Original Paper

Hip Joint Abnormalities During Midstance in Osteoarthritic Patients

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ABSTRACT: Osteoarthritis is one of the most debilitating diseases in Europe affecting the lower limb joints, especially the hip and knee, having a bad influence on gait in the long run as well. Rehabilitation physicians use gait in order for the whole body to be seen in ensemble, and through midstance as moment of gait to also take predilection to falls into consideration. Goniometry is the quantifiable measure of a rehabilitation treatment by measuring the range of motion of each treated joint and studied during time. The patients that volunteered to be part of this study have been divided into four groups, depending on the level of osteoarthritis present at the lower limb joints: hip, knee, both hip and knee osteoarthritis or control group with no osteoarthritis, have been asked to walk for a few times and the video recordings were uploaded into the Angles App where we measured the lower limb joint angles during midstance. Patients with knee osteoarthritis present a more extended hip on both dominant and non-dominant sides compared to the ones with hip osteoarthritis, hip and knee osteoarthritis or control group. The results can be explained through the body's kinematic chains that link the knee and hip, hip and pelvis during the midstance phase in the sagittal plane. A physician can use a video goniometry app in order for him to thoroughly evaluate an osteoarthritic patient as well as follow him or her during the entire course of treatment.

KEYWORDS: *Goniometer, hip, midstance, osteoarthritis, covid-19, telemedicine.*

Introduction

Osteoarthritis (OA) is a joint mobility disease, making over 40 million people in Europe suffer from joint impairment [1,2].

As an early diagnosis method, gait analysis for hip and knee OA has been taken into account [3,4], but only small groups of subjects have participated in the studies, thus, until now, the kinematic parameters have not been considered sufficient for them to be quantifiable measures for OA [5,6].

Physicians have been using gait analysis as a means of diagnosis for multiple diseases with musculoskeletal or neurological deficiencies on patients that are coming into rehabilitation clinics [7].

Gait is divided between 2 important phases, that are also subdivided: stance phase consisting of loading response, midstance and terminal stance; and swing phase: initial swing, midswing and terminal swing [8,9].

Midstance has been chosen as the moment of gait to be focused on in this paper, since it is very important for rehabilitation in order for a complete rehabilitation program to be established based on stability [10-12] given the kinematic chain of the impaired patient [13].

Goniometry is one of the most common clinical tools used for the physician to measure the range of motion, the video goniometer in both two dimensional and three-dimensional devices has been thought and researched lately because of its accessibility and reliability.

Recent literature has discussed that goniometry apps offer a very comfortable and affordable alternative to the classic goniometer [14-16], offering comparable results to the joint angle parameters already measured through other modalities [17,18].

Photographic-based apps were used by researchers for them to be able to make assessments using as little equipment as possible at a higher level, lowering the investments and the effort of the physician.

Also, given the Covid-19 pandemic context, a telemedicine approach can be taken into account since the patient can show the physician their improvement or changes without actually having to go to the rehabilitation facility [15,16,19-22].

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Materials and Methods

Participants

In this paper we have a single-blinded randomized trial.

We have examined 154 subjects suffering from lower limb OA, having no functional differences between the left and right limb and the right side as the dominant side.

We have excluded 12 patients out of the study because 12 of them had stage 4 OA with severe gait disfunctions and needed the help of assistive devices to walk, 6 of them also suffered a stroke and severe lesions (Figure 1).

The recruitment was made based on volunteering.

The 136 subject groups, 42 to 83 years old, were divided as such: people suffering hip OA (HOA), knee OA (KOA), hip and knee OA and control group.

This study has been conducted according to the Declaration of Helsinki and its principles with an Informed Consent provided by all the volunteers that were to be tested afterwards. The study has been approved by the Ethics Committee of the University of Medicine and Pharmacy of Craiova.

