

Research article

Accuracy of clinical examination and magnetic resonance in assessment of chondral lesion of knee joint by arthroscopy

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Abstract

Introduction: The knee joint has a unique anatomical structure in the human body. The localization between the two longest bones in the human body – femur and tibia – makes it prone to injuries, trauma, and other pathologies. Clinical examination of the joint is still the primary method in evaluating the condition of the patient's knee. The study aims to determine the diagnostic accuracy of clinical examination and magnetic resonance (MR) in assessing chondral lesions of knee joint using arthroscopy as a reference standard.

Patients and methods: The examination was conducted on 94 patients (58 males and 36 females) with knee injuries. Clinical examination indicated a primary chondral lesion of knee cartilage in eight patients (five men and three women), with an average age of 45.75. Besides the clinical examination, the diagnostics were performed using MR imaging by Siemens of 0.5 Tesla, and arthroscopy was performed using Storz arthroscope.

Results: Our research has generated the following values of clinical and MR results for chondral lesions: Sensitivity (Se) = 12.5%, Specificity (Sp): could not be calculated, Positive Predictive Value (PPV) = 100%, Negative Predictive Value (NPV) = 0% and Accuracy (ACC) = 12.5%. The accuracy of clinical and intraoperative results for chondral lesion was: Se = 100%, Sp: could not be calculated, PPV = 100%, NPV: could not be calculated, and ACC = 100%. MR imaging and arthroscopy findings of chondral lesion showed: Se = 100%, Sp = 0%, PPV = 12.5%, NPV: could not be calculated and ACC = 12.5%. In comparing the clinical sign and MR and intraoperative result, Positive Predictive Value for patients with chondral lesion was maximal (100%), while comparing MR with the intraoperative result, Positive Predictive Value was 12.5%. In comparison between clinical sign and intraoperative results, the accuracy for patients with chondral lesion was 100%, while comparing the clinical sign with MR result and MR with the intraoperative result, the accuracy was 12.5%.

Conclusion: Our examinations have shown that MR examination is not currently as valid for diagnosing injury of chondral cartilage of knee as the medical community or patients have anticipated it.

Keywords: cartilage lesion of knee, MR, arthroscopy

Introduction

The knee joint has a unique anatomical structure in the human body that, together with localization between the two longest bones in the human body –

femur and tibia – makes it prone to injuries, trauma, and other pathologies. [1].

Joint surfaces of condyle and femur trochlea, tibia, and patella plateau are pre-covered with specialized connective tissue – hyaline cartilage – of different



thicknesses. The joint hyaline cartilage has a complex and unique structure, and its integrity is crucial for the proper functioning of the joint. The cartilage is exceptionally smooth on articulated surfaces, elastic, capable of sustaining high pressure generated even during regular movements within the joint. It is primarily composed of chondrocytes and proteoglycans. The macroscopic and microscopic analysis helped conclude that the cartilage composition is not the same in every segment. Still, it is layered, depending on the collagen fibers orientation and chondrocytes density. [2]

Clinical examination of the joint is still the primary method in evaluating the condition of the patient's knee. The clinical examination is commenced with collecting the anamnestic information, informing on symptoms and description of means of injuring, inspection, palpation, and static and dynamic evaluation of the joint's condition. Clinical tests: Fründ's "fear test," "crepitation," and "Patellar apprehension test" are applied for clinical assessment of the state of the knee cartilage. [1-3] The following method in the diagnostic protocol is most frequently the standard radiography of the knee joint in two directions. Suppose both clinical and radiography signs indicate the lesion of cartilage. In that case, it is necessary to do magnetic resonance (MR) because MR has been proven to be an excellent diagnostic method for evaluating articulated cartilage. Multi-Detector Computed Tomography, with higher spatial resolution, may have a more significant role in diagnosing chondral damages. [2-4]

The aim of the study is to determine the diagnostic accuracy of clinical examination and MR in assessing chondral lesions of the knee joint using arthroscopy as a reference standard.

Patients and Methods

The study included patients treated from a knee injury at polyclinic "MEDICAL Centre" in Travnik between June 1st, 2016, and June 1st, 2018. A total of 94 patients (58 men and 36 women) were examined. Eight patients (five men and three women) had a clinically primary chondral lesion. The youngest patient was eight, while the oldest one was 71-year-old. The mean age was 45.75, with a median of 54.5. Two patients were injured in February, and the others were injured in January, March, April, May, August, and November, respectively. Seven patients with chondral lesions injured their right leg, and one patient injured their left leg. All eight patients suffered from a knee injury and had

clinically positive clinical signs: Fründ's fear test "and "crepitation."

