

Original Research Article

Correlation between histopathologic and radiological changes in articular cartilage of the knee joint with degenerative joint disease

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ABSTRACT

Background: Osteoarthritis (OA) of the knee is among the most common disabling diseases which may cause pain and decrease in functional status. It is the commonest form of arthritis and is most prevalent in the elderly, with 50% of adults aged 65-75 years and almost 70% of those 75+ years suffer from this disease. The aim of this study was to investigate consistency of radiologic findings with histomorphologic structure of bone in patients with severe gonarthrosis.

Methods: 62 knees of 57 patients over 60 years old who had stage 3-4 gonarthrosis according to Kellgren-Lawrence classification were included in the study. Patients were separated into two groups as having stage 3 or stage 4 gonarthrosis. All the patients underwent total knee replacement procedure. During the operation distal femoral medial/lateral condyle and proximal tibial medial/lateral plateau were removed and sent to histologic examination for the measurement of thickness of cartilage layer and subchondral bone, number and thickness of trabeculae, space between two trabeculae.

Results: Average thickness of subchondral bone was measured at stage 3 gonarthrosis and at stage 4 gonarthrosis. Only the difference between medial tibial condyle values of two groups was statistically significant. Average trabecula thickness was measured both at stage 3 and at stage 4 gonarthrosis. Only the difference between lateral tibial condyle values of two groups was statistically significant. Furthermore, as for the number of trabeculas and cavity between trabeculae, a significant difference couldn't be found.

Conclusions: Despite having radiological differences two groups can be said to show similar histopathological characteristics.

Keywords: Gonarthrosis, Kellgren-Lawrence classification, Subchondral bone

INTRODUCTION

Osteoarthritis (OA) of the knee is among the most common disabling diseases which may cause pain and decrease in functional status. It is the commonest form of arthritis and is most prevalent in the elderly, with 50% of

adults aged 65-75 years and almost 70% of those 75+ years suffer from this disease.¹⁻³

Aging of the population and the increasing trends of obesity will probably cause the prevalence of knee OA to raise even more in the nearby future.⁴

There is various treatment options according to the plain radiograph findings of osteoarthritis combined with physical examination of the patient. In this study we aimed to investigate the consistency of radiologic findings with histomorphologic structure of bone in patients with severe gonarthrosis (Kellgren-Lawrence stage 3 and 4) and try to display if there is histologic difference between two stages of the disease.

METHODS

The patients with intense knee pain even during resting and had a Kellgren-Lawrence stage 3 and 4 osteoarthritis was planned for the total knee arthroplasty between 2013 and 2014 and they had constituted our study cohort. Knee roentgenographies of the patients were graded by two orthopaedic surgeons who were blind to the study (Figure 1-2). In this context, 62 knees of the 57 patients were involved in the study. The specimens including medial and lateral femoral condyle, medial and lateral tibial plateaus were obtained from the patients undergoing total knee arthroplasty.



Figure 1: The knee roentgenographie of Kellgren-Lawrence stage 3.

After surgery, the specimens underwent fixation in 10% formalin for 2 days. Then all specimens decalcified in the formic acid (10%) for 5-7 days. After decalcification, 4 samples were taken from medial-lateral tibial plateaus, medial-lateral condyles of distal femur. Both normal

cartilage and destroyed cartilage were sampled in the same section. After tissue process (graded alcohols, cleared in xylene and embedded in paraffin wax), 5 micrometer sections were stained with haematoxylin and eosin.



Figure 2: The knee roentgenographie of Kellgren-Lawrence stage 4.

In histological assessment thickness of cartilage, subchondral bone, trabecula and number of trabecula and space between trabeculas were measured. Three measurements from the most severely affected locations were measured histopathologically with light microscopy (under Leica microscope camera) for each sample. Osteoarthritis cartilage histopathology grade and stage were assessed according to the Pritzner et al article.⁵ All the histological assesments were done by an expert pathologist in musculoskeletal subdivision (Figure 3, 4).