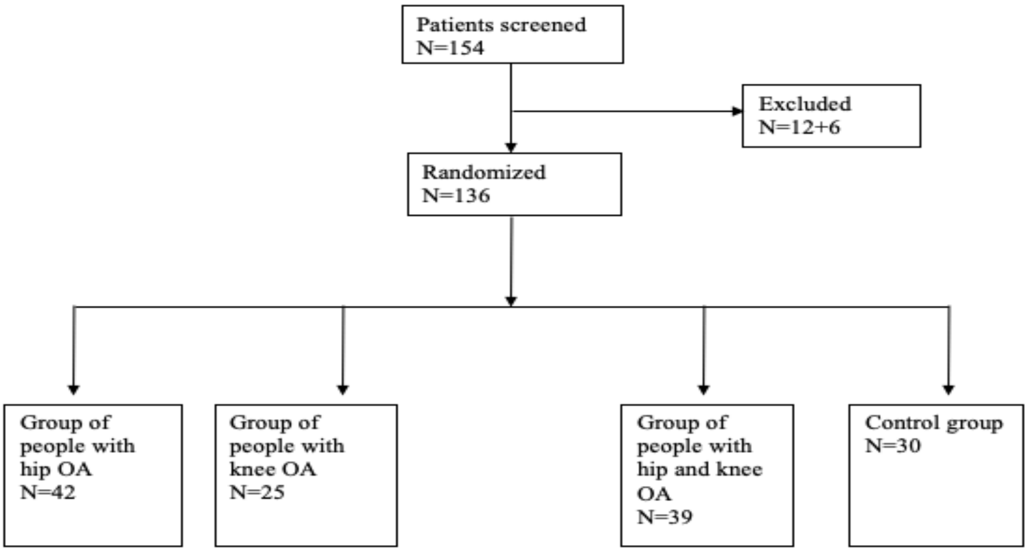

Figure 1. Flowchart of the explanation of the subjects' assignment during the study.

Statistical Analysis

A comparison within the groups has been made for this observational study [1] using the standardized methods [23] with the help of the ordinary one-way ANOVA test.

We have used a personal computer on which a statistics package software was installed (GraphPad Software was used, with Prism 9.0 for macOS being the updated version).

The statistical significance was set at $p<0.05$.

The calculations for statistical analysis data were made as means±95% Cis.

We asked the patients to walk with their normal gait speed for a few times for them to adjust to the conditions.

We set the camera at 1m above the ground, fixing it with the recording towards the lateral side of the patient, for us to be able to make the measurements in the sagittal plane, thus offering us the stability of the video examination and the capacity of visualization of the entire subject's body.

The patient walked 6 times, a video recording was made 3 times on each side and the videos were uploaded on the Angles video goniometry App [24].

The joint angles of hip, knee and ankle were evaluated during midstance and midswing, but during this paper we will only discuss the hip angles during midstance.

Results

In Table 1 are shown the differences between the left and right side of the measured subjects at a normal speed (Figure 2), revealing the fact that the patients with HOA present a higher hip joint angle during midstance on the right side than the patients suffering from KOA with 7.683 degrees more.

The patients with KOA compared to the ones people with hip and knee OA they have a more flexed hip with a mean of-8.228 and than the control group with a mean of-7.775.

On the left side, the subjects with HOA have a more extended hip than the ones suffering from KOA with a mean difference of 7.944 degrees, the patients with KOA on the left hip present a more flexed hip than the patients with hip and knee OA (-8.288 degrees) and also compared to the control group on the left side (-6.039 less degrees as a mean difference).

Table 1. Hip joint angle during midstance. Differences between the left and the right side of the measurements. Normal gait speed of the participants.

Šídák's multiple comparisons test	Mean Diff	95,00% CI of diff	Adjusted P value
Subjects with HOA-right hip vs. Subjects with KOA-right hip	7,683	3,317 to 12,05	p<0,0001
Subjects with HOA-left hip vs. Subjects with KOA-left hip	7,944	3,577 to 12,31	p<0,0001
Subjects with KOA-right knee vs. Subjects with hip and knee OA-right hip	-8,228	-12,66 to -3,800	p<0,0001
Subjects with KOA-right hip vs. Control group-right hip	-7,775	-12,46 to -3,094	p<0,0001
Subjects with KOA-left hip vs. Subjects with hip and knee OA-left hip	-8,288	-12,72 to -3,860	p<0,0001
Subjects with KOA-left hip vs. Control group-left hip	-6,039	-10,72 to -1,359	p=0,0025

