JCPR Journal of Clinical Physiotherapy Research Original Article

Comparison of Vertical Ground Reaction Force during Walking in Patients with Sacroiliac Joint Pain and Healthy People

Akram Arezoomandi [a], Abbas Rahimi [a*], Mehri Ghasemi [a], Alireza Akbarzadeh [b], Khosro Khademi Kalantari [c]

a Department of Physiotherapy, School of Rehabilitation, Shahid Beheshti University of Medical Sciences, Tehran, Iran; ***b*** Department of Basic Sciences, School of Rehabilitation, Shahid Beheshti University of Medical Sciences, , Tehran, Iran; ***c*** Physiotherapy Research Center, School of Rehabilitation, Shahid Beheshti University of Medical sciences, Tehran, Iran

***Corresponding Author:** Abbas Rahimi, Department of Physiotherapy, School of Rehabilitation, Shahid Beheshti University of Medical Sciences, Tehran, Iran. **Tel:** +98 21 77561721-4; **E-Mails:** arahimiuk@yahoo.com, a_rahimi@sbmu.ac.ir

Submitted: 2017-01-24; **Accepted**: 2017-06-08

Abstract

Introduction: Vast majority of the muscular disorders are known to be related to Sacroiliac joint. Due to the main role played by Sacroiliac joint, the current study was conducted to examine the effect of the pain among the people suffering from Sacroiliac joint pain on the vertical ground reaction force parameter. **Materials and Methods:** This case control study was carried out on 19 participants with Sacroiliac joint pain, VAS 3-5 and average age of 27±5.7, and 19 subjects with normal health conditions and average age of 29±7.6. The relevant data were collected while the participants were asked to walk at their desired speed over the force plate located on their way. Later on, all the parameters of vertical ground reaction force in the stance phase were recorded. At the end, data collected were compared by independent T-test in SPSS. **Results:** The results of the study revealed that participants distributed in control (healthy individuals) and experimental (individuals with Sacroiliac joint pain) groups were significantly different regarding the parameters of time and speed required to reach the stage of weight transition to the heel. **Discussion:** Considering the findings, it can be concluded that some compensatory strategies were adopted by the individuals with Sacroiliac joint- related problems in order to decrease the force that body experienced during walking.

Key words: Force Plate, Sacroiliac Joint, Vertical Ground Reaction Force

Please cite this paper as: Arezoomandi A, Rahimi A, Ghsemi M, Akbarzadeh A. Comparison of Vertical Ground Reaction Force during Walking in Patients with Sacroiliac Joint Pain and Healthy People. J Clin Physio Res. 2017; 2(3): 99-103.

Introduction

Sacroiliac joint is considered as the largest pivot joint in the body which perfumes variety of functions (1, 2). Transfer of the strength to the lower limb, reinforcement of data to activate the deep sense and pelvic stability can be named as its main functions (3-5). Sacroiliac joint was known as the main reason for the pain in back in 1905 (1). There are both internal and external factors which can be reflected as the main reasons contributing to the pain in Sacroiliac joint; from among the internal factors arthritis and infection can be named, on the other hand, bone fractures, damages to ligament and myofascial are key external causes of pain in Sacroiliac joint (6). It should be mentioned that the pain in this joint is ambiguously reported in hip and buttocks. Furthermore, Sacroiliac joint was recognized as the major source of pain in two areas of back and hip in 1966 among 15-20 percent of the population (1). Sacroiliac joint has recently received a lot of attention especially among those who suffer from backache so that the anomalies in the Sacroiliac joint has been identified as the major factor among large number of people with backache at the beginning of the twentieth century (6). Commonly patients suffering from pain in their back are suggested to go on a regular walk, but unfortunately majority of them refuse to do so; therefore, it is highly important to examine the potential effects that the pain can have on their ability to walk in order to accommodate going on walk to their schedule (7). The researchers have shown that the individuals with backache walk slowly and take shorter steps

in comparison with their peers. Although there are few studies conducted to examine the parameters relating to walking ability among people diagnosed with backache, no research has been carried out to study the important walking parameters among those who had problem in the Sacroiliac joint. Being inspired by the gap spotted in the literature, we have conducted the present study to observe these parameters as well as their changes among patients suffering from Sacroiliac joint pain.

Materials and Methods

This analytical study was the case control one which was conducted on the population of the available subjects selected based on the simple sampling. The sample comprised 38 subjects of both genders (male and female). There were 19 healthy individuals in control group whose age average was considered to be 29±7.6 and 19 ones suffering from Sacroiliac joint problem with age average of 27±5.7 in the experimental group. The subjects were selected in accordance with the inclusion and exclusion criteria of the study, they were also required to have the written consent provided by the Beheshti University signed up to be able to participate in the study.

