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BRIEF REPORT

Spatial-temporal parameters of gait in women with fibromyalgia

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Abstract The aim of the present study was to determine if there are differences in such parameters among patients affected by fibromyalgia (FM) and healthy subjects and whether the degree of affectation by FM can decrease the gait parameters. We studied 55 women with FM and 44 controls. Gait analysis was performed using an instrumented walkway for measurement of the kinematic parameters of gait (GAITRite system), and patients completed a Spanish version of Fibromyalgia Impact Questionnaire (FIQ). Significant differences ($p<0.001$) between FM and control groups were found in velocity, stride length, cadence, single support ratio, double support ratio, stance phase ratio, and swing phase ratio. There were significant inverse correlations between FIQ and velocity, stride length, swing phase, and single support, whereas significant direct correlations were found with stance phase and double support. Gait parameters of women affected by FM were severely impaired when compared to those of healthy women. Different factors such as lack of physical activity, bradikinesia, overweight, fatigue, and pain together with a lower isometric force in the legs can be responsible for the alterations in gait and poorer life quality of women with FM.

Keywords Biomechanics · Fibromyalgia · Gait · Quality of life

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Introduction

Fibromyalgia syndrome (FM) is a systemic chronic pain and multiple tender points condition found primarily in woman, characterized by reduced physical work capacity and muscular fatigue [1], muscle weakness [2], widespread muscle pain, and lower pressure pain thresholds of tender sites in the upper and lower limbs [3]. This pathology also affects several gait parameters and different muscle recruitment patterns [1, 4–6]. Auvinet et al. [4] and Pankoff et al. [5] have reported that gait in patients with fibromyalgia is characterized by reduced walking speed, cycle frequency, sand stride length. The slower walk of fibromyalgia patients appears to be a consequence of decreases in stride length and cycle frequency, and bradykinesia [4]. Others researches found a significant correlation between Fibromyalgia Impact questionnaire (FIQ) and a 6-min walk test after an exercise program [5, 6], but there are currently no reports correlating FIQ results with gait parameters. On the other hand, Pierrynowskia et al. [1] reported that patients affected by FM and control subjects (C) walked with similar stride lengths, times, and velocities and exhibited similar joint angles and ground reaction force, although they used different muscle recruitment patterns. Refer data reported by Pierrynowskia et al. [1] has been scaled and normalized, but the same authors related in his article that both scaled and non-scaled data exhibited similar gait characteristic between FM and C.

In view of the controversy found among various research studies concerning the differences in velocity, frequency, and stride length between FM and control subjects, the aim of the present study was to determine if there are differences in such parameters among patients affected by fibromyalgia and healthy subjects and whether the degree of affectation by fibromyalgia can decrease the gait parameters.

Materials and methods

Participants

We studied 55 women who met American College of Rheumatology criteria for fibromyalgia [7]. Controls were recruited among individuals with a negative history for musculoskeletal disease, neurological disorders, and gait abnormalities. The 44 controls were women matched to the patients on age, height, body weight, body mass index (BMI) and percent of body fat (PBF) (FM group: age, 49.5±8.9 years; height, 157.9±6.6 cm; body weight, 69.2±12.9 kg; BMI, 27.8±5.1; PBF, 37.9±8.2%; control group: age, 47.1±6.8 years; height, 157.0±5.4 cm; body weight, 67.8±13.4 kg; BMI, 27.3±5.3; PBF, 36.4±6.6%). All participants provided informed consent on clinical assessment before they enrolled into the study. Gait analysis was performed in both groups by the same investigator using the same equipment and measurement protocol.

Materials

Gait analysis was performed using an instrumented walkway for measurement of the kinematic parameters of gait (GAITRite system; CIR Systems Inc., Clifton, NJ, USA). The GAITRite system is a 4.6-m long electronic walkway that connects to the serial port of a computer. The walkway is 1/8-in. thick and contains 16,128 sensors sandwiched between a thin vinyl top cover and a rubber bottom. The active sensor area is 0.61-m wide×3.66-m long. The carpet is portable and can be rolled up for transfer [8].

Patients completed a Spanish version of Fibromyalgia Impact Questionnaire (FIQ) [9]. The FIQ is a specific health questionnaire, which evaluates current health status in patients with FM. Today, FIQ is one of the most commonly used tools for clinical investigators in patients with FM [10].

