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Research Article

Assessment of Fixed Flexion Deformity of Knee Joint and it's Association to American College of Rheumatology (ACR) Clinical Disease Severity Criteria for Knee Osteoarthritis

Uqba Nafea Yousif[1], Rayan Mohammad Maree Altaee[2] and May Nafia Yousif[3]*

[1]*Deparmtment of Medicine, Tikrit University, Iraq*

[2]*Department of Rheumatology, Alshikhan General Hospital, Iraq*

[3]*Ministry of Education, Tikrit Science Institution, Iraq*

Abstract

Objective: To assess the knee flexion deformity and to discover it's associations with American College of Rheumatology clinical disease severity criteria of knee Osteoarthritis.

Materials and methods: 154 knee joints measured by Plastic goniometer collected from 81 patients with knee Osteoarthritis as independent cases in this Case-series study. The sample was divided into two groups according to the angle of knee FD and compared regarding (age, gender, and BMI, X-Ray and ACR criteria).

Results: The American College of Rheumatology criteria showed a high significant correlation with both flexion deformity (P-Value 0.001) and the degree of knee flexion deformity (P-Value 0.000).

Conclusion: As long Flexion deformity is a common deforming and disabling complication in knee osteoarthritisit contributes to disease severity as suggested by the relationship with the ACR clinical criteria.

Keywords: Osteoarthritis; Flexion deformity; Plastic goniometer; ACR of OA knees

Introduction

Osteoarthritis (OA) can be defined as a chronic musculoskeletal disease that involves the entire joint organ (bone, cartilage and supporting elements) [1] that affects many different joints, particularly knee, hand, hip and spine [2]. It is characterized by focal degeneration of the cartilage of synovial joints, new bone formation in the form of osteophyte at the base of cartilage lesion and at the joint margin, in addition to remodelling of the joint contour [1].

Osteoarthritis (OA) is the most common joint disorder in the world [3] and it is prevalent in all racial groups [1], irrespective of race, geographical location and climate [4]. OA is a highly prevalent disease with markedly increasing impact worldwide because of the aging of populations [5,6].

The very important clinical characteristics of osteoarthritis are stiffness and pain that is aggravated by prolonged activity [7], tenderness, swelling, crepitus on motion, bony hypertrophy, peri-articular muscle wasting, deformity and marked loss of joint motion [8], radio graphically by osteophytes and Joint Space Narrowing (JSN), and histo pathologically by alterations in cartilage and subchondral bone integrity [9].

Diagnosis is based on observed symptoms, radiographic changes or both [10]. The clinical classification criteria developed by American College of Rheumatology (ACR) remain a popular method of classifying knee OA, recommended for formal clinical and laboratory studies and the practice of primary care [11].

The main goals of therapy are pain relief, improved physical and social function, and maintaining or improving joint mobility [12]. However, treatments do not modify the course or progression of the disease and are not considered curative [13].

Knee flexion deformity or contracture

When the knee is affected by arthritis, the consequent pathological changes may prevent full extension; this is usually referred to as a knee flexion contracture or FD (Figure 1). In the knee osteoarthritis, the degenerative changes developed within particular cartilage and those changes as erosion and/or osteophytes would be likely to accompany a knee flexion deformity [14], and then full extension may be prevented if contracture and adhesions develop in the posterior capsule, the hamstring muscles and possibly the cruciate ligaments. It is common sequelae to knee osteoarthritis, especially in association with varus deformity [15].

Functional limitation, varus malalignment, palpable effusion,

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***Corresponding author:** Uqba Nafea Yousif, Department of Medicine, Faculty of Rheumatology, Tikrit University, Salahaldin, Iraq, E-mail: Okynafy@yahoo.com

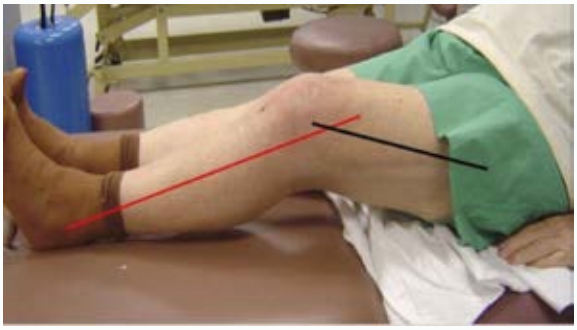

Figure 1: Fixed flexion deformity of the knee joints.

bony enlargement and flexion deformity tended to be associated especially with tibio-femoral osteoarthritis [16].

