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Original Research

The Localizations of Osteoarthritis in the Knee, Ankle and Foot Joints of Cadaver: Comparison in Radiological, Morphological and Histopathological Aspects

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ABSTRACT

Objective: Osteoarthritis (OA) is the most common joint disease. In this study it was aimed to compare the general features of OA such as location, placement, severity and shape of the lesions in terms of radiological and morphological aspects and to determine their relationship with each other.

Methods: In our study, the antero-posterior and lateral radiographies of knee talocrural and transverse tarsal joints of 20 cadavers by age between 30 and 50 years were taken. The results obtained from the radiological examination were graded according to the Kellgren and Lawrence scale. For each of the identified regions, the presence of degenerative changes was noted. Then samples were taken from these regions were examined by microscopic methods. The cartilage degeneration changes, presence of fibrillations, density, depth, chondrocyte aggregation, and necrotic changes were evaluated.

Results: In the radiological examination OA was found in 35% in knee joint, 25% in the talocrural joint, 15% in the transverse tarsal joint. In the morphological examination OA was found in 31.5% knee joint, 25% ankle joint and 5% transverse tarsal joint. In the microscopic examination OA was found in 94.7% knee joint, in 94.7% ankle joint and in 100% transverse tarsal joint.

Conclusion: Although radiological and macroscopic OA was detected in approximately 1/3 of cadavers aged between 30 and 50 years, degeneration of varying degrees was detected in all joints examined in microscopic examination. This shows that an advanced age disease OA, starts at a very early age.

Key words: Osteoarthritis, Knee joint, Talocrural joint, Transverse tarsal joint

INTRODUCTION

Osteoarthritis (OA) is the most common joint disease in the world, and pain, deformity and loss of function arises by the progresive damage of the joint cartilage (1). Radiological images are important in defining the OA. Narrowing in the joint space, osteophyte, subchondral sclerosis, cyst formation, bone contour abnormalities are common radiological findings. OA frequency increases with age and pain is the most important symptom. However, the relationship between radiological image and joint pain is not always correlated (2).

Knee joint is a large joint of medial, lateral and patellofemoral components. These regions may be affected seperetaly or in different combinations in OA. Knee OA development is slow and usually takes years. The relationship between the clinic and radiology of knee OA is not strong (3).

The foot consists of many bones and small joints. All or a few of these small joints may be affected by the OA. The ankle OA is more rare, although it is a traumatic zone and is a load-bearing joint. OA may be less common due to the complicated geometry

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and limited known biomechanics of the joints in the foot area. OA is more frequent in subtalar joint, but it rarely causes clinical symptoms.

Large osteophytes can often be seen in the talonavicular, calcaneocuboid joints. In the anterior part of the foot, OA is most common in the first metatarsophalangeal joint (4).

OA is mainly a disease in which articular cartilage destruction is accompanied by subchondral bone changes. Although the general approach is to prioritize the destruction of the articular cartilage, it has also been reported that changes in the subchondral bone initiate the destruction of the articular cartilage in some cases. However, when symptoms occur, as both articular cartilage and subchondral bone are usually affected, it is not known which of them started first (5) .

Cadaver studies can provide more accurate information on this issue. In addition, the examination of the bone also provides important data about the relationship of degenerative changes in the joints (6).

In this study, to determine the frequency of OA in the knee, ankle and foot joints in cadavers aged between 30-50 years, radiologically, macroscopically and microscopically, to compare the general features of OA such as location, location, severity and the shape of the lesions in terms of radiological and morphology and to reveal their relationship with each other was aimed.

METHODS

Cases

In our study, 20 amputee lower extremity materials, which were have data usage permission with the decision numbered 2008.01.02.0016 and were fixed with 10% formaldehyde solution in Akdeniz University Faculty of Medicine, Department of Anatomy and with data usage permission, were used. The ages of the cases were between 30 and 50 years.

Radiological Examination

The results obtained from radiographs of the knee joint, talocrural joint and transverse tarsal joint were graded for each joint according to the Kellgren and Lawrence scales. According to this system, joints with different OA were evaluated in 5 degrees between 0-4 (7, 8).

According to this rating; each case rated as;
0 - Normal (OA table absent),
1 - Suspicious (Suspicious appearance for small osteophytes),
2 - Minimal (There are osteophytes. Joint space is intact),
3 - Moderate (Moderate narrowing at the joint space is observed),
4 - Severe (The joint space is greatly impaired and there is sclerosis increase of the subchondral bone.).

Main Points:

- OA is a disorder characterized by pain, loss of function and joint stiffness in advanced ages.
- OA frequency increases with age and pain is the most important symptom.
- According to the data obtained in our study, it was concluded that OA, an advanced age disease, actually begins at a very early age.

Macroscopic Examination

The knee joint, talocrural joint, and transverse tarsal joint opened with proper dissection. Each joint surface divided in to five areas as anterior, posterior, medial, lateral and central (Figure 1, Figure 2 and Figure 3). Articular surfaces were examined morphologically. The joint degeneration was evaluated in 5 grades from 0 to 4 (9, 10).

