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Comparing the Accuracy of Radiography and Sonography in Detection of Knee Osteoarthritis: A Diagnostic Study

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Abstract

BACKGROUND: Knee osteoarthritis (OA) is the most common degenerative disorder occurring in older people. Radiography and sonography are convenient techniques to detect diverse pathological features of knee OA.

AIM: The aim of the present study was to evaluate the diagnostic efficacy of radiography and sonography in the detection of diverse features of knee OA.

METHODS: In a prospective cross-sectional diagnostic accuracy study, 50 consecutive patients with suspected knee OA (40 women and 10 men, mean age 41.2 ± 6.1 years), referred to the rheumatology clinic of the Shohada Hospital of Khorramabad. All obtained magnetic resonance imaging (MRI), radiographic and sonography images were evaluated by two radiologists and rheumatologist with sufficient expertise in degenerative knee disorders. MRI has been considered as a gold standard test in evaluating other tests. The sensitivity, specificity, positive predictive values (PPV), negative predictive values (NPV) and accuracy with 95% confidence intervals of radiography and sonography in the diagnosis of knee OA were calculated.

RESULTS: Prevalence of the marginal osteophyte, geode and decreased joint thickness were significantly higher in patients with age > 40 years compared to ≤ 40 years ($P < 0.05$). The incidence of diverse features of knee OA was not significantly different in terms of the patient's gender, except for decreased joint space. The specificity of radiography was higher than its sensitivity.

CONCLUSION: Our study showed that both radiography and sonography are useful imaging modalities, especially to diagnosis the positive cases of knee OA. The specificity of radiography is higher than to its sensitivity for all pathological features of knee OA. The sensitivity of sonography to detect some features of knee OA such as decreased joint thickness is considerably higher than radiography.

Introduction

Knee osteoarthritis (OA), as a degenerative disorder, is the most common diagnosis arthropathy cause of pain and disability in older patients [1], [2]. The prevalence of OA in adult individuals increases with age [2], [3]. Other risk factors include gender, obesity, knee injury and family history of OA. About %25 of the population older than 55 years shows signs of knee OA in radiography [4]. However, due to various parameters such as deposition of calcium crystal and the presence of inflammation, OA shows variability in pathological evidence and clinical symptoms [5].

Although magnetic resonance imaging (MRI) is the current gold standard diagnostic imaging modality for knee OA, it is expensive and not easily available for routine use in clinical practice. Therefore, radiography is usually used as an initial imaging test in patients suspected of having knee OA and also to assess the severity of the disease [6]. Radiographic features of OA include narrowing knee joint space, marginal osteophytes and subchondral sclerosis, which are pathological changes [7]. Sonography is another diagnostic modality which is routinely used in rheumatology clinics to elucidate several features of

knee OA. Ultrasound provides data about the thickness and integrity of cartilage. Also, ultrasound has some advantages over radiography such as low cost, easier to use, convenient and no radiation exposure [8].

Although radiography and sonography are commonly used to evaluate patients with knee OA, few previous studies evaluated the diagnostic accuracy of these diagnostic imaging modalities for knee OA. Thus, the current study aimed to evaluate the diagnostic accuracy of radiography and sonography in the detection of diverse features of knee OA.

Material and Methods

In a prospective cross-sectional diagnostic accuracy study, all consecutive patients with suspected knee OA referring to the Rheumatology Clinic of the Shohada Hospital of Khorramabad, during May 2012 until May 2013, were evaluated. The study was conducted after approval of the institutional ethics committee and obtaining informed consent from all participants. Patients who had sing and symptoms suggesting knee OA and had the radiographic imaging of knee after verification of expert rheumatologist for the presence of osteoarthritis were included in this study. For patients who meet the inclusion criteria, also the sonography and MRI imaging were taken according to previous studies [9]. All MRI images and radiographic were reviewed by two board-certified radiologists and rheumatologist with sufficient expertise in degenerative knee disorders. The diagnosis of knee OA was established according to the American College of Rheumatology clinical/radiographic classification criteria, including the presence of knee pain along with at least one of the following three items along with osteophyte in knee X-Ray: age > 50 years old, morning stiffness < 30 minutes and crepitus on knee motion. Also, patients with the presence of knee pain along with at least three of the following six items classified as knee OA: age > 50 years old, morning stiffness < 30 minutes, crepitus on knee motion, bony tenderness, bony enlargement and no palpable warmth [10].