Five patients had MR diagnostics and arthroscopy performed at the same month of injury occurrence. Two patients performed the following month, while one patient arthroscopy was completed two months following the injury.

The MR imaging device was Siemens 0.5 Tesla (T). Arthroscopy was used as the "golden standard" using Storz arthroscope. Arthroscopies performed under local anesthesia with analgesedation went uneventful.

Table 1 shows the calculations of sensitivity, specificity, positive predictive values, negative predictive values, and test accuracy.

	Positive variation	No variation and negative variation	Total
Positive changes	True positive /TP/	False positive /FP/	
No changes and negative changes	False negative /FN/	True negative /TN/	
Total			

Table 1. Table for calculating sensitivity, specificity, positive predictive values, negative predictive values, and test accuracy.

Sensitivity represents the true positive rate. It is calculated as a proportion of True Positive cases concerning the total number of ill patients using the following formula:

$$\text{Sensitivity (Se)} = \frac{TP}{TP+FN} \quad (1)$$

Sensitivity is the measure of the test accuracy related to the population of patients with the condition and represents the test's ability to identify those patients who have the condition.

Specificity is the accuracy in negative samples. It is calculated as a proportion of True negative patients in relation to the total number of healthy patients using the following formula:

$$\text{Specificity (Sp)} = \frac{TN}{TN+FP} \quad (2)$$

Specificity is the measure of test accuracy related to the population of patients who do not have the condition and represents the ability of the test to eliminate the presence of the condition.

Positive Predictive Value (PPV) refers to the patients with positive test results. It is calculated as a proportion of patients with the condition in relation to the total number of patients with positive test results using the following formula:

$$\text{Positive predictive value (PPV)} = \frac{TP}{TP+FP} \quad (3)$$

Negative Predictive Value (NPV) refers to patients with negative test results. It is calculated as a proportion of healthy patients in relation to the total number of patients with negative test results using the following formula:

$$\text{Negative predictive value (NPV)} = \frac{TN}{TN+FN} \quad (4)$$

Accuracy (diagnostic accuracy, test effectiveness, overall accuracy) is calculated as a proportion of accurate results in the diagnostic table using the following formula:

$$\text{Accuracy (ACC)} = \frac{TP+TN}{TP+FP+FN+TN} \quad (5)$$

Results

In observing only those patients with chondral lesions and in testing clinical signs and MR results, it has been determined that one patient (12.5%) has a lesion of knee cartilage, confirmed both clinically and by MR. In seven (87.5%) patients, clinical signs indicated chondral lesion of knee cartilage, while only one patient did not have a cartilage lesion as per MR result. The calculated values of clinical and MR results for chondral lesion: Se = 12.5%, Sp = could not be calculated, PPV = 100%, NPV = 0% and ACC = 12.5%. All of the eight patients had a chondral knee lesion that was diagnosed by clinical signs and confirmed by arthroscopy. The results of accuracy of clinical and intraoperative result for chondral lesion in our study were: Se = 100%, Sp = could not be calculated, PPV = 100%, NPV = could not be calculated and ACC = 100%. One (12.5%) of the eight patients with chondral lesions had both MR and intraoperative results with a lesion, while seven (87.5%) patients had intraoperative results characterizing lesions and MR results without lesion. The values of MR result and arthroscopy result for chondral lesion were: Se = 100%, Sp = 0%, PPV = 12.5%, NPV = could not be calculated and ACC = 12.5%. In eight patients who had chondral lesions, the highest sensitivity (100%) was recorded by comparing intraoperative results with clinical signs and MR imaging results. While comparing clinical signs with MR results, the sensitivity was 12.5%. Specificity for eight patients with chondral lesions was calculable only while comparing MR and intraoperative findings, and it was 0%. The Positive Predictive Value for patients with chondral lesions was maximal (100%) while comparing clinical signs with MR and intraoperative results. While comparing

MR and intraoperative results, Positive Predictive Value was 12.5%. For patients with a chondral lesion, Negative Predictive Value was calculable only while comparing clinical signs with MR results, and it was 0%. The Accuracy for patients with chondral lesions was 100% correlating data of clinical signs with intraoperative findings. In comparing the clinical sign with MR imaging results and MR and intraoperative results, the overall accuracy was 12.5%.

Discussion

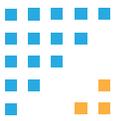
Ever since Reicher et al. [3] 1985 pioneered the introduction of nuclear magnetic resonance imaging for knee examination, it has become the diagnostic method of choice in assessing the knee joint injury with a sensitivity of diagnosing injury of ligament cruciate anterior (LCA) and ligament cruciate posterior (LCP) of 92% – 94% and specificity of 95% – 100%. It provides a better exposition of anatomical structures and pathological changes in the muscle-tendon relationship, soft tissues, ligaments, menisci, and joint cartilage than the Computed Tomography does. [3]

Our study generated the following values of clinical and MR results for chondral lesion: Se = 0.125, Sp = , PPV = 1.000, NPV = 0.000 and ACC = 0.125.