Gait protocol

Each participant of the study walked five trials unassisted at her comfortable speed along a 18.6-m walkway. We recorded at least 20 steps over the GaitRite, a condition recognized as improving precision in studies of gait disorders [10]. The GaitRite system was located in the middle of the walkway in order to avoid the nonstabilized walking periods at the beginning and end of the test [2]. Participants wore closed shoes with flat flexible soles.

Definition of variables

Velocity is the distance walked per second (cm/s); cadence, steps per minute (steps/min); stride length, heel-to-heel distance of the same lower limb in the gait cycle (cm); single support ratio, single limb support phase duration/gait cycle duration (%); double support ratio, double limb support duration/gait cycle duration (%); swing phase ratio, swing phase duration/gait cycle duration (%); stance phase ratio, stance phase duration/gait cycle duration (%); and heel to heel base of support or base width (H–H base support) (cm), the vertical distance from heel center of one footprint to the line of progression formed by two footprints of the opposite foot and total score of FIQ.

Statistical analysis

Student t test was used to analyze differences in gait parameters between patient and control groups. The Pearson correlation was used to calculate the relationship between gait parameters and FIQ in fibromyalgia group. The significance level was determined at $p \leq 0.05$. Statistical analysis was carried out using SPSS v.14 for Windows (SPSS, Chicago, IL, USA).

Results

Significant differences ($p<0.001$) between FM and C groups were found in velocity, stride length, cadence, single support ratio, double support ratio, stance phase ratio, and swing phase ratio (Table 1). With regard to H–H base support, the p value in this last parameter ($p=0.058$) was very close to the level of significance established for the present study. All gait variables except double support, stance phase, and H–H base support were significantly lower in the group with fibromyalgia compared to the control group.

There were significant inverse correlations between FIQ and velocity ($r=-0.354$, $p<0.01$), stride length ($r=-0.425$, $p=0.001$), swing phase ($r=-0.352$, $p<0.01$), and single support ($r=-0.350$, $p<0.01$), whereas significant direct correlations were found with stance phase ($r=0.349$,

Table 1 Gait analysis variables between fibromyalgia and control groups

Variables	Fibromyalgia (Mean±SD)	Controls (Mean±SD)	p value
Gait velocity (cm/s)	109±20.5	139.2±16.9	<0.001
Cadence (steps/min)	109.5±12.6	124.8±8.5	<0.001
Stride length (cm)	119.1±14.7	133.9±11.6	<0.001
Single support (%)	36.6±2.2	39.0±1.4	<0.001
Double support (%)	26.7±4.5	22.1±2.8	<0.001
Swing phase (%)	36.6±2.2	39.0±1.4	<0.001
Stance phase (%)	63.4±2.2	60.9±1.4	<0.001
H–H Base Support (cm)	9.3±2.9	8.2±2.7	0.058

p=0.01) and double support (r=0.354, p<0.01). There were no significant correlation between H–H base support and FIQ.

Discussion

Measurements of the spatial and temporal parameters from footstep patterns are frequently obtained to identify gait deviations, make diagnoses, determine appropriate therapy, and monitor patient progress. In concordance with previous findings [11, 12], GAITRite® measures of speed, cadence, and stride length demonstrated good concurrent validity. The method used in our study has a number of advantages for outpatient gait analysis. No special experimental setup is needed, and the data are obtained rapidly and non-invasively, all that makes this methodology suitable for gait disorder quantification in clinical practice.

In agreement to what has been reported by other researchers [4, 5], walking speed was severely reduced in our patients with fibromyalgia. A reduction in gait speed/velocity can be influenced by several factors like the degree of physical activity, age, or gender [4]. In the present study, the reduction in gait velocity exhibited by the patients affected by fibromyalgia syndrome was matched by a decrease in cadence and a lower stride length. These results agree with those reported by Auvinet et al. [4] who related these changes in gait parameters to bradikinesia. Moreover, these authors stated that bradikinesia may be suitable for quantifying physical activity in patients with fibromyalgia. Therefore, fatigue rather than pain would be the main factor responsible for the lower life quality of women with FM [13]

On the order hand, the women with FM showed a significantly higher double support phase (FM, 26.7±4.5 vs C, 22.1±2.8) and a minor single support phase (FM, 36.6±2.2; C, 39.0±1.4) than a control group. It has been reported that the women with FM had significantly lower isometric force in bilateral leg extensors, unilateral knee extensors, and flexors than healthy women [13]. These muscular alterations together with general pain and overweight exhibited by the women in the FM group of the present study (PBF, 37.9±8.2) impede these women to support their corporal weight upon a single support during a long period of time and causes them to decrease the single support time in the gait cycle.