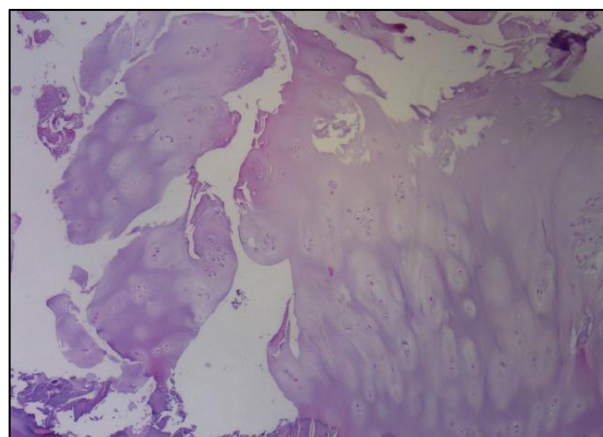


Figure 3: The histopathologically appearance with light microscopy of OARSI 4

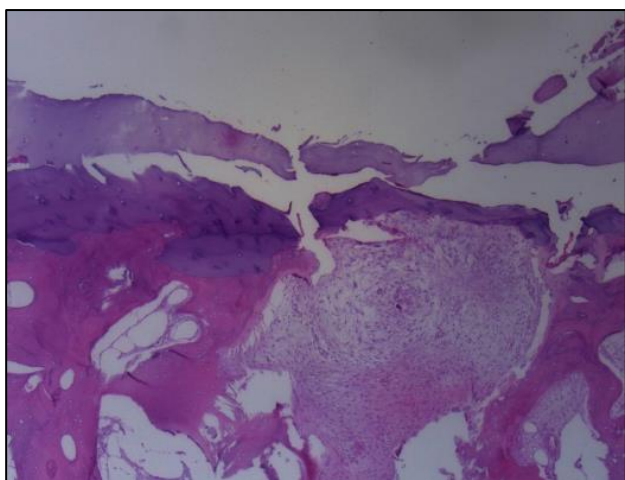


Figure 4: The histopathologically appearance with light microscopy of OARSI 5.

Statistical analysis

The statistical analysis was performed by using SPSS 15 (SPSS Inc., Chicago, IL). The chi-square and Fisher's exact tests were used for descriptive statistics. Pearson chi-square test was used for correlation analysis. A p value of less than 0.05 was accepted as statistically significant.

RESULTS

Average cartilage thickness was measured as 1.85, 2.38, 2.34 and 2.44 mm at medial tibial condyle, lateral tibial condyle, medial femoral condyle and lateral femoral condyle respectively at stage 3 gonarthrosis. These values were 2.32, 2.51, 2.64 and 2.97 mm at stage 4 gonarthrosis. However, the differences between same anatomic regions of stage 3 and 4 groups were not statistically significant.

Average thickness of subchondral bone was measured as 378.6, 335.2, 361.9 and 371.3 mm at medial tibial condyle, lateral tibial condyle, medial femoral condyle and lateral femoral condyle respectively at stage 3 gonarthrosis. These values were 310, 339.8, 333.9 and 308.4 mm at stage 4 gonarthrosis. The difference between medial tibial condyle values of two groups was statistically significant ($p = 0.037$). However, the differences were not statistically significant regarding lateral tibial condyle, medial femoral condyle and lateral femoral condyle.

Average trabecular thickness was measured as 227.4, 216.9, 207.7 and 207.9 mm at medial tibial condyle, lateral tibial condyle, medial femoral condyle and lateral femoral condyle respectively at stage 3 gonarthrosis. These values were 200.8, 191.5, 210.7 and 216.7 mm at stage 4 gonarthrosis. The difference between lateral tibial condyle values of two groups was statistically significant ($p = 0.048$). However, the differences were not

statistically significant regarding medial tibial condyle, medial femoral condyle and lateral femoral condyle.

Furthermore, as for the number of trabeculae and cavity between trabeculae, a statistically significant difference couldn't be found. A significant relationship between parameters at correlation analysis couldn't be set between stage 3 and 4 gonarthrosis.

DISCUSSION

OA is regarded as a whole joint disease with a multifactorial etiology, including increased mechanical stress, ligament derangements, cartilage degradation, subchondral bone changes and muscular impairments.¹⁻³ Supporting the recognition that OA is a disease of the whole joint, there is mounting evidence that subchondral bone plays an important role in OA. Bone remodeling in the OA joint occurs preferentially in the subchondral plate. Surgical specimens from persons with OA have demonstrated that subchondral bone changes, including subchondral bone attrition which is a flattening or depression of the subchondral bony surface unrelated to gross fracture, are common.^{4,6}

As life getting longer with improvements in health care, osteoarthritis has been seen more frequently. This problem makes patients life quality worser. Patient related complaints usually starts with walking, but as the time passes the pain make the patient suffer even during resting. As this problem is getting important, great attempts to prevent and treat this condition has been displayed by the clinicians.