Statistical analysis

For evaluating the diagnostic accuracy of radiography and sonography in comparison to MRI as the gold standard test, the sensitivity, specificity, positive predictive values (PPV), negative predictive values (NPV) and accuracy with 95% confidence intervals were analysed using X2 test by SPSS software version 16.00. For all statistical outputs, a p-value less than 0.05 were considered significant.

Results

In total, 50 patients (40 women and 10 men) with a mean age of 41.2 ± 6.1 years were studied. Based on MRI findings, decreased joint space and thickness, marginal osteophyte and geode were significantly increased in patients with age > 40 years compared to ≤ 40 years (P < 0.001). The MRI findings of patients are presented in Table 1.

Table 1: Different features of osteoarthritis in the knee using MRI according to patients' age

Type of pathology	Age (years)	Yes	No	P-value
Decrease joint space	≤ 40	6 (20.7)	23 (79.3)	0.001
	> 40	9 (42.9)	12 (57.1)	
Marginal Osteophyte	≤ 40	10 (34.5)	19 (65.5)	0.012
	> 40	17 (81)	4 (19)	
Geode	≤ 40	2 (6.9)	27 (93.1)	0.024
	> 40	7 (33.3)	14 (66.7)	
Joint Thickness	≤ 40	6 (20.7)	23 (79.3)	< 0.0001
	> 40	15 (71.4)	6 (28.6)	
Joint effusion	≤ 40	9 (31)	20 (69)	0.621
	> 40	8 (38.1)	13 (61.9)	
Medial Meniscus rupture	≤ 40	14 (48.3)	15 (51.7)	0.34
	> 40	13 (61.9)	8 (38.1)	
Lateral Meniscus rupture	≤ 40	2 (6.9)	27 (93.1)	0.56
	> 40	0 (0)	21 (100)	
Subchondral sclerosis	≤ 40	2 (6.9)	27 (93.1)	0.63
	> 40	3 (14.3)	18 (85.7)	

In contrast, the prevalence of knee OA was not significantly different based on the gender of patients except for decreased joint space (Table 2).

Table 2: Different features of osteoarthritis in the knee using MRI according to patients' gender

Type of pathology		Yes	No	P-value
Decrease joint space	Women	9 (22.5)	31 (77.5)	0.048
	Men	6 (60)	4 (40)	
Marginal Osteophyte	Women	23 (57.5)	17 (42.5)	0.48
	Men	4 (40)	6 (60)	
Geode	Women	6 (15)	34 (85)	0.35
	Men	3 (30)	7 (70)	
Joint Thickness	Women	17 (42.5)	23 (57.5)	0.88
	Men	4 (40)	6 (60)	
Joint effusion	Women	13 (32.5)	27 (67.5)	0.71
	Men	4 (40)	6 (60)	
Medial Meniscus rupture	Women	21 (52.5)	19 (47.5)	0.73
	Men	6 (60)	4 (40)	
Lateral Meniscus rupture	Women	1 (2.5)	39 (97.5)	0.27
	Men	1 (10)	9 (90)	
Subchondral sclerosis	Women	3 (7.5)	37 (92.5)	0.25
	Men	2 (20)	8 (80)	

Evaluation of different features of the knee using sonography has been shown in Table 3.