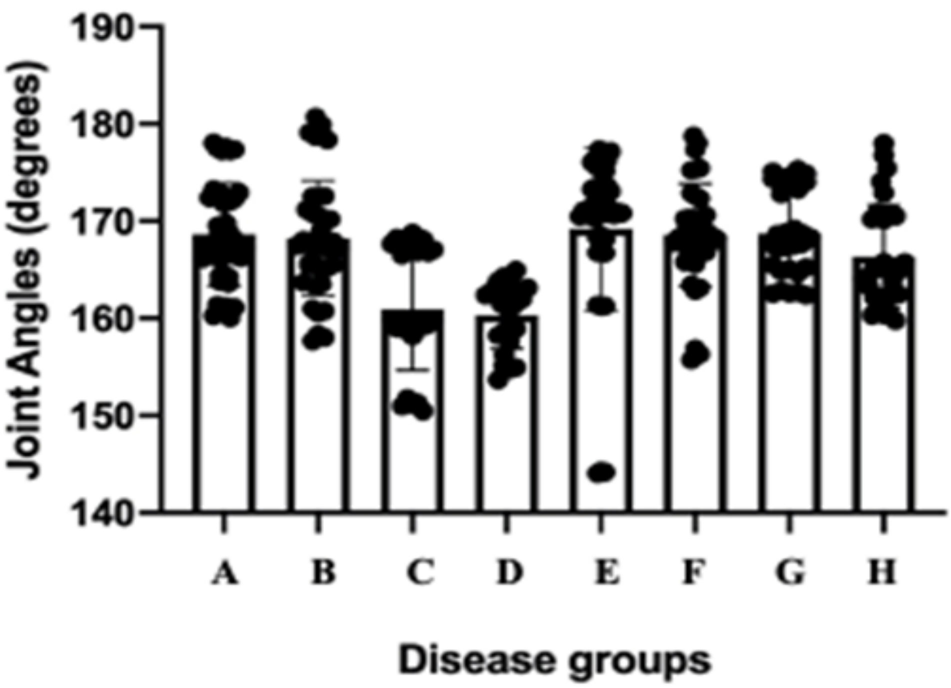

Figure 2. Hip joint angle measurements during midstance. Fluctuations between disease groups with normal gait speed. Left versus right.

A-Subjects with HOA-right hip; B-Subjects with HOA-left hip; C-Subjects with KOA-right hip; D-Subjects with KOA-left hip; E-Subjects with hip and KOA-right hip; F-Subjects with hip and KOA-left hip; G-Control group-right hip; H-Control group-left hip.

In the comparison made in Table 2 between the female groups targeted in the study (Figure 3, Groups A-H), the hip joint during midstance is more extended in the patients suffering from HOA on the right (7.463 more degrees as a mean difference) and left (6.927 more degrees as a mean difference) side compared to the subjects in the KOA group.

Furthermore, the KOA group presents a more flexed hip comparing to the hip and knee OA on the right side (-7.814 degrees as a mean difference), and to the control group on the right side (-7.854 degrees as a mean difference) as well.

The group with KOA also has a more flexed hip on the left side with a mean difference of-9.088 degrees compared to the control group on the left side.

Table 2. Hip joint ROM during midstance.
Fluctuations between right and left side of the female groups with normal gait speed.

Šídák's multiple comparisons test	Mean Diff	95,00% CI of diff	Adjusted P value
Subjects with HOA-right hip vs. Subjects with KOA-right hip	7,463	2,211 to 12,72	p=0,0005
Subjects with HOA-left hip vs. Subjects with KOA-left hip	6,927	1,675 to 12,18	p=0,0018
Subjects with KOA-right hip vs. Subjects with hip&knee OA-right hip	-7,814	-12,82 to-2,806	p<0,0001
Subjects with KOA-right hip vs. Control group-right hip	-7,854	13,78 to-1,929	p=0,0017
Subjects with KOA-left hip vs. Control group-left hip	-9,088	14,10 to-4,080	p<0,0001
Subjects with KOA-left hip vs. Control group-left hip	-6,998	-12,92 to-1,073	p=0,0083

Table 3 reveals the fact that the male subjects (Figure 3, groups I-P) suffering from hip OA have a more extended hip on the right side than the ones suffering from KOA, with an 8.837 degrees mean difference.

The subjects with KOA have a-9.827 degrees more flexed hip joint on the right side than the subjects in the hip and knee OA group.