The inclusion criteria upon which the subjects in both control and experimental groups were selected included; range age of 18 to 40 and BMI of 18 to 25 Kilograms per square meter, apart from the criteria mentioned there were some other inclusion criteria regarded for the subjects in the experimental group only, they can be named as pain intensity of 3-5 on the visual analog scale, having the consistent painful area on the joint, experiencing pain for about 2 months, positive active straight leg raising experiment and report of the pain while changing the position from sleeping to sitting, sitting to standing, going up stairs and getting in or out of the car (8). Radiculopathy, Deformities in spinal cord and lower limb, spinal cord surgeries, Vestibular problems, dizziness and Epilepsy, on the other hand, were considered as the exclusion criteria in this study (4, 9-11).

Observation, evaluation and confirmation of Sacroiliac joint involvement was closely made by a physiotherapist during the study. At first, the positive result of ASLR Test was examined, then the self-designed questionnaire was filled out. Eventually, the parameters relating to the plantar pressure were recorded by BERTC force plate made in America with frequency of 5000 Hertz. As previously mentioned, age overage of the subjects in the experimental group and the control group was 29±7.6 and 27±5.7 respectively. Afterward, the subjects were briefed on the stages and procedure of the experiment. Prior to the performance of the main experiment, the force plate had been placed on the subjects' way, then they were asked to take a normal walk along the five-kilometer way for several times, finally the main experiment was performed. During the experiment, the participants were instructed to walk over the force plate placed on their way while they had to stay in relaxed status, keep a normal arm swing and their head up. To have the required data collected, records relating to the stance phase in the painful leg of the individuals placed in the experimental group were documented by the force plate and compared with the records related to the control group. It is worth mentioning that, at every stage of the experiment if the subjects failed to touch the force plate, the experiment was repeated so that only three experiments were recorded at the end of the study. To have the data analyzed, the average of data resulted from the ground reaction force on the vertical axis were documented in Excel software. To begin with, the data relating to the vertical ground reaction force which were based on the individual's weight were normalized then, the time axis in accordance with percentage was altered finally, FZ axis underwent some necessary changes. After the implementation of the mentioned stages, the intended variables of the current study were computed. The main variables include; the first peak power on the vertical axis of the ground reaction force, the time of the first peak on the vertical axis of the ground reaction force, diagram slope of the vertical ground reaction force starting from the stance phase lasting at the transition of the weight to the heel stage, the required time to reach the stage of weight transition to the sole, the required time starting from the stane phase lasting at the weight transition to the ball stage. All the data collected were analyzed and compared by the use of SPSS software version 16.

Results

The analysis of data of this study was performed by SPSS software, version 16. Firstly, Kolmogorov–Smirnov test enjoying minor sensitivity was carried out to assess the normal distribution of data. The result obtained (0.05) verified the normality of the distribution. Additionally, to have the homogeneity of the control and experimental groups computed, the independent T-test was done whose results (0.05) approved that two groups involved in the study were homogeneous in terms of age average (26.63±5.66 and 28.73±7.6) and BMI (23.1±3.033 and 24.1±3.87). Table 1 demonstrates the information on the age and weight of both control and experimental groups in details. Finally, the independent T-test was carried out to assess the difference between two groups regarding the data relating to their walking patterns.

Table 1. Demographic description of subjects (N=19)

Variable	Study group	Mean±SD
Age (year)	Control	26.63±5.66
	Experimental	28.73±7.6
BMI (Kilograms per square meter)	Control	23.1±3.33
	Experimental	24.1±3.87

Table 2. Balance index during walking (N=19)

	Group	Mean±SD	Standard error	*P*-value
Time starting from stance phase lasting at the weight transition to the heel stage (based on stance phase percentage)	Control	25.17±3.15	0.72	0.01
	Experimental	28.47±4.23	0.97	
Time duration starting from stance phase lasting at the weight transition to the ball stage (based on stance phase percentage)	Control	74.94±1.23	0.28	0.656
	Experimental	74.72±1.73	0.39	
Amount of force at weight transition to the heel stage (based on body weight percentage)	Control	103.37±3.8	0.87	0.35
	Experimental	102.18±3.9	0.89	
diagram slope of the vertical ground reaction force starting from the stance phase and lasting at weight transition to ball the stage (based on percentage of body weight per second)	Control	580.84±116.08	26.63	0.002
	Experimental	455.12±115.11	26.41	
Time required to reach weight transition to sole stage (based on percentage of stance phase)	Control	47.1932±3.21	0.73	0.663
	Experimental	46.19±4.15	0.95	

The analysis of the vertical ground reaction force data during walking stage revealed that the time required to have the weight transmitted to the heel was much longer so that there was a statistically significant difference between two groups with regard to the parameter of time (*P*: 0.01). Two groups were also significantly different when it came to parameter of the diagram slope of the vertical ground reaction force starting from the stance phase and lasting at the stage of weight transition to the heel (*P*: 0.002). In the figure 1, parameters involved in the stance phase are presented in details.

