 50 | 1 | 20 | 5.14 | 3.938 |
| *MS* | 49 | 2.0 | 5.0 | 4.541 | .6442 |
| *VAS* | 48 | 1.0 | 10.0 | 5.219 | 2.1658 |
| *WOMAC* | 50 | .5 | 80.0 | 37.884 | 21.9597 |
| *K-L* | 50 | 1 | 4 | 2.48 | .64 |
| *CT MC RK* | 50 | .06 | 1.80 | .7594 | .40360 |
| *CT LC RK* | 50 | .06 | 2.10 | .7380 | .40182 |
| *CT IC RK* | 50 | .18 | 3.90 | 2.0156 | .89192 |
| *CT MC LK* | 50 | .03 | 2.20 | .6594 | .39152 |
| *CT LC LK* | 50 | .05 | 2.30 | .6604 | .44883 |
| *CT IC LK* | 50 | .15 | 4.50 | 2.0276 | .83833 |
| *Valid N (listwise)* | 48 | | | | |

*Legend: BMI=Body mass index; AC=Abdominal circumference; MS=Muscle strength; VAS=Analog visual scale; WOMAC= Western Ontario and McMaster Universities Osteoarthritis Index; K-L=Kellgren-Laurence grade, CT MC RK = Cartilage thickness medial condyle right knee; CT LC RK = Cartilage thickness lateral condyle right knee; CT IC RK = Cartilage thickness intercondylar right knee; CT MC LK = Cartilage thickness medial condyle left knee; CT LC LK = Cartilage thickness lateral condyle left knee; CT IC LK = Cartilage thickness intercondylar left knee*

- The pain affected the right knee in 16 patients (32%), the left one in 8 (16%) of the subjects and both joints in 25 cases (50%).
- When looking at the sample, the differences in osteophytes' severity regarding the rural/urban area.
- No patient in the rural group had osteophytes in the internal right compartment. Still, the severity of osteophytes in the right lateral compartment and the internal left compartment is greater than in the urban group. The average osteophyte severity can be seen in **Figure 1.**




*IRC= internal right condyle; ERC= external right condyle; ILR= internal left condyle; ELC= external left condyle; OSM= osteophyte severity mean*

**Figure 1.** The osteophytes' severity mean distribution regarding the living area.

*2.1.3. Correlations*

The analysis identified some emergent themes. Regarding VAS level and lateral femoral cartilage width, our group noted a small inverse correlation when Pearson coefficient r was calculated (r=-0.33 for the right knee). We then calculated the linear regression equation (Figure 2).

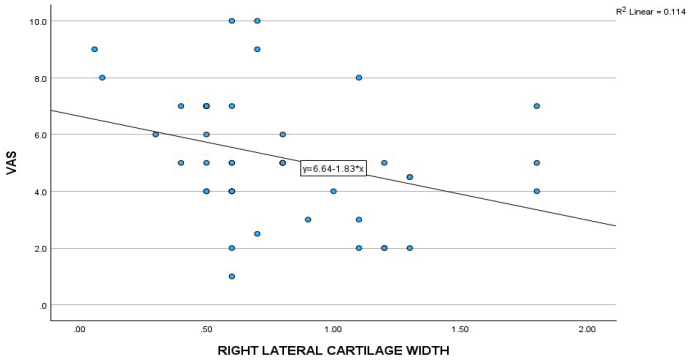



**Figure 2.** The correlation between VAS scale and right lateral cartilage width with linear regression equation

In the same manner, small inverse correlations were observed between BMI and the lateral femoral cartilage (r=-0.28) for both knees and between the level of cholesterol and the number of osteophytes (r=-0.32) (Figure 3).