Diagnosis of the osteoarthritis is very easy and a standing knee X- ray is usually enough. There are many staging methods for the grading of osteoarthritis and in 1957 Kellgren and Lawrence introduced one of the widely used grading systems. Kellgren and Lawrence grading system were adapted at the World Health Organization meeting in 1961. This grading system helps the orthopaedic surgeons to decide which measures to take for the treatment of this progressive condition.^{8,9}

The most obvious histopathologic features of an osteoarthritic joint are damaged cartilage, subarticular cysts, alterations in the shape of the articular surfaces and osteophytes. Especially in load bearing areas, the cartilage may be entirely absent and have a polished marble like appearance (eburnation). Microscopic examination of the cartilage reveals a spectrum of changes. In the early stages the cartilage is thicker; with the progression of disease, the joint surface thins and vertically oriented clefts occur. Deep cartilage ulcers, extending to bone, can be seen. There are several macroscopic and microscopic grading systems for histopathologic assessment of osteoarthritis.⁵ These systems are based on the cartilage surface changes in advanced osteoarthritis.

There are many treatment options in knee osteoarthritis as injections, medical treatment, and arthroscopy, osteotomies around the knee, unicondylar arthroplasty and total knee arthroplasty. Patients age, degree of osteoarthritis, complaints makes us to choose our treatment options. In severe gonarthrosis (stage 4 according to Kellgren-Lawrence classification), there is no doubt for the optimal treatment option with arthroplasty. However, in moderate gonarthrosis (stage 3 osteoarthritis) there is still an uncertainty in the treatment strategy. All options listed above can be done for the treatment. In a study Razak BA et al compares the arthroscopic findings and Kellgren- Lawrence classification in osteoarthritic knees and found poor correlation.¹⁰ In that point, we aimed to search for the histopathological difference between stage 3 and stage 4 osteoarthrosis if it can help us to guide our treatment strategy.

It has been hypothesized that cartilage loss is a mechanically mediated process that is more likely to occur in regions subjected to high stress; such areas of high stress are influenced by bone shape.¹¹ Understanding the implications of bony alterations on the biomechanical environment of the joint is critical as biomechanics are known to play an important role in knee OA. The association of static malalignment and higher dynamic knee adduction moments with knee OA progression supports the importance of mechanical influences in knee OA pathogenesis.^{12,13}

Specifically, subchondral bone in OA has increased thickness and volume, but is weaker and less mineralized than normal bone.¹⁴⁻¹⁸ With alterations in its properties, subchondral bone may be less able to absorb and dissipate energy, thereby increasing forces transmitted through the joint and predisposing the articular surface to deformation.^{4,7}

In a study by Hunter et al, histomorphometric evaluation has also demonstrated that BMLs to have many of the same features noted to occur in OA bone, but to a greater extent; these changes include increased bone volume fraction, decreased tissue mineral density, increased trabecular thickness and spacing but decreased number, and to be more plate-like than bone in other areas of the same (osteoarthritic) knee.¹⁹ Overall, these histomorphometric changes constitute the basic changes in osteoarthritis.²⁰

In this study subchondral bone thickness values were compared in four different area of the knee joint. Except medial tibial plateau no difference was observed between stage 3 and 4 gonarthrosis. In medial tibial condyle we detected decreased subchondral bone thickness.

To our knowledge, our study was the first one to compare the relationship between histopathological and radiological changes in knee osteoarthritis. However, Brandt et al compare the radiographic grading with the

arthroscopic articular cartilage in the knee osteoarthritis and they found no difference.²¹

Despite, extensive use of Kellgren- Lawrence classification for the detection of severity of knee osteoarthritis by the clinicians, patient symptom's and signs should be the priority for the optimal treatment modality selection for gonarthrosis.

CONCLUSION

There was not a statistically significant difference between stage 3 and stage 4 gonarthrosis patients in terms of cartilage thicknesss, number of trabeculae and cavity between trabeculae which mean that radiological staging was not consistent with histopathological evaluation. Treatment of patients with gonarthrosis should not rely on radiological staging but patient's solely symptoms and signs. Further studies might be needed to find out modalities for the better deliniation of radiological staging methods.

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