According to this score, each examined joint surface were graded as;
0 - Normal (No degeneration)
1 - Suspicious (slight deterioration of the cartilage)
2 - Minimal (slight defect at the cartilage, fissure)
3 - Moderate (Obvious erosion bigger than 1.5 cm cartilage defect)
4 - Severe (a defect that has reached the bone)

Microscopic Examination

The samples taken from the knee joint, talocrural joint, and transverse tarsal joint stained by toluidin-blue and hematoxylin-eosin by using routine examination methods. The slides that we prepared were examined and the degeneration changes in cartilage, presence of fibrillation, density, depth, clustering of cartilage cells, necrotic changes were evaluated according to the literature in 5 degrees from 0 to 4 (5, 11).

Figure 1. The division of the articular surfaces into regions is schematized on the distal articular surface of the femur in cadaver images.

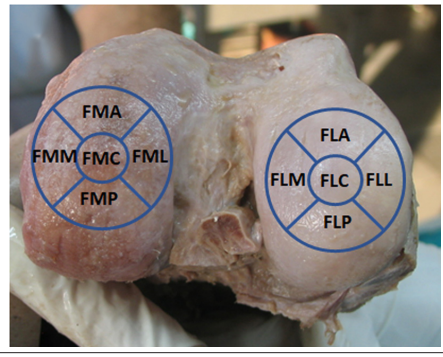
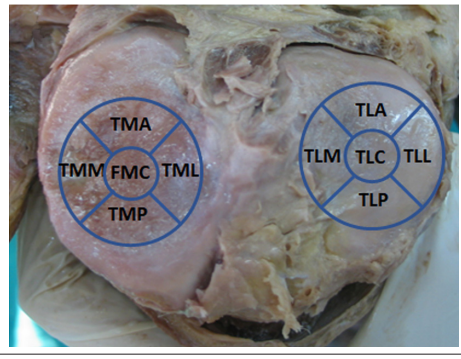
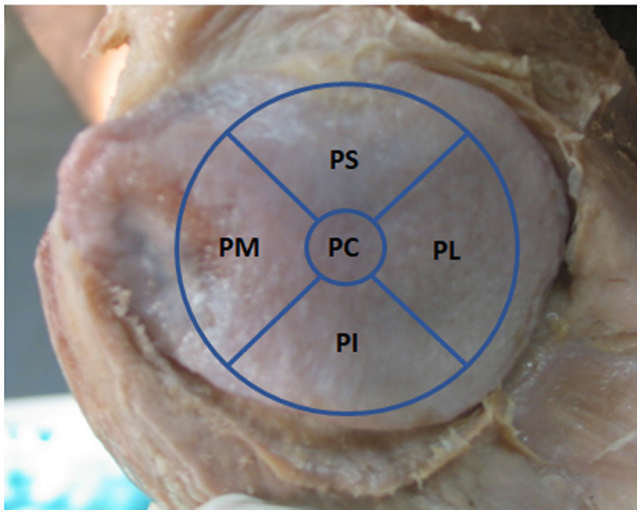


Figure 2. The division of articular surfaces into regions in cadaver images is schematized on the proximal articular surface of the tibia.



According to this classification, each case graded as;
0 - No pathology
1 - Nearly normal structure
2 - Fibrillation (for predegenerative changes)
3 - Cleft or significant erosion (more intense and deeper fibrillations)
4 - Cartilage degeneration, severe changes, intense fibrillation, aggregation of cartilage cells, and necrotic changes.

Figure 3. The division of articular surfaces into regions in cadaver images is schematized on the joint surface of the patella.



Statistical Analyses

All analyzes were performed with the IBM SPSS 23.0 package program (IBM Corp., Armonk, NY). Categorical variables were shown by frequency and percentage. Kappa coefficient was calculated in order to evaluate the agreement of microscopic and macroscopic measurements. The degree of agreement is "insignificant" if the kappa coefficient is equal to or less than 0.20, "weak" if it is between 0.21-0.40, "moderate" if it is between 0.41-0.60, "significant" if it is between 0.61-0.80 and "significant" if it is between 0.81-0.00 defined as "very good" fit. Spearman correlation test was used to determine the relationship between the measurement values obtained from the two methods. P values less than 0.05 were considered statistically significant.

RESULTS

Radiological Results

In the morphological examination, the joint surfaces were divided into five zones, while in the radiological examination, only each joint surface was scored without dividing the joint surfaces into five zones due to the visual limitation of the joint surfaces from all directions. The Kellgren and Lawrence classification is graded 0 to 4. In order to compare the radiological and morphological results more easily, we accepted this rating as 0 normal, 1 and 2 points as mild signs of OA, and generalized it by giving 1 point. We accepted the 3 and 4 scoring groups as severe OA signs and generalized by giving 2 points.

As a result of radiological examination, OA was found in 7 (35%) of the 20 patients, of which 5 were severe and 2 were mild in knee joint. Ankylosis was detected in one case. In the examination of talocrural joint, OA was found in 5 (25%) of the cases, of which 3 were severe and 2 were mild. Severe OA was found in 3 cases (15%) in transverse tarsal joint. In summary, the involvement of the knee joint is observed in the radiological examination most commonly (Figure 4, Figure 5 and Figure 6).

Figure 4. AP radiographs of both knees, bilateral osteoarthritis in the knee joint. Lateral narrowing in both two joints, tapering in eminentia and joint corners.