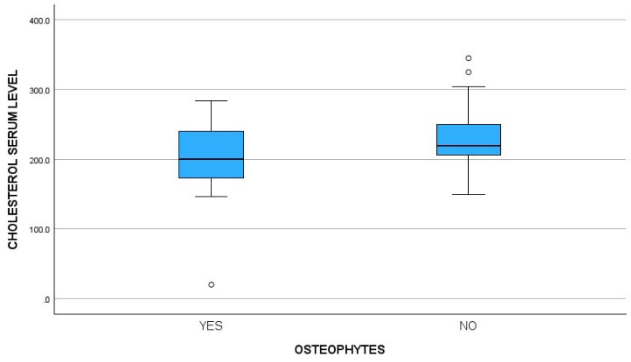



**Figure 3.** Serum cholesterol levels in the groups of patients with/without osteophytes

Direct week correlations were identified regarding abdominal circumference and the number of osteophytes and between the uric acid serum level and medial femoral condyle cartilage width (r=0.30), respectively, the intercondylar groove cartilage width (r=0.26).

Moreover, such linkage was also found when cholesterol level and intercondylar groove cartilage width were analysed (r=0.32).

Correlations were investigated, but no significant linkage was found between:

- WOMAC and cartilage thickness,
- ESR and cartilage thickness,
- glycaemia and cartilage thickness,
- abdominal circumference and cartilage size,
- meniscus injuries and cartilage thickness

We also didn't find a connection between muscle strength in the femoral quadriceps and cartilage changes.

Another inquiry was about the correlation between the severity of the osteophytes and the cartilage width, but as mentioned above, no significant correlation was found. We didn't find any association between functionality and US pathological modifications. Regarding the association between X-ray modifications and clinical manifestations, we found a weak direct correlation between WOMAC and K-L grading (r = 0.34). We couldn't establish any linkage between K-L and the pain level or cartilage thickness.

*2.1.4. Difference in lateral condyle width between osteophytes and no-osteophytes groups*

The following groups were defined: the patients with osteophytes and those without osteophytes (Table 3). The table below presents the characteristics of the two groups. There are some differences between the samples, and the tests were performed considering the variances are unequal.

**Table 3.** Characteristics of patients, grouped by the presence or absence of osteophytes

| | *Total* | *With osteophytes* | *Without osteophytes* |
|---|---|---|---|
| | 50 | 23 (46%) | 27 (54%) |
| *Age* | M=60.52 SD=9.35 | M=62.78 SD=8.23 | M=58.62 SD=9.88 |
| | Variance=87.47 | Variance=67.81 | Variance=99.09 |
| *BMI* | M=32.59 SD=10.48 | M=31.86 SD=7.66 | M=33.21 SD=12.52 |
| | Variance=110.016 | Variance=58.73 | Variance=157.76 |

*Legend: BMI=Body mass index*

The calculated p-value, using the Independent Samples t-test to identify whether there is a difference in the right lateral condyle cartilage width between the two groups, **was 0.002**.

- This means a high statistically significant difference in cartilage width between the groups.
- The 95% confidence interval indicates a mean difference between the following values: **(-0.54, -0.13)**.

Using the same grouping variable, the same algorithm was performed to calculate if there is a difference in the samples regarding the left lateral condyle cartilage width. The **p-value is 0.012**, meaning a statistically significant difference. The 95% confidence interval is **(-0.47, -0.07)**.

*2.1.5. Difference in intercondylar groove width between the smoker and non-smoker groups*

Additionally, the patients were divided into two samples by smoker/non-smoker attribute. The characteristics are shown in the table below (Table 4). Because the groups are very different in terms of dimensions, they differ significantly, and the non-smoking group, the larger one, is more similar to the entire sample of patients.

**Table 4.** Characteristics of the patients grouped by smoking status.

| | *Total* | *Smoking* | *Non-smoking* |
|---|---|---|---|
| | 50 | 6 (12%) | 44 (88%) |
| *Age* | M=60.52 SD=9.35 | M=56.67 SD=3.14 | M=61.07 SD=9.75 |
| | Variance=87.47 | Variance=9.87 | Variance=96.18 |
| *BMI* | M=32.59 SD=10.48 | M=28.95 SD=7.86 | M=33.09 SD=10.77 |
| | Variance=110.016 | Variance=61.83 | Variance=116.06 |

*Legend: BMI=Body mass index*

The one-sided Independent Samples t-test was performed again regarding the intercondylar groove cartilage width (Table 5).