Knee flexion deformities fall into three grades based on the degree of deformity. Grade one represents mild knee FD which is ten degrees or less. Grade two knee FD is of moderate severity, approximately ten to thirty degrees. Grade three is a severe knee FD of more than thirty degrees [17].

The position of full extension of the lower limb is mandatory for the weight bearing and stability without undue muscular action.

The presence of knee FD may impair function in patients with osteoarthritis and may result from increased energy requirements and earlier fatigue of the quadriceps, causing, limping gait, decreased walking distance or problems with sporting or leisure activities. Knee FD causes increased forces across the patello-femoral joint, predisposing the patient toward anterior knee pain and quadriceps fatigue pain. It may also lead to abnormal loading of the posterior femoral condyles and the posterior tibial plateau during the stance phase of gait [15].

Progressive flexion places more force on the quadriceps, leading to overstretching of the muscle fibers and the infrapatellar tendon, causing patellar fragmentation, chondromalacia, joint instability, muscle weakness in terminal extension and pain secondary to patellofemoral degenerative joint disease [18].

Treatment of knee FD is aimed at halting progression. Physiotherapy and quadriceps strengthening program in some sever FD patient need total arthroplasty [19].

Material and Methods

Study design

Case-series study (descriptive clinical study).

Subjects

Patients with Knee Osteoarthritis (OA)

Eighty one patients aged 40 years to 78 years (20 males and 61 females) complaining from knee pain (unilateral or bilateral) who were diagnosed as knee osteoarthritis patients according to the clinical classification criteria of idiopathic knee OA of the American College of Rheumatology (ACR) which is the following:

Knee pain in addition to at least any three of the six points of the followings:

- Over 50 years of age.
- Less than 30 minutes of morning stiffness.
- Crepitus on active movement.
- Bony tenderness.
- Bony enlargement.
- No palpable warmth of synovium.

The sensitivity of these criteria is 95% and the specificity is 69% [20].

No detectable warmth of the joint to the touch criterion was also added [21].

Inclusion criteria

Any male or female, 40 years in age or older who fulfill the ACR criteria.

Exclusion criteria

- New and old major trauma affecting the knee.
- Inflammatory condition.
- Neoplasm.
- Endocrine diseases.
- Root pain.
- Age less than 40 years.

History

Full history was taken from patients for diagnostic purposes. A questionnaire form was filled which included information from both history and physical examination.

Clinical examination

The clinical examination that was done for the patients included weight and height measurement to derive Body Mass Index (BMI) by this equation:

BMI = (weight in kg) / (height in m) 2 [22].

Where patient in supine position, clinical examination of the knee joint included carful detection of findings required for the ACR criteria (crepitus on active motion, bony tenderness, enlargement and no palpable warmth of synovium).

Then knee Flexion Deformity (FD) measurement was done using a goniometer. Measurement was done in supine position, with the knees extended by the patient as far as possible. The fulcrum of goniometer is aligned with the lateral epicondyle of the femur. The stationary arm is aligned with the midline of the femur toward the greater trochanter of femur, while the moving arm with the midline of the fibula toward the lateral malleolus of fibula.

Instruments and equipments

The instruments used in this study were:

- Weight and height scale (SECA -Germany).
- X-RAY Equipment MULTIX Swing model (SIEMENS -Germany).
- Plastic goniometer (Figure 2).

Investigations

X-Ray is the only investigation that was done for the patients, with standing position, anterio-posterior view of the both knees taken for

Figure 2: Plastic goniometer.

all patients and assessed by the same radiologist to determine the presence of Joint Space Narrowing (JSN), osteophytes, sub cortical sclerosis and cysts.

In addition to determine the severity of JSN and osteophytes of the knees X-Ray by using the semi quantitative grading system (score, 0 to 3) as following:

JSN grades:

- Grade 0 (normal) = no JSN.
- Grade 1 (mild) = 1%-33% JSN.
- Grade 2 (moderate) = 34%-66% JSN.
- Grade 3 (sever) = 67%-100% JSN.

Osteophytes grades:

- Grade 0 (normal) = no osteophytes.
- Grade 1 (mild) = small beak like osteophytes.
- Grade 2 (moderate) = intermediate size osteophytes.
- Grade 3 (sever) = proliferative or mushroom like osteophytes [23].

Methods

The patients enrolled in this study were 81 patients (20 male and 61 female) who had unilateral or bilateral knee OA as follow:

- Twenty males (3 patients unilateral knee OA and 17 patients bilateral Knee OA) (i.e., 37 joints).
- Sixty one female (5 patients unilateral knee OA and 56 patients bilateral Knee OA) (i.e., 117 joints).

