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Original article

Gait characteristics of women with fibromyalgia: a premature aging pattern

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ABSTRACT

Background: Fibromyalgia is a condition which involves chronic pain. Middle-aged individuals with fibromyalgia seem to exhibit changes in gait pattern, which may prematurely expose them to a gait pattern which resembles that found in the elderly population.
Objective: To determine the 3 D spatial (linear and angular) gait parameters of middle-aged women with fibromyalgia and compare to elderly women without this condition.
Methods: 25 women (10 in the fibromyalgia group and 15 in the elderly group) volunteered to participate in the study. Kinematics was performed using an optoelectronic system, and linear and angular kinematic variables were determined.
Results: There was no difference in walking speed, stride length, cadence, hip, knee and ankle joints range of motion between groups, except the pelvic rotation, in which the fibromyalgia group showed greater rotation ($P < 0.05$) compared to the elderly group. Also, there was a negative correlation with pelvic rotation and gluteus pain ($r = - 0.69$; $P < 0.05$), and between pelvic obliquity and greater trochanter pain ($r = - 0.69$; $P < 0.05$) in the fibromyalgia group.
Conclusion: Middle-aged women with fibromyalgia showed gait pattern resemblances to elderly, women, which is characterized by reduced lower limb ROM, stride length and walking speed.

Características da marcha de mulheres com fibromialgia: um padrão prematuro de envelhecimento

Palavras-chave:
Dor crônica
Envelhecimento
Marcha

RESUMO

Introdução: Fibromialgia é uma condição que envolve dor crônica generalizada. Além disso, mulheres de meia idade com fibromialgia apresentam alterações no padrão de marcha, expondo-se prematuramente a um padrão de marcha semelhante ao encontrado na população idosa.

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Objetivo: Determinar os parâmetros espaciais (linear e angular) da marcha de mulheres com fibromialgia e compará-los com idosas sem essa condição.
Métodos: 25 mulheres (10 no grupo com fibromialgia e 15 no grupo de idosas) se qualificaram como voluntárias para participar do estudo. A análise cinemática foi realizada por meio de um sistema optoeletrônico, e as variáveis lineares e angulares foram determinadas.
Resultados: Ambos os grupos apresentaram similaridades na velocidade da marcha, tamanho da passada, cadência e amplitude de movimento do quadril, joelho e tornozelo ($p > 0,05$), exceto para a rotação da pelve, na qual o grupo com fibromialgia apresentou maior rotação de quadril ($p < 0,05$) quando comparado ao grupo de idosas. Além disso, houve correlação negativa no grupo com fibromialgia entre rotação do quadril e dor no glúteo ($r = -0,69$; $p < 0,05$), e entre obliquidade da pelve e dor na região do trocanter maior ($r = -0,69$; $p < 0,05$).
Conclusão: Mulheres de meia idade com fibromialgia apresentaram um padrão de marcha similar ao de idosas, o qual é caracterizado por amplitude de movimento, tamanho da passada e velocidade da marcha reduzidos.

Introduction

Fibromyalgia (FM) is an impairment disease that involves systemic chronic pain and its pathogenesis and etiology are still not fully understood.[1,2] Functionally, FM is a condition frequently accompanied by diminished physical work capacity[3,4] and muscular fatigue.[5] Difficulties with maintaining concentration during cognitive tasks, neurological complaints (e.g. morning stiffness, muscle pain and spasms) and mechanical impairments (e.g., fatigue and weakness) have also been reported in patients with FM.[5–6] These symptoms may affect their ability to perform simple daily tasks and cause a negative impact on their quality of life.[7]

Gait problems have been listed as a common complaint among patients with FM.[8] Indeed, when compared to a matched control group, subjects with FM show altered gait parameters, characterized by reduced walking speed, cycle frequency, and stride length[9–11] which are also observed in the elderly.[12,13]

Muscle discomfort, as it is seen in FM, is accompanied by reduced range of motion and muscle weakness and is positively correlated with changes in gait.[12–14] For instance, Paschalis et al.[15] showed that subjects with ongoing pain (induced by delayed muscle soreness in response to severe eccentric exercises bouts) alter a number of gait parameters to prevent further muscle damage and/or discomfort. In general, muscle discomfort and pain are accompanied by a reduced range of motion and muscle weakness, which are positively correlated with gait changes and may be related to fall incidence.[12,16–18]

Thus, middle-aged FM subjects who are chronically exposed to pain also show reduced joint range of motion and may present changes on gait pattern likely similar to elderly persons. Researchers found that women with FM (between 40 and 50 years old) exhibit a slow walking speed,[9–11] that is described as the best fall predictor in elderly population.[19,20] In addition, studies have demonstrated a high incidence of reported falls per year among middle-aged women with FM (40%-50%),[17,21,22] which is even higher when compared to the elderly.[23,24] Furthermore, middle-aged individuals with FM may be prematurely exposed to a gait pattern which resembles the one found in the elderly.