- p value = **0.015** with equal variances not assumed
- the difference found ➔ **-0.78**
- the 95% confidence interval **(-1.38, -0.19)**.

**Table 5.** Student t-test for equality of means between smoker and non-smoker groups

| | | t-test for Equality of Means | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | t | df | Significance | | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
| | | | | One-Sided p | Two-Sided p | | | Lower | Upper |
| Intercondylar cartilage medium width | Equal variances not assumed | -3.086 | 7.808 | .008 | .015 | -.78 | .25 | -1.38 | -.19 |

The results indicate a statistically significant intercondylar groove cartilage width difference between the groups (Figure 4).

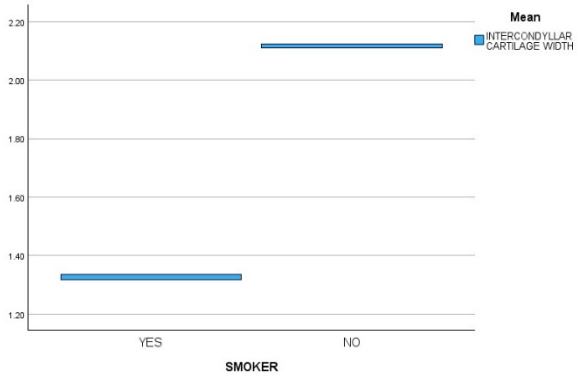



**Figure 4.** Intercondylar cartilage width in smoking and non-smoking population

## 3. Discussion

Knee OA is a condition commonly found in the general population, especially after the age of 50, but not so rarely associated with intense pain influencing the daily quality of life and sometimes with significant disability. Cartilage alterations are a crucial component of the OA knee pathogenically chain and are closely connected to the symptoms. However, other changes like osteophytes, intra/periarticular effusions and meniscal injuries, usually findings in knee OA, are involved in clinical aspects. All of these could be assessed by MSUS, a non-invasive, easy-to-perform and repeatable technique which permits a "real-time" dynamic and functional evaluation. Recent research showed objective data about the correlation between these imagistic parameters and the clinical and functional assessment of the patients.

In our group, VAS and BMI were weak inversely corelated with lateral femoral condyle cartilage size. At the same time, the thickness of the external femoral condyle was directly linked with the severity of lateral osteophytes, and smokers' injuries on the intercondylar groove were increased. The associations between biological blood tests and ultrasound findings hadn't statistical significance or concordance with previous data from the literature. However, we didn't find a correlation between WOMAC (functionality) and cartilage thickness, ESR and cartilage thickness, glycaemia and cartilage thickness, abdominal circumference and cartilage size, as well as meniscus injuries and cartilage thickness.

A weak part of the study was the US assessment made by a single technician. Even if the method has been proven to have good intra and interobserver reliability, this aspect could be a source of bias. The second limitation of our research was the sample size; 50 patients was insufficient to allow us to generalise our findings. The small number of

patients and the heterogeneity of the groups analysed means we needed to use tests adapted to those inequalities. Therefore, the results may tend to be synthetic and a bit far from the absolute truth. However, from the findings of this small number of subjects, we can note several aspects of the cartilage's changes in knee OA and their association with other parameters. The thinner the cartilage is on the lateral femoral right condyle, the more intense the pain reported by the patient (Pearson correlation coefficient, r=-0.33). We didn't find the same linkage for the left knee. This observation is concordant with the results of a multicentric study recently published (2023), which also concluded that the patients with knee OA, who have frequent anterior joint pain, had a higher risk of increasing cartilage injuries after 2 years and developing severe lateral patella-femoral OA [24]. Another study by Romanian researchers found that the cartilage damage score independently predicted the pain level, as quantified by the VAS scale [22]. This information could be helpful in the prevention of OA worsening, using appropriate therapeutical interventions at the right moment [40].