Discussion

By taking the results of the present study into account, it can be concluded that participants distributed in control and experimental groups were different in parameters of the ground reaction force and the required time to reach the stage of placing the heel on the ground. Furthermore, a marked difference was witnessed between two groups of subjects in term of the diagram slope from stance phase to the transition of the weight to the heel. To illustrate the significance of the current study it should be mentioned that no research has been so far conducted to examine the parameter of the ground reaction force exclusively among the people suffering from Sacroiliac joint related problems. In this section the results of this study are compared with some other equivalent studies focusing mainly on the ground reaction force among people with chronic backache.

First and foremost, according to the results of this study, there was not any difference between two groups of participants in the amount of force produced during when the participants wanted to place the heel on the ground. The findings are compatible with other studies conducted by da Fonseca (12) and C. Ellen Lee (7). Lee *et al.* have compared the amount of the force produced during placing the heel on the ground between the group of individuals with backache and those whose backache caused them to feel pain in their leg, the density of the pain was measured to be 3.9±2.1 (7). The results displayed no significant difference between two groups. This can be stated that the vertical ground reaction force was initially affected by the speed in walk. Since the participants in this study were asked to walk at their desired speed, they preferred to walk slowly which prevented the change in the amount of force produced at the weight transition to the heel stage.

Moreover, as previously mentioned, a statistically significant difference was observed between two groups of this study in term of the diagram slope of the ground vertical force which is

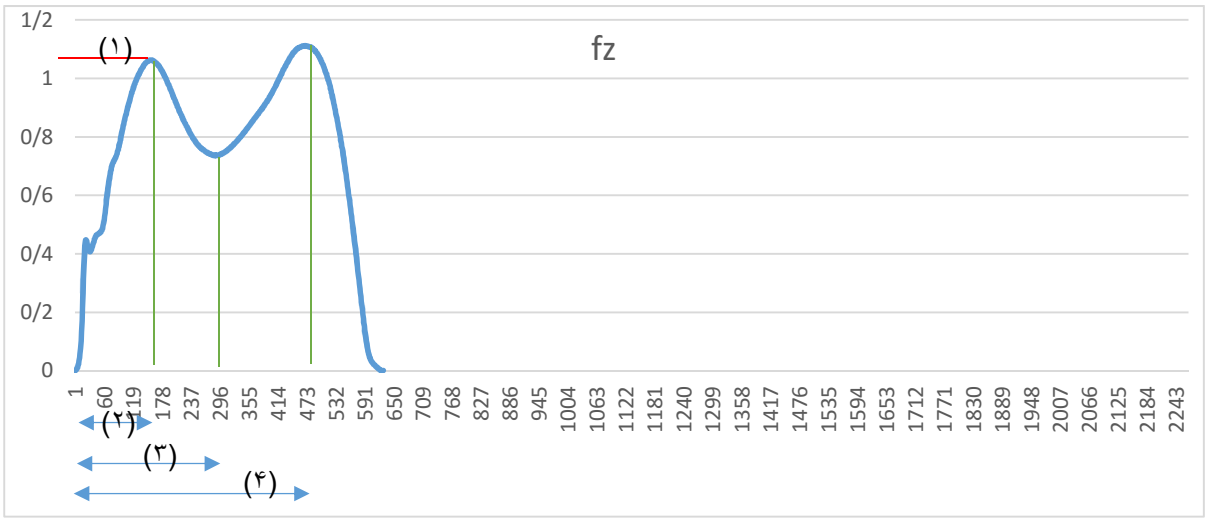

Figure 1. *1)* amount of the force during the weight transition to the heel (based on the body weight percentage); *2)* time duration starting from stance phase lasting at weight transition to the heel stage (based on stance phase percentage); *3)* required time to reach the weight transition to the sole (based on stance phase percentage); *4)* time duration starting stating from stance phase and lasting at transition of weight to the ball stage (based on stance phase percentage)

consistent with the results of the research carried out by da Fonseca in 2009 (12). According to the results of that study in which participants suffering from backache were compared with the applicants with normal health conditions, there was the decrease in the speed of weight transition to the heel. To explain the obtained results of the current study, it could be mentioned that the participants adopted a useful strategy in order to decrease the amount of the force imposed on body. As a matter of fact, this strategy led to an increase in the time required to have the weight transmitted to the heel; however, there was no difference between two groups regarding the amount of the force when they put the heel on the ground (12). This brought about a decrease in the speed and diagram slope among the participants with Sacroiliac joint problem. This finding is in complete agreement with the study conducted by Lee *et al.* (7) when they investigated the difference of diagram slope among people suffering from backache as well as referential pain in their leg and healthy individuals. This can be justified by considering the increase in the required time to have the weight transition to the heel done.