Therefore, the aim of the present study was to determine spatial (linear and angular) gait parameters of middle-aged women with FM and compare to a group of elderly women without FM. It was hypothesized that subjects with FM present a gait pattern that resembles the pattern exhibited by the elderly, irrespective of age differences between groups. The gait pattern of middle-aged women with FM was compared to a group of older women without FM, as they are described as to have an altered gait pattern and, thus, are more prone to falls than young and adults.

Methods

Participants

Twenty-one sedentary middle-aged women diagnosed with FM, according to the American College of Rheumatology 1990's criteria[2] from a Rheumatology Ward, volunteered to participate in the study. Twenty-five elderly women (over 65 years old) with a sedentary life-style without FM symptoms were invited from the local community and were allocated in the control groups.

A number of exclusion criteria were applied for both groups and included: (a) the presence of arthritis, (b) arthritis rheumatoid, (c) uncontrolled changes in thyroid, (d) BMI greater than 39 $kg{\bullet}m^{-2}$ and (e) history of fractures, (f) joint surgery or (g) any other medical problems in the six months before the start of this study which could interfere on gait performance. In addition, the elderly group did not report pain symptoms that could interfere in their daily life activities or walking during data collection.

After applying the inclusion and exclusion criteria, ten middle-aged women with fibromyalgia were allocated in the FM group, while the 15 elderly women without FM composed the elderly group. Sample size was calculated for each group; for both groups it was accepted maximum error of five points and $\alpha = 0.05$. The standard deviation of ten units was used for the older group and eight units for the FM group. Therefore, 15 women for the older group and 10 women for the FM group were considered a valid sample size for each one. All subjects who agreed to participate in the study signed an informed consent form, which was previously approved by the University's Ethics Committee.

The International Physical Activity Questionnaire[25] was applied to assess the physical activity level, and the American College of Sports Medicine criteria[26] was applied to determine a sedentary life-style (< 150 minutes per week).

Pain assessment

To characterize the FM group, participants answered a pain enquiry about their global pain and for three specific areas (tender point region), through a 10 cm visual analog scale (VAS), in which they rated the current level of pain, ranging from 0 cm (no pain) to 10 cm (worst imaginable pain). Also, the three specific pain areas (knee, great trochanter and gluteus maximus) were assessed with a VAS, as they may impact on gait performance. These specific areas were named as knee pain, great trochanter pain and gluteus pain.

Gait analysis

Gait analysis was assessed in a six meters walkway by a 3D kinematics systems (Vicon MX13+, Vicon Motion System Inc, USA) at 100 Hz. Participants were allowed to walk barefoot along the walkway (three to five trials) in an attempt to warm-up and to get familiarized with the experimental protocol. After the warm-up, each participant walked ten trials unassisted at their comfortable speed along the walkway.

Twelve reflective markers were attached to the right and left lower limb, placed on the anterior superior iliac spine, the most prominent protuberance of the greater trochanter, lateral femoral epicondyle, lateral malleolus, the fifth metatarsal joint and heels. Fig. 1 depicts the mark placement sites. The markers were placed on both sides of the body, however, only the right side was used for analysis. A suit of Lycra was worn during the data collection in an attempt to minimize movement artifacts due to movements of the markers. Based on these landmarks, a three dimensional movement reconstruction was performed. These procedures have been used in other studies.[13,27] The gait cycle was determined as an interval between two consecutive heel strikes. Heel contact was defined visually by the instant where the heel marker was first set on the ground. The ensemble average of three clear gait cycles per participant was calculated to represent individual patterns. A clear gait cycle was the one in which all markers were visible during the gait cycle and subjects did not perform any strange movements (e.g., scratching). Then, kinematics data were processed to provide estimates of linear (walking speed, stride length, cadence) and angular (hip, knee and ankle joints range of motion and their maximum and minimum values) variables.