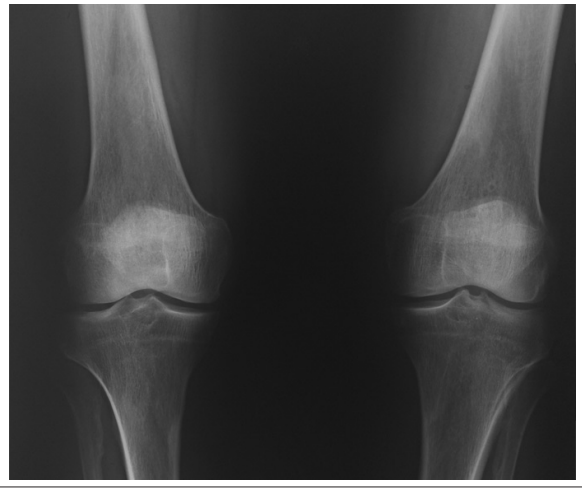


Figure 5.Lateral knee joint radiograph, retropatellar tapering and distance narrowing.

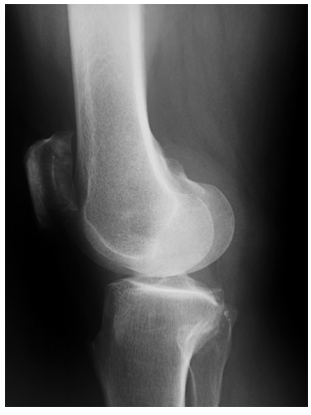
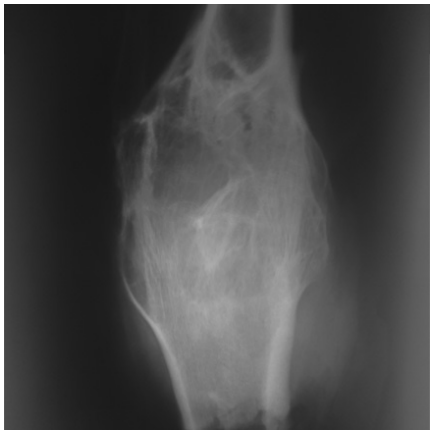


Figure 6. AP knee joint radiograph, ankylosis in the knee joint.



Macroscopic Results

In the macroscopic examination, 67 different areas of 20 cadavers were examined. The knee joint of only 1 case could not be examined because of ankylosis. As a result of the macroscopic examination, the most frequently affected areas in the knee joint of 20 cases were the anterior part of the medial condyle of the femur (FMA), the inner lateral part of the patella (PM), and the least affected areas were the inner lateral part of the lateral condyle of the femur (FLM) and the outer lateral part (FLL) of the lateral condyle of the femur. On the tibial surface, the most affected area was the center of the medial condyle of the tibia (TMC), and the least affected area was the outer lateral part of the lateral condyle of the tibia (TLL).

In the talocrural joint examination, the most affected areas were the inner lateral part of the distal articular surface of the talus (TAM) and the posterior part of the distal articular surface of the talus (TAP), the least affected areas were the center of the distal articular surface of the talus (TAC), the distal center of the articular surface of tibia (TIC), the inner lateral part of the distal articular surface of the tibia (TIM), and the outer lateral part of the distal articular surface of the tibia (TIL) were found. According to the transverse tarsal joint examination, it was observed that this joint was not affected except the anterior part of the distal articular surface (TAA) of the talus. In summary, it was revealed that the medial and patellofemoral surfaces are mostly affected in the knee joint, while the anteroposterior and medial aspects of the talus are mostly affected in the talocrural joint. In general morphological examination, in 6 of 20 cases (4 definite, 2 suspicious, 1 ankylosis) (31.5%) knee OA, in 5 cases (1 definite, 4 suspected) (25%) ankle OA and 1 case (suspected) (5%) transverse tarsal joint OA was determined.

Microscopic Results

As a result of microscopic examination, the most frequently affected areas in the knee joint of 20 cases were found as FMA in the femur (Figure 7), the center of the medial condyle of the femur (FMC), the upper part of the os patella (PS), the PM, and the outer lateral part of the os patella (PL) (Figure 8). It was observed that the lateral part was least affected. On the tibial surface, the most affected area was the outer lateral part of the medial condyle of the tibia (TML) (Figure 9), and the least affected area was the posterior part of the medial condyle of the tibia (TMP).

In the talocrural joint examination, the most affected area in the talus was the posterior part of the proximal articular surface of the talus (TP), the least affected areas were the center of the proximal articular surface of the talus (TC), the most frequently affected area in the tibia was the distal center of the articular surface of tibia (TIC), the least affected area was the anterior part of the distal articular surface (TIA) of the os tibia.

In the transverse tarsal joint, in the talonavicular joint, the most frequently affected area was center of the distal articular surface of the talus (TAC) and the posterior part of the navicula (NAP), while the least affected areas were the outer lateral part of the distal articular surface of the talus (TAL), the anterior part of the navicula (NAA), and the anterior part of the distal articular surface of talus (TAA) and in calcaneocuboid joint it was found that the center of the cuboideum (CUC), the posterior part of the cuboideum (CUP) and the outer lateral part of the cuboideum (CUL) were most common.

In general microscopic examination, the degenerative changes were found in 18 of 20 cases (9 definite, 9 mild) (94.7%) knee joint, in 18 cases (94.7%) (8 definite 10 mild) ankle joint and 20 cases (100%) (9 definite 11 mild) transverse tarsal joint. we found that the knee joint had ankylosis in one case. In another case we observed osteophytic tissue (Figure 10).