Table 3: Different features of osteoarthritis in the knee using sonography according to patients' age

Type of pathology	Age (years)	Yes	No	P-value
Marginal Osteophyte	≤ 40	7 (24.1)	22 (75.9)	0.001
	> 40	15 (71.4)	6 (28.6)	
Joint Thickness	≤ 40	9 (31)	20 (69)	< 0.0001
	> 40	17 (81)	4 (19)	
Joint effusion	≤ 40	10 (34.5)	19 (65.5)	0.54
	> 40	9 (42.9)	12 (57.1)	
Medial Meniscus rupture	≤ 40	10 (34.5)	19 (65.5)	0.11
	> 40	12 (57.1)	9 (42.9)	
Lateral Meniscus rupture	≤ 40	0 (0)	29 (100)	1
	> 40	0 (0)	21 (100)	

The prevalence of osteoarthritis's different features was not affected by the gender of participants (Table 4).

Table 4: Different features of osteoarthritis in the knee using sonography according to patients' gender

Type of pathology		Yes	No	P-value
Marginal Osteophyte	Women	18 (45)	22 (55)	0.39
	Men	4 (40)	6 (60)	
Joint Thickness	Women	22 (55)	18 (45)	0.77
	Men	4 (40)	6 (60)	
Joint effusion	Women	14 (35)	26 (65)	0.38
	Men	5 (50)	5 (50)	
Medial Meniscus rupture	Women	19 (47.5)	21 (52.5)	0.48
	Men	3 (30)	7 (70)	
Lateral Meniscus rupture	Women	0 (0)	40 (100)	1
	Men	0 (0)	10 (100)	

Evaluation of different features of the knee using radiography has been shown in Table 5.

Table 5: Detection of different features of osteoarthritis in the knee using radiography according to patients' age

Type of pathology	Age (years)	Yes	No	P-value
Decrease joint space	≤ 40	6 (27)	23 (97.3)	0.091
	> 40	4 (19)	17 (81)	
Marginal Osteophyte	≤ 40	7 (24.1)	22 (75.9)	0.018
	> 40	12 (57.1)	9 (42.9)	
Geode	≤ 40	0 (0)	29 (100)	0.14
	> 40	4 (19)	17 (81)	
Subchondral sclerosis	≤ 40	4 (13.8)	25 (86.2)	0.021
	> 40	9 (42.9)	12 (57.1)	

According to data, the prevalence of marginal osteophyte, geode and subchondral sclerosis were significantly increased in patients older than 40 years old in comparison to patients having less than 40 years old. The features of knee osteoarthritis in radiography were not significantly different by gender (Table 6).

Table 6: Different features of osteoarthritis in the knee using radiography according to patients' gender

Type of pathology		Yes	No	P-value
Decrease joint space	Women	12 (30)	28 (70)	1
	Men	3 (30)	7 (70)	
Marginal Osteophyte	Women	14 (35)	26 (65)	0.47
	Men	5 (50)	5 (50)	
Geode	Women	3 (7.5)	37 (92.5)	0.79
	Men	1 (10)	9 (90)	
Subchondral sclerosis	Women	10 (25)	30 (75)	0.76
	Men	3 (30)	7 (70)	

Sensitivity and specificity, PPV and NPV of radiography and sonography were presented in Table 7.

Table 7: Diagnostic efficacy indices for radiography in detecting different features of knee osteoarthritis

Radiography	Decrease joint space Percentage (95% CI)	Marginal Osteophyte Percentage (95% CI)	Geode Percentage (95% CI)	Subchondral sclerosis Percentage (95% CI)
Sensitivity	73.3 (44.8-91)	66.6 (46-82.7)	33.3 (9-69)	23 (6.1-54.1)
Specificity	88.5 (72.3- 96.2)	95.6 (76-99.7)	97.5 (85.5-99.8)	94.5 (80.4-99)
Positive Predictive Value	73.3 (44.8-91)	94.7 (71.8-99.7)	75 (21.9-98.6)	60 (17-92.7)
Negative Predictive Value	88.5 (72.3- 96.2)	70.9 (51.7-85.1)	76.9 (73-94.5)	77.7 (62.5-88.2)
Accuracy	84	80	86	76

Based on the data, specificity and PPV of radiography were greater than sensitivity and NPV in all features of knee OA. The sensitivity of radiography to detect Geode and subchondral sclerosis was very low (33.3 and 23%, respectively). Sonography information revealed that diagnostic efficacy indices for different features of knee OA are different (Table 8).