Each diagnosed joint was considered as an independent item, so the total studied sample was 154 joints. And the sample was divided into two groups according to the goniometric measurement of the angle of knee FD.

The first group was patients with FD, who's had reading more than 0° (presence of FD). The second group was patients without FD; a fully extended knee (180°) was given an angle of (0°) (absence of FD). These two groups were compared regarding (age, gender, BMI, ACR criteria).

Statistical analysis

The data obtained by study was enrolled through the (Minitab Project) program, version 13 and undergone the following:

- Standard statistical methods were used to determine mean and standard deviation.
- Unpaired T-test to determine the statistical difference between the studied groups.
- Statistical association between the studied groups' data was done by chi-square test.
- Correlation coefficient between two random variables was tested by Karl Pearson correlation.
- Correlation by ranks was tested by Spearman's rho Coefficient of rank correlation.
- P-value ≤ 0.05 was considered statistically significant.

Results

Eighty one patients (n=81). Aged 40-78 years (20 males and 61 females) the number of joints were studied was 154 (n=154).

The patients included in this study had a high BMI, and the majority (95.5%) of studied sample occurs in the higher BMI group (BMI ≥ 25 kg/m^2), with mean BMI for the studied sample was (33.69 ± 5.47) kg/m^2.

The percentage of the flexion deformity within the same age group increased with age group it's more in patient aged above 70 years old 65% and less in age group (40-50) 22.2% (Table 1) and within same gender shows in female higher 49.6% than male gender 45.9% (Table 2).

The number of ACR criteria for OA had mean (4.25 ± 0.94) in the total sample, and it had mean (4.51 ± 0.84) and (4.00 ± 0.96) in both FD and Without FD groups respectively, with a very high significant difference (Table 3). FD showed increasing in percentage with the increase number of ACR criteria (Table 4). Also shows the percentage of flexion deformity within same (number of ACR criteria) group, and it is showing clear increase in the percentage of flexion deformity with the increase of collected number of ACR criteria (Table 4).

Regarding correlations of flexion deformity with X-Ray findings the JSN was present in (79.2%) of studied sample, and it was higher

Table 1: The percentage of flexion deformity within same age group.

Age (years)	Flexion Deformity (No)	Total (No)	Flexion Deformity % in age group
40-50	6	27	0.222
50-60	31	66	0.47
60-70	25	41	0.61
≥ 70	13	20	0.65
Total	75	154	0.487

Table 2: The percentage of flexion deformity within same gender.

Sex	Flexion Deformity (No)	Total (No)	Flexion Deformity % in the same gender
Male	17	37	0.459
Female	58	117	0.496
Total	75	154	0.487

Table 3: Flexion deformity distribution according to number of ACR criteria.

No. of ACR Criteria	With Flexion		Without Flexion		Total		P-Value*
	No.	(%)	No.	(%)	No.	(%)	
3	10	13.3	31	39.2	41	26.6	0
4	24	32	22	27.9	46	29.9	NS
5	34	45.3	21	26.6	55	35.7	0.015
6	7	9.3	5	6.3	12	7.8	NS
Total	75	100	79	100	154	100	0.003
Mean ± SD	4.51 ± 0.84		4.00 ± 0.96		4.25 ± 0.94		0.001**

*Chi-square test; **Unpaired t-test

in patients with FD than in those without FD (86.7%) and (72.2%) respectively, with just significant difference. And osteophytes were present in (83.1%) in the studied sample, also were present in higher percentage in patients with FD than those without FD (88.0%) and (78.5%) respectively, with no significant difference. While sclerosis were present in (43.5%) of the studied sample, but in lower percentage in FD group than in those without FD, (38.7%) and (48.1%) respectively, with no significant difference Cysts were present in (2.6%) of the total sample, but in lower percentage in FD group than in those without FD, (0.0%) and (5.1%) respectively, with just significant difference. JSN and osteophytes scores both showed a very high significant correlation with both FD and the degree of FD parameters Table 5 and 6 respectively.

Table 4: The percentage of flexion deformity within same number of ACR criteria.

ACR Criteria	Flexion Deformity No.	Total No.	Flexion Deformity % in the same no. of ACR criteria
3	10	41	0.244
4	24	46	0.522
5	34	55	0.618
6	7	12	0.583
Total	75	154	0.487

Table 5: Correlations of flexion deformity with age, gender, no. of ACR criteria, no. of XR findings, score of JSN and scores of osteophytes.