Eventually, the decrease in the speed of the vertical ground reaction force during the weight transition to the heel is not compatible with the findings of the study by C. Ellen Lee (7). In that study the speed of the vertical ground reaction force during the weight transition to the heel when compared among people with backache and healthy ones, did not decrease. This can be explained if the age average of the participants is borne in mind. In the current study while the average age of the subjects in control and experimental groups was 29±7.6 and 27±5.7 respectively, subjects in the study by Lee *et al.* (7) had average age of 46-4. Besides, the painful area among the participants in two studies was totally different which can be known as one of the important reasons leading to inconsistency of the findings. In the current study the participants with Sacroiliac joint-oriented pain had pain in one side of their body which can be the reason for the change in the vertical ground reaction force during walking.

Conclusion

The main findings of the current study were related to the statistically significant difference among the subjects distributed in the control and experimental groups in terms of the vertical ground reaction force parameters. According to the findings, it took the applicants suffering from the Sacroiliac joint-related problems longer to reach the stage of weight transition to the heel, they additionally have slower speed to reach that stage. This clearly demonstrated that they adopted these compensatory strategies (slower speed and longer time) in order to decrease the pain they experienced while walking. Having said that, patients suffering from Sacroiliac joint pain should be provided with some helpful treatments, such as suitable exercises and appropriate shoes, to have their pain alleviated during the walking status.

Acknowledgments:
None

Conflict of interest:
None

Funding support:
This project had no external funding, and no financial or other relationships pose a conflict of interest

Authors' contributions:
All authors made substantial contributions to conception, design, acquisition, analysis and interpretation of data.

References

1. Cusi MF. Paradigm for assessment and treatment of SIJ mechanical dysfunction. Journal of bodywork and movement therapies. 2010;14(2):152-61.
2. Park G, Ju S-b, Jang HJ. The effect of pelvic adjustment on the stability of elderly men. Journal of Physical Therapy Science. 2011;23(6):937-9.
3. Placzek JD, Boyce DA. Orthopaedic physical therapy secrets: Elsevier Health Sciences; 2016.
4. Jung K-H, Cho I-Y, Park S-K, Kim K-E. Effect of the Sacro-Occipital Technique Category II Blocking on Attention and Postural Sway. Journal of Convergence Information Technology. 2013;8(12):299.
5. Arumugam A, Milosavljevic S, Woodley S, Sole G. Effects of external pelvic compression on form closure, force closure, and neuromotor control of the lumbopelvic spine–A systematic review. Manual therapy. 2012;17(4):275-84.
6. Hertling D, Kessler RM. Management of common musculoskeletal disorders: physical therapy principles and methods: Lippincott Williams & Wilkins; 2006.
7. Lee CE, Simmonds MJ, Etnyre BR, Morris GS. Influence of pain distribution on gait characteristics in patients with low back pain: part 1: vertical ground reaction force. Spine. 2007;32(12):1329-36.
8. Shadmehr A, Jafarian Z, Talebian S. Changes in recruitment of pelvic stabilizer muscles in people with and without sacroiliac joint pain during the active straight-leg-raise test. Journal of back and musculoskeletal rehabilitation. 2012;25(1):27-32.
9. Brumagne S, Janssens L, Janssens E, Goddyn L. Altered postural control in anticipation of postural instability in persons with recurrent low back pain. Gait & posture. 2008;28(4):657-62.
10. Hamaoui A, Do M-C, Bouisset S. Postural sway increase in low back pain subjects is not related to reduced spine range of motion. Neuroscience letters. 2004;357(2):135-8.
11. Salavati M, Mazaheri M, Negahban H, Ebrahimi I, Jafari AH, Kazemnejad A, et al. Effect of dual-tasking on postural control in subjects with nonspecific low back pain. Spine. 2009;34(13):1415-21.
12. da Fonseca JL, Magini M, de Freitas TH. Laboratory gait analysis in patients with low back pain before and after a Pilates intervention. Journal of Sport Rehabilitation. 2009;18(2):269-82.