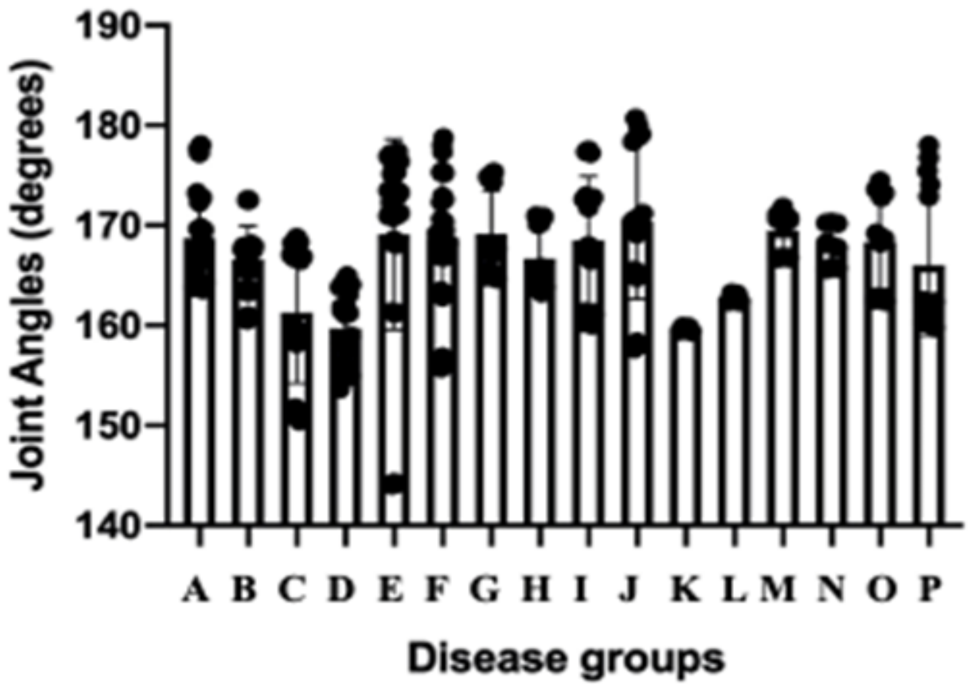

Figure 3. Hip joint angles measurements during midstance. Fluctuations between disease groups with normal gait speed. Female patients with OA. Male patients with OA.

A-Subjects with HOA-right hip-female group; B-Subjects with HOA-left hip-female group; C-Subjects with KOA-right hip-female group; D-Subjects with KOA-left hip-female group; E-Subjects with hip and KOA-right hip-female group; F-Subjects with hip and KOA-left hip-female group; G-Control group-right hip-female group; H-Control group-left hip-female group; I-Subjects with HOA-right hip-male group; J-Subjects with HOA-left hip-male group; K-Subjects with KOA-right hip-male group; L-Subjects with KOA-left hip-male group; M-Subjects with hip and KOA-right hip-male group; N-Subjects with hip and KOA-left hip-male group; O-Control group-right hip-male group; P-Control group-left hip-male group.

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Table 3. Hip joint ROM during midstance.
Changes between right and left side of the male groups with normal gait speed.

Šídák's multiple comparisons test	Mean Diff	95,00% CI of diff	Adjusted P value
Subjects with HOA-right hip vs. Subjects with KOA-right hip	8,837	0,06718 to 17,61	p=0,0466
Subjects with KOA-right hip vs. Subjects with hip&knee OA-right hip	-9,827	-19,50 to-0,1508	p=0,0433

Discussions

Overall, the patients suffering only from KOA present a more flexed hip on both the dominant and the non-dominant side, comparing to the subjects with hip disease that present a more extended hip on both sides.

The subjects suffering also from HOA, hip and knee OA or control groups present more extended hips when compared to the KOA group alone.

These results can be compared to the most recent literature as well [25,26].

On one hand, the hip is more extended in patients with the hip osteoarthritis afflictions and can be explained by the diminishing of the range of motion due to the disease itself, it could even be a coping mechanism for the pain, on the other hand another explanation for this phenomenon would be the higher participation of the hamstring muscles [27,28] in the KOA rather than in HOA or hip and knee OA group of patients, that would appear to have closer values to the control groups rather than the KOA groups when it comes to hip measurements.

Midstance has been known to be the point of the open kinematic chain, giving the stability of the trunk through the limb remaining on the floor [29,30].

Correlations have been proven to be existent between knee and hip, hip and pelvis during the stance phase in the sagittal plane [29].

Mobilizers of the trunk (gastrocnemius, quadriceps, hamstrings, adductors, hip flexors) can become overactive and react to pain and pathology with spasm, altering the posture during gait, thus the more flexed hip that appears in our study can be explained in KOA pathologies, more than in HOA and hip and knee OA, whereas in the latter two, the hip presents as more extended [31].

The functional torque between hamstrings and quadriceps can be one of the causes that gives these differences between the four groups of subjects [32].

Given the details we already know about closed kinetic chains, we can furthermore implement a better rehabilitation program with integrated corrective exercises for the stability of the lower limb, enhancing the proprioception [30].

Conclusion

Concluding, physicians can measure with the help of their personal phone through video goniometry apps, range of motions for each joint, during the examination in both static and dynamic (gait), before and after implementing a rehabilitation program.

One can store, in this way, in a greater archive, the patients' data and see their evolution during more rounds of treatment and even add through telemedicine evaluation, when it comes to the inability of the patient to come into the rehabilitation facility.

A thorough analytic, clinical and functional evaluation of the patient must be done, along with the closed and opened kinematic chain of the lower limb at the admission, in order for a complete diagnostic and optimal treatment to be delivered.

Abbreviations

OA-osteoarthiritis, KOA-knee osteoarthritis, HOA-hip osteoarthritis; ROM-range of motion.

Conflict of interests

None to declare.

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