Figure 7. Images of microscopic findings in the anterior region of the medial condyle of the femur (FMA).

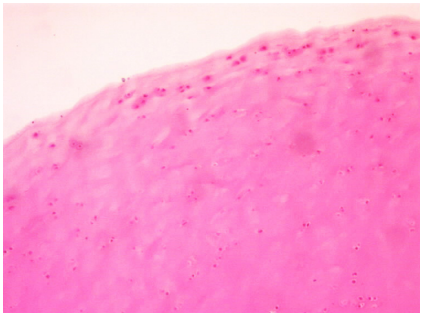


Figure 8. Images of microscopic findings in the lateral region (PL) of the patella and fibrillation in the cartilage tissue

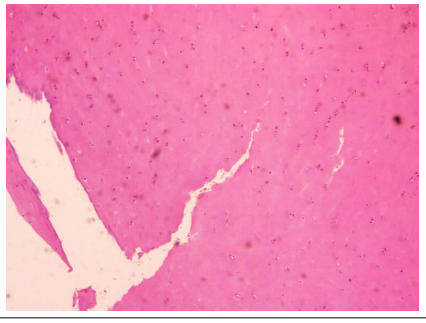


Figure 9. Fibrillation in the cartilage tissue of the lateral region of the outer condyle of the tibia (TML).

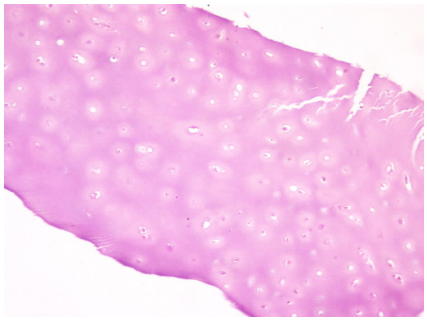
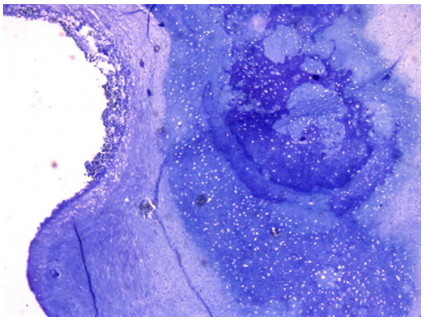


Figure 10. Osteophytic tissue (image taken at 50x magnification).



Radiological, microscopic and macroscopic results are not statistically compatible with each other. Kappa rate is less than 0.800 (Table 1).

When macroscopic and microscopic findings of osteoarthritis were compared in the knee joint, statistically significant difference was observed in PI, PM, PL, FLP, FLM, FMA, FMP, TMM values. In the ankle; Statistically significant difference was observed in TM and TIA values. In foot; statistically significant difference was observed in TAC and CUA values. There was no significant difference in the findings of other parametersin both knee joint, ankle joint and foot (Table 1). The macroscopic and microscopic evaluation of knee joint, talocrural joint and transverse tarsal joint were shown in Table 2.

Table 1. Macroscopic and microscopic evaluation of osteoartrit

	Macroscopic		Microscopic			
Variables, n (%)	**No**	**Yes**	**No**	**Yes**	**Kappa**	**p**
Knee						
FS	16(84.2)	3(15.8)	14(73.7)	5(26.3)	0.066	0.764
FI	15(78.9)	4(21.1)	15(78.9)	4(21.1)	0.050	0.827
PS	16(84.2)	3(15.8)	12(63.2)	7(36.8)	–0.027	0.891
PC	14(73.7)	5(26.3)	13(68.4)	6(31.6)	0.362	0.111
PI	17(89.5)	2(10.5)	13(68.4)	6(31.6)	0.406	**0.028**
PM	13(68.4)	6(31.6)	12(63.2)	7(36.8)	0.650	**0.004**
PL	17(89.5)	2(10.5)	13(68.4)	6(31.6)	0.406	**0.028**
FLA	16(84.2)	3(15.8)	16(84.2)	3(15.8)	0.208	0.364
FLC	17(89.5)	2(10.5)	17(89.5)	2(10.5)	–0.118	0.608
FLP	18(94.7)	1(5.3)	16(84.2)	3(15.8)	0.457	**0.018**
FLM	16(84.2)	3(15.8)	12(63.2)	7(36.8)	0.486	**0.013**
FLL	19(100)	0(0)	19(100)	0(0)	–	–
FMA	11(57.9)	8(42.1)	14(73.7)	5(26.3)	0.431	**0.046**
FMC	13(68.4)	6(31.6)	13(68.4)	6(31.6)	0.269	0.241
FMP	16(84.2)	3(15.8)	14(73.7)	5(26.3)	0.689	**0.002**
FMM	16(84.2)	3(15.8)	17(89.5)	2(10.5)	0.313	0.161
FML	15(78.9)	4(21.1)	14(73.7)	5(26.3)	0.275	0.226
TLA	19(100)	0(0)	16(84.2)	3(15.8)	–	–
TLC	18(94.7)	1(5.3)	11(57.9)	8(42.1)	0.142	0.228
TLP	18(94.7)	1(5.3)	12(63.2)	7(36.8)	–0.101	0.433
TLM	15(78.9)	4(21.1)	11(57.9)	8(42.1)	0.073	0.719
TLL	18(94.7)	1(5.3)	16(84.2)	3(15.8)	–0.086	0.656
TMA	16(84.2)	3(15.8)	15(78.9)	4(21.1)	0.128	0.570
TMC	18(94.7)	1(5.3)	9(47.4)	10(52.6)	–0.106	0.279
TMP	18(94.7)	1(5.3)	18(94.7)	1(5.3)	–0.056	0.809
TMM	16(84.2)	3(15.8)	16(84.2)	3(15.8)	0.999	**<0.001**
TML	17(89.5)	2(10.5)	12(63.2)	7(36.8)	0.070	0.683
Ankle						
TA	17(85)	3(15)	16(80)	4(20)	–0.207	0.348
TC	20(100)	0(0)	19(95)	1(5)	–	–
TP	18(90)	2(10)	16(80)	4(20)	0.231	0.264
TM	17(85)	3(15)	19(95)	1(5)	0.459	**0.015**
TL	19(95)	1(5)	20(100)	0(0)	–	–
TIA	19(95)	1(5)	17(85)	3(15)	0.459	**0.015**
TIC	20(100)	0(0)	17(85)	3(15)	–	–
TIP	20(100)	0(0)	16(80)	4(20)	–	–
TIM	19(95)	1(5)	17(85)	3(15)	–0.081	0.666
TIL	19(95)	1(5)	16(80)	4(20)	–0.087	0.608
Foot						
TAA	20(100)	0(0)	16(80)	4(20)	–	–
TAC	19(95)	1(5)	17(85)	3(15)	0.459	**0.015**