In addition, the knee range of movement was divided into two phases to represent the actions from impact to support (ROM1) and from support to push-off (ROM2).[15] The first phase was defined as the period between heel strike and the instant the shank segment is vertical, while the second phase was defined as the period the shank segment is vertical until toe-off instant. The ROM1 and ROM2 allow to determining whether different strategies were applied in the load response (to absorb impact forces) and the push-off phase of the movement (to generate propulsive forces). The joint range of motion was defined as the difference between maximum extension and flexion displacements. Pelvic rotation was defined as pelvis movements in the transversal plane around a vertical rotation axis fixed at the hip joint center. Pelvic obliquity was defined as the rising and lowering of the pelvis that occurs in the frontal plane and around a horizontal rotation axis.

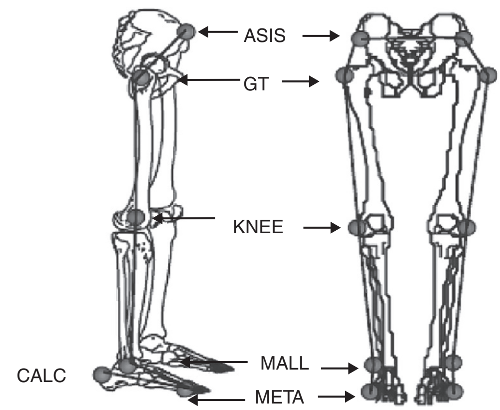

Figure 1 – Body landmarks and angular displacement conventions. Representation of the anatomical landmarks, body segments, joints and movement convention: ASIS - anterior superior iliac crest, GT - the most prominent protuberance of the greater trochanter, KNEE - lateral femoral epicondyle, MALL - lateral malleolus, and META - the fifth metatarsal joint, CALC – calcaneus.

Statistics

Descriptive statistics (mean and standard deviation) were calculated. The Shapiro-Wilk test confirmed data normality, while Levene's test confirmed data homogeneity. Differences in spatial gait variables were compared by mean one-way ANOVA, with groups as fixed factors. The Spearman correlation coefficient was performed to identify the relationship between gait parameters and pain level in the FM. The statistical procedures were performed using the software STATISTICA 7.0® and the level of significance was set at $p < 0.05$.

Results

The mean general pain in the FM group was 8.70 (2.00), knee pain was 6.43 (3.54), greater trochanter pain was 6.23 (3.77) and gluteus pain was 7.29 (3.54) in the visual analogue scale. Both groups were similar in BMI and physical activity level. There were no differences in walking speed, stride length, cadence, hip, knee and ankle joints range of motion between groups, except the pelvic rotation, in which FM group showed greater rotation ($p < 0.05$), when compared to ELD group (Table 1). The

Table 1 – Gait analysis variables between fibromyalgia and elderly groups.

	FM		ELD		p value
	Mean	SD	Mean	SD	
Age (years)	50.2	2.35	68.1	2.45	<0.001[a]
Height (m)	1.54	0.07	1.58	0.08	0.195
Mass (kg)	77.35	8.87	74.66	8.32	0.448
BMI (kg/m²)	32.62	3.37	31.23	4.57	0.177
PA (min/week)	160.6	131.2	125.5	111.9	0.231
Stride length (m)	0.96	0.16	1.03	0.14	0.241
Walking speed (m/s⁻¹)	0.93	0.15	0.96	0.16	0.677
Cadence (step/min)	58.19	2.84	55.36	4.87	0.112
Ankle total ROM (°)	25.37	3.94	23.27	3.62	0.182
Knee total ROM (°)	54.35	4.09	49.93	3.30	0.107
Knee ROM1 (°)	6.94	4.11	6.75	3.03	0.135
Knee ROM2 (°)	9.23	4.57	6.99	3.22	0.164
Hip total ROM (°)	26.45	6.55	24.41	3.14	0.306
Pelvic rotation total ROM (°)	14.3	9.59	5.08	1.53	0.001[a]
Pelvic obliquity total ROM (°)	4.71	1.59	6.29	2.86	0.125

Results of one-way measures analysis of variance test.
BMI, Body Mass Index; ROM, Range of Motion; (°), degrees.
[a] $p < 0.05$.

ensemble average of the ankle, knee and hip joint displacements of FM and ELD are present on Fig. 2.

There were negative correlation with pelvic rotation and gluteus pain ($r = -0.69$; $p < 0.05$), and between pelvic obliquity and greater trochanter pain ($r = -0.69$; $p < 0.05$) in the FM. No other significant correlations were detected between tender points and kinematic parameters ($p > 0.05$).