Table 8: Diagnostic efficacy indices for sonography in detecting different features of osteoarthritis

Radiography	Joint effusion Percentage (95% CI)	Marginal Osteophyte Percentage (95% CI)	Joint thickness Percentage (95% CI)	Medial meniscus rupture Percentage (95% CI)	Lateral meniscus rupture Percentage (95% CI)
Sensitivity	70.5 (44-88.6)	74 (53.4-88.1)	90.4 (68.1-98.3)	62.9 (42.4-79.9)	0 (0-80.2)
Specificity	78.7 (60.6-90.3)	91.3 (70.4-98.4)	75.8 (56-88.9)	78.2 (55.7-91.7)	1 (90.7-100)
Positive Predictive Value	63.1 (38.6-82.7)	90.9 (69.3-98.4)	73 (51.9-87.6)	77.2 (54.1-91.3)	0 (0)
Negative Predictive Value	83.8 (65.5-93.9)	75 (54.7-88.5)	91.6 (71.5-98.5)	64.2 (44.1-80.6)	96 (85.1-99.3)
Accuracy	76	82	82	70	96

Same to radiography, the specificity of sonography to the diagnosis of marginal osteophytes was higher than its sensitivity. In contrast, the sensitivity of sonography for detection of joint thickness was more reliable compared to its specificity (90.4% and 75.8%, respectively).

Discussion

According to our data regarding MRI and ultrasound imaging, the incidence of decreased joint thickness significantly augmented in patients older than 40 years old. Conversely, some previous studies showed the age of participant were not significantly associated with the incidence of decreased joint thickness [11], [12]. Also, decreased joint thickness and marginal osteophytes were the most common pathological features in patients having knee OA. In line with our results, Kornattp et al. reported that joint thickness and marginal osteophytes are common features of knee OA in MRI [5].

Despite the development of more sensitive and specific imaging modalities, the radiography remains the most common diagnostic test in rheumatology clinics to detect OA of the knee. The results of our study indicated that specificity and PPV of radiography are more reliable than its sensitivity and NPV. Thus, positive reports of radiography imaging are more trustworthy compared to negative reports. Also, data showed that the subchondral features of knee OA could be properly diagnosed using radiography, and there is no need for MRI imaging as a non-convenient and expensive technique.

About sonography, data showed that sensitivity and specificity of sonography changes in diverse features of knee OA. However, sonography showed excellent agreement with MRI. The specificity of sonography in the detection of marginal osteophyte was more than its sensitivity (91.3 versus 74,

respectively). In contrast, sonography is more sensitive to the diagnosis of decreased joint thickness. Other studies also reported that sonography is specific to detect marginal osteophyte [13], [14], [15]. Also, some studies showed that sonography is sensitive to detect decreased joint thickness [16].

It has been previously indicated that almost all joint effusion can be detected using ultrasonography [15]. But, according to the results of the presented study, just 70.5% of cases with joint effusion have been diagnosed by sonography. The possible explanations for this controversy may be using diverse instruments and different operator, various sample size and different interpretation by radiologists. About medial and lateral meniscus rupture of the knee, the results of our study showed that sonography is not reliable imaging modality in comparison to MRI. It has been reported that the sensitivity of sonography to detecting medial collateral ligament (MCL) injury is 94% [17]. Other studies also indicate that sonography is a very operator dependent diagnostic modality [13].

In conclusion, our study showed that both radiography and sonography are useful imaging modalities, especially to diagnosis the positive cases of knee OA. The specificity of radiography is higher than to its sensitivity for all pathological features of knee OA. The sensitivity of sonography to detect some features of knee OA such as decreased joint thickness is considerably higher than radiography.

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