Table 1. Macroscopic and microscopic evaluation of osteoartrit

	Macroscopic		Microscopic			
Variables, n (%)	No	Yes	No	Yes	Kappa	p
Foot						
TAP	20(100)	0(0)	17(85)	3(15)	-	-
TAM	20(100)	0(0)	18(90)	2(10)	-	-
TAL	20(100)	0(0)	18(90)	2(10)	-	-
NAA	20(100)	0(0)	17(85)	3(15)	-	-
NAC	20(100)	0(0)	17(85)	3(15)	-	-
NAP	20(100)	0(0)	14(70)	6(30)	-	-
NAM	20(100)	0(0)	15(75)	5(25)	-	-
NAL	20(100)	0(0)	20(100)	0(0)	-	-
CAA	19(95)	1(5)	14(70)	6(30)	0.219	0.117
CAC	19(95)	1(5)	15(75)	5(25)	-0.091	0.554
CAP	20(100)	0(0)	18(90)	2(10)	-	-
CAM	20(100)	0(0)	17(85)	3(15)	-	-
CAL	20(100)	0(0)	19(95)	1(5)	-	-
CUA	19(95)	1(5)	18(90)	2(10)	0.643	**0.002**
CUC	20(100)	0(0)	15(75)	5(25)	-	-
CUP	20(100)	0(0)	15(75)	5(25)	-	-
CUM	20(100)	0(0)	19(95)	1(5)	-	-
CUL	20(100)	0(0)	18(90)	2(10)	-	-

FS: Upper part of the intercondylar space of the femur, FI: The lower part of the intercondylar space of the femur, PS: Upper part of patella, PC: Center of patella, PI: Lower part of patella, PM: Inner lateral part of os patella, PL: Outer lateral part of patella, FLA: Anterior part of the lateral condyle of the femur, FLC: Center of the lateral condyle of the femur, FLP: Posterior part of the lateral condyle of the femur, FLM: Medial lateral portion of the lateral condyle of the femur, FLL: Lateral part of the lateral condyle of the femur, FMA: Anterior part of the medial condyle of the femur, FMC: Center of the medial condyle of the femur, FMP: Posterior part of medial condyle of femur, FMM: Medial condyle of femur medial lateral part, FML: Lateral part of medial condyle of femur, TLA: Anterior part of lateral condyle of tibia, TLC: Center of lateral condyle of tibia, TLP: Posterior part of lateral condyle of tibia, TLM: Inner lateral portion of the lateral condyle of the tibia, TLL: Outer lateral portion of the lateral condyle of the tibia, TMA: Anterior part of medial condyle of tibia, TMC: Center of the medial condyle of the tibia, TMP: Posterior part of medial condyle of tibia, TMM: Inner lateral part of the medial condyle of the tibia, TML: Lateral part of medial condyle of tibia, TA: Anterior portion of the proximal articular surface of the talus, TC: Center of the proximal articular surface of the talus, TP: Posterior part of the proximal articular surface of the talus, TM: Inner lateral portion of the proximal articular surface of the talus, TL: Lateral part of the proximal articular surface of the talus, TIA: the least affected area was the anterior part of the distal articular surface, TIC: the distal center of the articular surface of tibia, TIP: Posterior part of the distal articular surface of the tibia, TIM: Inner lateral part of the distal articular surface of the tibia, TIL: Lateral part of the distal articular surface of the tibia, TAA: Anterior portion of the distal articular surface of the talus, TAC: Center of the distal articular surface of the talus, TAP: Posterior part of the distal articular surface of the talus, TAM: Inner lateral part of the distal articular surface of the talus, TAL: Lateral part of the distal articular surface of the talus, NAA: Anterior part of the navicular, NAC: Center of the navicular, NAP: Posterior part of navicular, NAM: Inner side of navicular, NAL: Outer part of navicular, CAA: Anterior part of calcaneus, CAC: Center of calcaneus, CAP: Posterior part of calcaneus, CAM: Inner side of calcaneus, CAL: Lateral part of calcaneus, CUA: Anterior part of cuboideum, CUC: Center of the cuboideum, CUP: Posterior part of cuboideum, CUM: Inner side of cuboideum, CUL: outer part of cuboideum.