Discussion

Fibromyalgia is a chronic condition characterized by widespread pain and muscle weakness,[1] which may cause changes in gait towards an aging pattern. The main finding of the study was that women with FM presented a pattern which resembles that generally reported in the elderly.

Walking speed has been proposed as one of the best kinematic fall predictors.[12,19,20] It has been proposed that a gait speed reduction of $0.1 m.s^{-1}$ represents a 10% decrement in the ability to perform instrumental daily life activities.[28] The kinematic analysis showed that women with FM in this study exhibited a similar slow walking speed ($0.93 m.s^{-1}$) to other studies that have assessed women with FM (from 0.9 to 1.1 $m.s^{-1}$) and performed comparisons with a control group.[9,10]

The similarities between FM and ELD in a number of measured gait parameters found in this study are suggestive that a decline in mobility may occur earlier in life with FM patients. Therefore, the risk of fall may be further increased later in life, when the cumulative effects of degenerative ageing processes may superimpose the influence of the FM on gait parameters. Cadence was comparable between groups and reinforces the idea that gait pattern in subjects with FM deteriorates earlier in life when it is compared to healthy age-matched individuals.[9]

Therefore, it is not surprising that reports show that the number of falls among patients with FM is greater than in the elderly.[17,21,22,29] It can be speculated that similarities in gait pattern (stride length, walking speed, hip, ankle and knee range of motion), between women with FM and the elderly, may have occurred due to pain during the eccentric phase in the stance, where internal muscle-tendon tension is greater than in other concentric phases of the movement. Paschalis et al.,[15] reported significant reductions on knee range of motion in response to induced muscle pain. Interestingly, the comparison between ELD and FM groups showed a comparable knee range of motion, but with a very different pattern from normative data values of healthy age-matched subjects. For instance, normal subjects present a range of motion from 20° (ROM1) to 15° (ROM2), while FM group showed a range 65.3% (ROM1) and 38.5% (ROM2) smaller than healthy counterparts.[30]

Interestingly, differences between groups in the present study did not occur around the knee, but around the hip joint and the pelvis. The pelvis showed a greater rotation in women with FM in comparison to the elderly. Other studies have pointed out the importance of the hip and pelvis in gait performance.[13,31] Pelvic rotation increment causes the swing segment to be placed advanced further forwards in the ground and increases the stride length.[13,32] Consequently, the greater pelvic rotation found in subjects with fibromyalgia may be viewed as a strategy to increase stride length as a compensatory mechanism to sustain a pattern. The findings of Pierrynowski et al.[33] corroborate with these arguments, as they have shown reduced ankle powers accompanied by increased hip power at push-off phase in women with FM.

The augmented pelvic rotation is intriguing since negative correlation was found between movement amplitude (pelvic rotation and obliquity) and pain intensity (gluteus pain and great trochanter pain) in the FM group. If there is a relationship between movement amplitude and pain intensity, the hip joint should be moved to a lesser extent in women with FM compared to the elderly, rather than the opposite. It may