Correlation of Flexion Deformity with the follow	r-Value	P-Value*
Age	0.269	0.001
Gender (Male)	-0.031	NS
Gender (Female)	0.031	NS
No. of ACR Criteria	0.274	0.001
No. of XR Findings	0.021	NS
The Score of JSN	0.283	0
The Score of Osteophytes	0.263	0.001

*Spearman's rho Correlation

Table 6: Correlations of the degree of flexion deformity with age, gender, no. of ACR criteria, no. of XR findings, score of JSN and score of osteophytes.

Correlation of The Degree of Flexion Deformity with the follow:	r-Value	P-Value*
Age	0.409	0
Gender (Male)	-0.01	NS**
Gender (Female)	0.01	NS**
No. Of ACR Criteria	0.337	0
No. Of XR Findings	0.089	NS
The Score of JSN	0.26	0.001
The Score of Osteophytes	0.282	0

*Pearson Correlation
**Spearman's rho Correlation

Discussion

Flexion Deformity (FD) is a real complication of knee OA which severely affects the activities of daily living of a person [15] and it's one of the most common causes of disability in old people [6].

The present study was performed to evaluate and the signs of OA that include Joint Space Narrowing (JSN), osteophytes, subchondral sclerosis and cysts. In parallel, other risk factors such as age, gender, Body Mass Index (BMI) and clinical disease severity which is assessed by American College of Rheumatology (ACR) clinical criteria for knee OA.

Many risk factors and their association with knee OA have been reported in several studies. Well recognized factors associated with knee OA include age, female gender, and obesity [24], but previous studies dealing directly with the frequency of FD in knee OA could not be founded in reviewing the literatures.

This study shows that the percentage of FD increases with age (Table1) and was compatible with other studies that founded the positive association between increasing age and physical impairment in knee OA [25]. This association may be partly explained by FD which increases with age.

Female gender is a major predisposing factor of knee OA [26,27] and is reportedly associated with worse clinical manifestations of knee OA than in men [28,29]. However in this study there's no effects of gender on FD (Table 2) also the effects of gender on the relationship between symptoms and radiographic grades of knee OA are not well understood [30].

The majority (95.5%) of studied sample occur in the higher BMI group (BMI ≥ 25 kg/m^2) Obesity and increased BMI is well known to be associated with knee OA and disability [31,32]. However, the effect of body weight on disease progression has been less consistently demonstrated than its effect on disease incidence while the existence of malalignment with increased BMI increase the risk of Knee OA progression [32] and some studies showed that the patients groups with moderate to severe knee OA were older and more obese than those with no to mild radiographic osteoarthritis [16].

The number of ACR criteria for OA had very high significant difference of mean in both with FD and Without FD groups (Table 3) and those with a FD showed increasing in percentage with the increase number of ACR criteria (Table 4).

The number of ACR criteria had a very high significant correlation with both FD and the degree of FD parameters Table 5 and 6) respectively. This result suggests an association between clinical severity and FD and certainly alters the normal pattern and the biomechanics of normal knee function and walking; keeping in mind that full extension of the knee is part of the normal walking cycle. Furthermore, the quadriceps muscle is over worked in the presence of FD [33]. Therefore some disability and clinical severity should be expected in the presence of FD.

The radiographic severity of knee OA is frequently assessed using the Kellgren-Lawrence (K/L) grading system, which relies on specific radiographic findings [34] and XR findings when taken separately, JSN and osteophytes scores were slightly higher in percentage and showed a very high significant correlation with both FD and the degree of FD, while subchondral sclerosis and cyst showed the opposite (Table 5 and 6) however number of XR findings showed no significant correlation with both FD and the degree of FD.

Review of literatures provide limited studies about the knee FD per se in OA, majorities of the studies have dealt with the pathological finding that may contribute to FD; it was supposed, for example, that osteophytes formation would be likely to accompany a FD in knee OA [14].

This study suggests the presence of association between FD and knee OA severity. It may be argued that the OA process leads to FD. However, once FD is established, it will add a burden on the knee which may accelerate the OA process, and that need further study and research.

Since the paucity of studies which deal specifically with flexion deformity in knee OA, urge us to suggest and recommend that this subject needs further research; especially that flexion deformity is a major challenging problem when the patient need total arthroplasty [19].

Conclusion

- Flexion deformity is a common deforming and disabling complication in knee osteoarthritis.
- Flexion deformity contributes to disease severity and disability as suggested by the relationship with the ACR clinical criteria.

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