Our group noticed that a small inverse correlation between BMI and the lateral femoral cartilage (r=-0.28) matches the results of the study realised by Pamukoff and Co. in 2020, which concluded that the echo intensity of the medial and lateral femoral cartilage was higher in individuals with obesity compared to those with average weight. In addition, a more significant peak knee adduction moment during walking was linked to a larger ratio of medial to lateral cartilage thickness in non-obese individuals but not obese individuals. This leads us to the idea that MSUS helps monitor the articular cartilage in obese individuals at high risk for knee OA occurrence and progressive evolution [26]. At the same time, it's necessary to mention the importance of maintaining a normal weight for patients with knee OA.

The observation that smokers have a higher risk of cartilage damage is consistent with the results of a recent study published in 2023. Its results showed that smoking is a significant risk factor in general for OA, influencing antioxidant enzymes in older adults consecutively increasing the degree of pain and loss of cartilage [41]. Uric acid level weak direct correlation with US knee changes isn't concordant with actual literature data. On the contrary, a higher level of blood uric acid was linked with an increased risk of cartilage surface deposits of monosodium urate and secondary OA. Epidemiological studies showed contradictory results about hypercholesterolemia related to OA. Still, our findings showed that a higher serum cholesterol level was associated with a thicker intercondylar cartilage layer (weak positive correlation – r= 0.32) and a lower rate of osteophyte occurrence on US evaluation [42].

Another observation in our group was that the cartilage's thickness on the external femoral condyle was correlated with the presence of lateral osteophytes, which was not at all consistent with the results of research by Keenen and Co. They noticed that the osteophyte's presence on the medial knee compartment strongly predicted full-thickness cartilage loss but not in the lateral compartment [43]. Regarding this observation, we found a study that included 25 female patients post anterior collateral ligament (ACL) reconstruction and tried to establish correlations between biomechanics of the gait and femoral cartilage thickness assessed by the US on the medial and lateral condyles and the intercondylar groove. In addition to the association between increased adduction angle and the thinning of the cartilage on the medial femoral condyle, the authors noted that lesions of the internal meniscus are associated with a smaller thickness of cartilage on the same femoral condyle [21].

The direct correlation between WOMAC and K-L grading (r = 0.34) shows that the more severe the radiological changes, the more the joint functionality is affected. This is in concordance with the result of a 2012 study that aimed to establish the relation between clinical signs, functionality, OMERACT US findings, and X-ray and MRI pathological changes in knee OA.

However, more samples could lead to a higher generalisation of our result. This finding could be applied in clinical practice to sustain the prevention of worsening knee OA by getting rid of or correcting risk factors like smoking and being overweight. Moreover, identifying specific changes, taking into account the associated diseases, could be chosen the proper treatment, including rehabilitation therapy with fewer systemic side effects than medication [44]. Some of the US changes are found in the early stages of the disease and could be predictors of its evolution. This technique is more sensitive for identifying osteophytes and narrowing joint space than X-ray [45]. Thus, since 2013, studies conducted by OMERACT/EULAR have proven an intra and inter-observational reproducibility of this lesion [46,47,48].

## 5. Conclusions

In this paper, we have presented a statistical study about US findings in knee OA in an attempt to understand which of these and how much they are involved in the occurrence of pain and dysfunction of the joint. We found a slight negative linkage between VAS and BMI, respectively, and the size of the lateral femoral condyle cartilage, with injuries in the intercondylar groove being more frequent among smokers. Our group also noted that the functionality is more affected by the patient's knee OA with severe radiological changes. Future work should prioritise assessing the importance of different associated risk factors for OA in the development of early US detectible joint changes to prevent the worsening of the disease by applying appropriate therapeutic strategies.

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