Table 2. Correlation between macroscopic and microscopic evaluation of knee joint, talocrural joint and transverse tarsal joint

Variables	r	p
Knee		
FS	0.176	0.470
FI	0.254	0.294
PS	0.030	0.903
PC	0.541	0.017
PI	0.679	0.001
PM	0.583	0.009
PL	0.651	0.003
FLA	0.387	0.101
FLC	0.284	0.238

FLP	0.529	0.020
FLM	0.320	0.181
FLL	0.255	0.292
FMA	0.346	0.147
FMC	0.677	0.001
FMP	0.607	0.006
FMM	0.562	0.012
FML	0.585	0.009
TLA	-0.045	0.853
TLC	0.158	0.518
TLM	-0.036	0.884
TLL	0.330	0.168
TMA	0.463	0.046
TMC	0.098	0.690
TMP	0.111	0.650
TMM	0.490	0.033
TML	0.350	0.141
Ankle		
TA	-0.261	0.267
TC	0.085	0.722
TP	0.325	0.162
TM	0.550	0.012
TL	-0.088	0.712
TIA	0.366	0.113
TIC	0.404	0.078
TIP	0.365	0.113
TIM	0.091	0.704
TIL	0.370	0.108
Foot		
TAA	0.278	0.235
TAC	0.069	0.772
TAP	0.216	0.360
TAM	0.432	0.057
TAL	-0.070	0.768
NAA	0.548	0.012
NAC	0.218	0.355
NAP	-0.063	0.792
NAM	0.509	0.022
NAL	0.242	0.304
CAA	0.340	0.143
CAC	0.182	0.441
CAP	0.385	0.094
CAM	0.430	0.058
CAL	0.380	0.098
CUA	-0.120	0.615
CUC	0.113	0.634
CUP	0.253	0.281
CUM	-0.033	0.889
CUL	0.349	0.131

FS: Upper part of the intercondylar space of the femur, FI: The lower part of the intercondylar space of the femur, PS: Upper part of patella, PC: Center of patella, PI: Lower part of patella, PM: Inner lateral part of os patella, PL: Outer lateral part of patella, FLA: Anterior part of the lateral condyle of the femur, FLC: Center of the lateral condyle of the femur, FLP: Posterior part of the lateral condyle of the femur, FLM: Medial lateral portion of the lateral condyle of the femur, FLL: Lateral part of the lateral condyle of the femur, FMA: Anterior part of the medial condyle of the femur, FMC: Center of the medial condyle of the femur, FMP: Posterior part of medial condyle of femur, FMM: Medial condyle of femur medial lateral part, FML: Lateral part of medial condyle of femur, TLA: Anterior part of lateral condyle of tibia, TLC: Center of lateral condyle of tibia, TLP: Posterior part of lateral condyle of tibia, TLM: Inner lateral portion of the lateral condyle of the tibia, TLL: Outer lateral portion of the lateral condyle of the tibia, TMA: Anterior part of medial condyle of tibia, TMC: Center of the medial condyle of the tibia, TMP: Posterior part of medial condyle of tibia, TMM: Inner lateral part of the medial condyle of the tibia, TML: Lateral part of medial condyle of tibia, TA: Anterior portion of the proximal articular surface of the talus, TC: Center of the proximal articular surface of the talus, TP: Posterior part of the

proximal articular surface of the talus, TM: Inner lateral portion of the proximal articular surface of the talus, TL: Lateral part of the proximal articular surface of the talus, TIA: the least affected area was the anterior part of the distal articular surface, TIC: the distal center of the articular surface of tibia, TIP: Posterior part of the distal articular surface of the tibia, TIM: Inner lateral part of the distal articular surface of the tibia, TIL: Lateral part of the distal articular surface of the tibia, TAA: Anterior portion of the distal articular surface of the talus, TAC: Center of the distal articular surface of the talus, TAP: Posterior part of the distal articular surface of the talus, TAM: Inner lateral part of the distal articular surface of the talus, TAL: Lateral part of the distal articular surface of the talus, NAA: Anterior part of the navicular, NAC: Center of the navicular, NAP: Posterior part of navicular, NAM: Inner side of navicular, NAL: Outer part of navicular, CAA: Anterior part of calcaneus, CAC: Center of calcaneus, CAP: Posterior part of calcaneus, CAM: Inner side of calcaneus, CAL: Lateral part of calcaneus, CUA: Anterior part of cuboideum, CUC: Center of the cuboideum, CUP: Posterior part of cuboideum, CUM: Inner side of cuboideum, CUL: outer part of cuboideum.

DISCUSSION

OA is one of the most common rheumatic diseases and its frequency increases with age. It is rare before the age of 50. When it gives symptoms, it is usually present in radiological findings.