In some patients, cartilaginous or osteochondral defect without osteoarthritis is more frequent. [4,5] Detecting early changes in cartilage and determining the degree of cartilaginous defects without osteoarthritis is essential in deciding the treatment and prognosis of the outcome of the treatment. [6-8]

Although many radiology methods today make the presentation of the joint cartilage possible, only MR ensures the visualization of the outlines of the entire cartilage of the joint unit possible and its inner structure and associated elements subchondral bone. [4]

The majority of the population suffers from cartilage diseases and defects of various causes that generate miscellaneous symptomatology. MR has shown great potential in assessing the condition of the articulated cartilage because it is possible to reach high contrast between the articulated cartilage and the surrounding structures. [5] MR is beneficial in diagnosing osteochondral defects and osteochondritis dissecans presenting with a more or more minor defect on subchondral bone. The display of isolated cartilage abnormality as in chondromalacia of inflammatory or degenerative arthritis poses a huge issue. [5]



Proper interpretation of MR results depends directly on the spatial resolution of the examination performed and the signal-to-noise ratio. The cartilage structure is small compared with spatial resolution of the entire image. Intrachondral variations are too small to be displayed clearly due to the "partial volume effect". As a consequence of the complex structure of cartilage, the MR signal generated from the very cartilage is difficult to quantify because it depends mostly on parameters applied during the imaging. So far, the achievement is that structural and physiological characteristics of cartilage are adequately displayed on the devices of higher magnetic field strength (3T, but on the systems of 1.5T too). This provides enough data with a high spatial resolution that enables visualization of internal cartilage structure [6]. In our research, we used a magnetic field of 0.5 Tesla. Nowadays, coils specialized for MR examination of the knee joint with optimal high resolution on standards MR scanners are widely used. [5, 6]

In the study of Jung et al., 3D isovoxel sequence and standard 2D MR examination were compared. The results obtained for standard 2D examination were 39% for sensitivity, 83% for specificity, while obtained values for 3D isovoxel sequence were 45% for sensitivity and 83% for specificity. [7] In detecting and interpreting chondral defects of the knee joint, standard 2D examination protocol had an average sensitivity of 69.55%, while the moderate specificity was 92.78%. The average sensitivity and specificity for the 3D True FISP sequence in detecting and characterizing chondral defects were 75.06% and 94.16%, respectively. [7]

Ai et al. published the results of a study in which higher sensitivity (70.9% in comparison with 50.6%) and specificity (72.6% in comparison with 58.9%) were obtained compared to standard 2D MR examination in detecting evaluating chondral defects. [8] The results showed the same or better sensitivity and specificity in detecting chondral defects by 3D True FISP sequence compared to the standard 2D protocol. Still, it should be noted that standard examination protocol requires an average of 17 minutes and 20 seconds of imaging, while 3D sequence requires up to 3 minutes. The contribution of this result is indisputable. [9]

The outlines of joint cartilage are better distinguished using FSE T2 fat sat sequences than three-dimensional gradient sequences. The contrast resolution of the cartilage and surrounding structures (meniscus, adipose tissue, muscles, and tendons) is

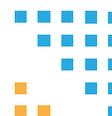
better. [10] In displaying a higher degree of cartilage defect, the FSE T2 fat sat sequence proved the sensitivity of 91.57% of the 2nd, 3rd, and 4th-grade defects. MR and arthroscopy made the identical classification. If only 3rd and 4th grade are taken into account, the result matching would be 100%. The matching of arthroscopic and MR result this high for FSE T2 sequence was also found by Disler et al. [10] Our test has shown the following calculated values of clinical and MR result for chondral lesion: Se = 0.125, Sp -, PPV = 1.000, NPV = 0.000 and ACC = 0.125. MR results and arthroscopy result for chondral lesion were: Se = 1.000, Sp = 0.000, PPV = 0.125, NPV- and ACC = 0.125.

Conclusion

This study has shown weak sensitivity and specificity of preoperative MR diagnostics in detecting cartilage lesions of the knee. High rates of false diagnosis have been noted, suggesting that MR of 0.5 Tesla is not very precise in assessing chondral lesions of knee joint cartilage. We conclude that MR examination is currently not valid for diagnosing the injury of the chondral cartilage of the knee, as the medical community or the patient might anticipate.

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