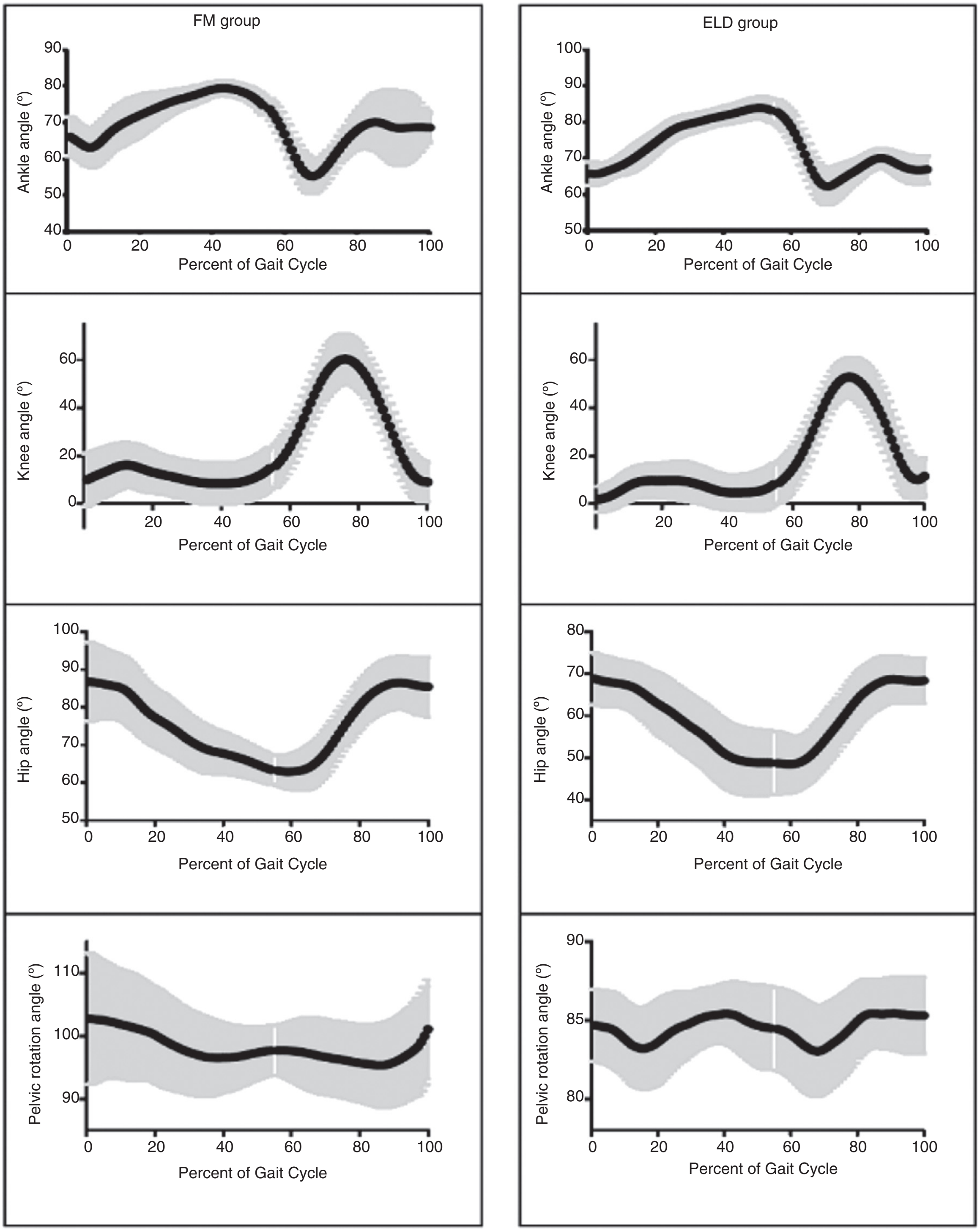

Figure 2 – The ensemble average of the ankle, knee and hip joint displacements and pelvic rotation of Fibromyalgia (FM) and Elderly group (ELD).

be also possible that subjects with FM use more pronounced actions around the hip despite of the discomfort caused by their chronic pain condition.

Therefore, clinical symptoms may not fully reflect compensatory strategies performed to sustain a certain outcome. As proposed by Pierrynowski et al.,[33] it may be viewed as a strategy of the neuromuscular system that relies more in the proximal muscles than the distal ones during walking. It is likely that strategies applied around the ankle are important to reduce the impact of pain-constrained movements.

This study has a number of limitations that include: (a) small sample size, which diminishes the chances to generalize the findings; (b) the lack of healthy control group, despite the fact that the purpose of the study was to verify whether or not women with FM present a premature pattern, which resembles the one observed in the elderly. Besides, the literature show that women with FM present a different pattern when compared to the control group;[9,10] (c) absence of pain assessment in the elderly group, which could interfere in their gait parameters, although they did not report the presence of a pain that could influence their gait pattern. Finally, (d) the BMI of both groups were relatively high and deemed overweight/obese. Thus, gait pattern may have also suffered influence of body mass, although groups were paired with respect to BMI.

Conclusion

In conclusion, the gait pattern of middle-aged women with fibromyalgia was found comparable to the one presented by elderly subjects, which raises concerns as they may be prematurely exposed to the adverse effects of the syndrome, which includes reduced mobility and increased risk of falls. It is further concerning the fact that middle-aged women with fibromyalgia already present a pattern similar to the elderly, which is known as to be more prone to falls than middle-aged counterparts. Later in life, the risk of falls in patients with fibromyalgia can be further increased and may cause a severe impact on quality of life. Other studies, with larger sample size are required to determine whether regular programs of physical activities are effective to modify gait parameters in patients with fibromyalgia. It is also necessary to analyze the gait pattern and fall incidence in elderly women with fibromyalgia using longitudinal approaches.

Conflicts of interest

The authors declare no conflicts of interest.

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