Therefore, it is accepted that joint degeneration begins long before it causes symptoms or radiological signs and progresses over the years and becomes symptomatic (1, 2). In this study, the knee, ankle and foot joints of cadavers aged 30-50 years were examined. Therefore, we think that this study, which examines the degeneration in the joints before the age of 50 from a macroscopic, microscopic and radiological point of view, may shed light on the concept of early OA diagnosis. In the literature, cadaveric materials have not been used in studies on OA so far. Takahama (11) performed histological examination of OA on mice. There are studies about the incidence of OA in the intervertebral disc, ankle, hand fingers, carpometacarpal joint, trapezio-metecarpal joint, and trapezium bone (12-16). Especially in the Turkish population, we could not come across such a study in decapitated material between the ages of 30 and 50, and any studies comparing all three methods with each other. Radiological assessment is an important diagnostic criteria for OA determination. Especially in the complaints of the human population accompanied by joint pain, simple and inexpensive as radiography method is preferred. In the study of Claessens et al. (17), it was stated that radiological findings are the most important clinical finding in the definition of OA. In our study, reading was made by a single observer to minimize the reading errors of the radiological graphies. Kellgren and Lawrence performed the radiological evaluation of OA and graded osteoarthritis in five grades (8). We have graded osteoarthritis based on this scale in all of our reviews. The incidence of OA in the knee joint is higher than in other joints (9). In this study, which is consistent with the literature, radiologically detected degeneration is more common in the knee joint than in the talocrural and tarsi transversa joints. Macroscopic examination is an invasive method used by researchers to observe degenerative changes. It cannot be used routinely for diagnostic purposes. In the study of Hirose et al. (18), cartilage degeneration in the talocrural and talocalcaneal joints of cadaver donors was examined macroscopically and it was reported that degenerative changes were seen more frequently in the talocrural joint. In the study of Nakamura et al. (19), degenerative changes in the hand finger joints of elderly cadavers were examined macroscopically and degenerative changes were detected more intensely in the thumb and middle finger. In the study of Koepp et al. (20) in the examination of degenerative changes in the ankle and knee joints in human donors, degeneration was observed increasing with age in men compared to women. Waldron examined the prevalence and distribution of OA in the former Londoner and German population and reported that the shoulder joint was the most affected joint macroscopically (21). In the study of Hirose et al. (18) in which they examined cartilage degeneration in the talocural and talocalcaneal joints from a macroscopic point of view, they observed degenerative changes more frequently in the anterior joint surfaces of the talocalcaneal joint and the medial joint surfaces of the talocrural joint. Similarly, in our study, TAM and TAP were the most degenerated regions in the talocrural joint.

In our study, degenerative changes were found in 31.5% of the knee joints, 25% of the talocrural joints and 5% of the tarsi transversa joints. As can be seen, the most affected joint is the knee joint. In the knee joint, it was determined that the medial and patellofemoral surfaces were mostly involved. This is the part that is most clinically affected. Waldron et al. (21) did not make a detailed evaluation and investigated the rate of involvement of the knee joint with other joints. Binks et al. (22) performed magnetic resonance imaging and histological evaluation in cadaver tissue for the potential role of the synovium of the posterior cruciate ligament in the joint effusion complex in early osteoarthritis. They detected prominent findings associated with microscopic OA changes of the posterior cruciate ligament and showed common pathological features in knee OA detected by magnetic resonance imaging (22). Iriuchishima et al. (23) evaluated OA changes in the patella-femoral joint on 203 cadaver knees and found that the medial area of the patella was the most affected area. In our study, various degrees of degeneration were detected in almost all cases in microscopic examination. The fact that the cases are in the 30-50 age group and there are mild or severe signs of degeneration in all examined joints indicate that OA begins at a very early age. Therefore, we can say that this is a very important finding for OA. Undoubtedly, mild microscopic findings cannot be detected macroscopically and radiologically. In our study, we also could not found relationship between the methods. However, it seems fit in terms of macroscopic and microscopic as can be seen from the table 1 as viewed by the severity. Irlenbuch et al. (23) reported that OA begins with subchondral ossification and progresses in a similar pathogenic mechanism to large joints. In our study, only cartilage was examined. Subchondral bone was not examined. In the study of Takahama (11) on the knees of C 57 mice, OA was detected in all 18-24 month-old mice, no fibrillation in the cartilage and no changes in the synovium were observed, and they evaluated the reason as the mice were not exposed to repetitive microtraumas (11). The presence of OA is observed more clearly in microscopic examination. However, the fact that it is an invasive method makes it impossible to use in healthy individuals. For this reason, it would be beneficial to develop other methods in order to detect degeneration earlier and taking necessary precautions.

CONCLUSION

OA is a disorder characterized by pain, loss of function and joint stiffness in advanced ages. In our study, we preferred age-determined cadaver material. We determined that OA most commonly affects the knee joint in the lower extremity and the medial and patellofemoral parts of this joint. There was no statistical relationship between the three methods we used. Although radiological and macroscopic OA was detected in approximately 1/3 of the cadavers, degeneration of varying degrees was detected in all joints examined in microscopic examination. According to the data obtained in our study, it was concluded that OA, an advanced age disease, actually begins at a very early age.