In the present study, women affected by FM had the lowest scores in the FIQ and the poorer gait parameters, as shown in Pearson correlation, decreasing the velocity, stride length, swing phase, and single support and increasing the stance phase and double support. These results can be associated with the lack of physical activity and overweight of the FM women in this study. In previous studies [14, 15], women that carried out aerobic exercise or aerobic exercise associated with progressive strength training improved their score in the FIQ and the distance traveled in a 6-min walk test and, therefore, their gait parameters.

Conclusion

Gait parameters of women affected by fibromyalgia were severely impaired when compared to those of healthy women. Furthermore, a significant correlation was found between the poorer gait parameters and lowest FIQ results of women with FM. Different factors such as lack of physical activity, bradikinesia, overweight, fatigue, and pain together with a lower isometric force in the legs can be responsible for the alterations in gait and poorer life quality of women with FM.

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Disclosures None

References

1. Pierrynowskia MR, Tiidusb PM, Galea V (2005) Women with fibromyalgia walk with an altered muscle synergy. Gait Posture 22:210–218
2. Maquet D, Croisier J, Renard C, Crielaard J (2002) Muscle performance in patients with fibromyalgia. Joint Bone Spine 69:293–299
3. Bendtsen L, Norregaard J, Jensen R, Olesen J (1997) Evidence of qualitatively altered nociception in patients with fibromyalgia. Arthritis Rheum 40:98–102
4. Auvinet B, Bileckot R, Alix AS, Chaleil D, Barrey E (2006) Gait disorders in patients with fibromyalgia. Joint Bone Spine 73:543–546
5. Pankoff B, Overend T, Lucy D, White K (2000) Validity and responsiveness of the 6 minute walk test for people with fibromyalgia. J Rheumatol 27:2666–2670
6. Mannerkorpi K, Nyberg B, Ahlmen M, Ekdahl C (2000) Pool exercise combined with an education program for patients with fibromyalgia syndrome. A prospective, randomized study. J Rheumatol 27:2473–2481
7. Wolfe F, Smythe HA, Yunus MB, Bennett RM, Bombardier C, Goldenberg DL et al (1990) The american college of rheumatology 1990 criteria for the classification of fibromyalgia. Arthritis Rheum 33:160–172
8. Ashwini KR, Lori Q, Karen SM (2005) Reliability of spatiotemporal gait outcome measures in Huntington's disease. Mov Disord 20:1033–1037
9. Rivera J, González T (2004) The fibromyalgia impact questionnaire: a validated Spanish version to assess the health status in women with fibromyalgia. Clin Exp Rheumatol 22:554–560
10. Kaufman KR, Chambers HG, Sutherland DH (1996) Variability of temporal distance measurements in pathological gait studies. Gait Posture 4:169
11. Bilney B, Morris M, Webster K (2003) Concurrent related validity of the GAITRite walkway system for quantification of the spatial and temporal parameters of gait. Gait Posture 17:68–74

12. McDonough AL, Batavia M, Chen FC, Kwon S, Ziai J (2001) The validity and reliability of the GAITRite system's measurements: a preliminary evaluation. Arch Phys Med Rehabil 82:419–425
13. Valkeinen H, Häkkinen A, Alen M, Hannonen P, Kukkonen-Harjula K, Häkkinen K (2007) Physical fitness in postmenopausal women with fibromyalgia. Int J Sports Med 29:408–413
14. Gowans SE, deHueck A (2007) Pool exercise for individuals with fibromyalgia. Curr Opin Rheumatol 19:168–173
15. Rooks DS, Silverman CB, Kantrowitz FG (2002) The effects of progressive strength training and aerobic exercise on muscle strength and cardiovascular fitness in women with fibromyalgia: a pilot study. Arthritis Rheum 47:22–28