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REFERENCES

1. Bijlsma JW, Berenbaum F, Lafeber FP. Osteoarthritis: an update with relevance for clinical practice. The Lancet. 2011;377(9783):2115-26. [Crossref]
2. Abramoff B, Caldera FE. Osteoarthritis: pathology, diagnosis, and treatment options. Medical Clinics. 2020;104(2):293-311. [Crossref]
3. Van Tunen JA, Dell'Isola A, Juhl C, Dekker J, Steultjens M, Thorlund JB, et al. Association of malalignment, muscular dysfunction, proprioception, laxity and abnormal joint loading with tibiofemoral knee osteoarthritis-a systematic review and meta-analysis. BMC Musculoskelet Disord. 2018;19(1):1-15. [Crossref]
4. Cushnaghan J, Dieppe P. Study of 500 patients with limb joint osteoarthritis. I. Analysis by age, sex, and distribution of symptomatic joint sites. Ann Rheum Dis. 1991;50(1):8-13. [Crossref]
5. Irlenbusch U, Dominick G. Investigations in generalized osteoarthritis. Part 2: special histological features in generalized osteoarthritis (histological investigations in Heberden's nodes using a histological score). Osteoarthritis and cartilage. 2006;14(5):428-34. [Crossref]
6. Jordan J, Hochberg M, Silman A, Smolen J, Weinblatt M, Weisman M. Epidemiology and classification of osteoarthritis. Rheumatology 4th ed Spain: Mosby Elsevier. 2008:1691-701.
7. Kawasaki T, Inoue K, Ushiyama T, Fukuda S. Assessment of the American College of Rheumatology criteria for the classification and reporting of osteoarthritis of the knee. Ryumachi. 1998;38(1):2-5. [Crossref]
8. Kellgren JH, Lawrence J. Radiological assessment of osteo-arthrosis. Ann Rheum Dis. 1957;16(4):494. [Crossref]
9. Kacar C, Gilgil E, Urhan S, Arıkan V, Dündar Ü, Öksüz M, et al. The prevalence of symptomatic knee and distal interphalangeal joint osteoarthritis in the urban population of Antalya, Turkey. Rheumatol Int. 2005;25(3):201-4. [Crossref]
10. Outerbridge R. The etiology of chondromalacia patellae. J Bone Joint Surg Br. 1961;43(4):752-7. [Crossref]
11. Takahama A. Histological study on spontaneous osteoarthritis of the knee in C57 black mouse. Nihon Seikeigeka Gakkai Zasshi. 1990;64(4):271-81. [Crossref]
12. Kihara H. Anatomical study of the normal and degenerative articular surfaces on the first carpometacarpal joint. Nihon Seikeigeka Gakkai Zasshi. 1992;66(4):228-39. [Crossref]
13. Lagier R, Mac Gee W. Erosive intervertebral osteochondrosis in association with generalized osteoarthritis and chondrocalcinosis; anatomico-radiological study of a case. Z Rheumatol. 1979;38(11-12):405-14. [Crossref]
14. Malemud CJ. The role of growth factors in cartilage metabolism. Rheum Dis Clin North Am. 1993;19(3):569-80. [Crossref]
15. North ER, Eaton RG. Degenerative joint disease of the trapezium: a comparative radiographic and anatomic study. J Hand Surg Am. 1983;8(2):160-7. [Crossref]
16. Tsukahara T. Degeneration of articular cartilage of the ankle in cadavers studied by gross and radiographic examinations. Nihon Seikeigeka Gakkai Zasshi. 1990;64(12):1195-201.
17. Claessens A, Schouten J, Van den Ouweland F, Valkenburg HA. Do clinical findings associate with radiographic osteoarthritis of the knee? Ann Rheum Dis. 1990;49(10):771-4. [Crossref]
18. Hirose K, Murakami G, Kura H, Tokita F, Ishii S. Cartilage degeneration in talocrural and talocalcaneal joints from Japanese cadaveric donors. J Orthop Sci. 1999;4(4):273-85. [Crossref]
19. Nakamura M, Murakami G, Isogai S, Ishizawa M. Regional specificity in degenerative changes in finger joints: an anatomical study using cadavers of the elderly. J Orthop Sci. 2001;6(5):403-13. [Crossref]
20. Koepp H, Eger W, Muehleman C, Valdellon A, Buckwalter JA, Kuettner KE, et al. Prevalence of articular cartilage degeneration in the ankle and knee joints of human organ donors. J Orthop Sci. 1999;4(6):407-12. [Crossref]
21. Waldron H. Prevalence and distribution of osteoarthritis in a population from Georgian and early Victorian London. Ann Rheum Dis. 1991;50(5):301-7. [Crossref]
22. Binks D, Bergin D, Freemont A, Hodgson R, Yonenaga T, McGonagle D, et al. Potential role of the posterior cruciate ligament synovio-entheseal complex in joint effusion in early osteoarthritis: a magnetic resonance imaging and histological evaluation of cadaveric tissue and data from the Osteoarthritis Initiative. Osteoarthritis Cartilage. 2014;22(9):1310-7. [Crossref]
23. Iriuchishima T, Ryu K, Aizawa S, Yorifuji H. Cadaveric assessment of osteoarthritic changes in the patello-femoral joint: evaluation of 203 knees. Knee Surg Sports Traumatol Arthrosc. 2013;21(9):2172-6. [Crossref]