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Research Article

Influence of leg dominancy over foot pressure and postural sway in middle age population: an observational study

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ABSTRACT

Background: The notion of limb dominance has been commonly used in the upper extremity, yet the two lower extremities are often treated as equal for clinical purposes. But both the lower limbs may not be perfectly symmetrical. There are conflicts of results with relation to leg dominancy, postural sway and foot pressure, which aided us to study the effect of lateralization on foot pressure and postural sway in middle age population.
Methods: Thirty two normal subjects were recruited based on criteria, whose dominant lower limb was ascertained, Foot Pressure and postural sway was assessed by weighing scale and postural sway meter respectively.
Results: Descriptive statistics and two way ANOVA were used as statistical analysis. Foot Pressure showed significant difference (P value <0.05) between dominant and non-dominant leg. On the other hand postural sway showed significant antero-lateral sway towards dominant side (P value <0.001).
Conclusions: Lateralization of foot pressure is significant over dominant leg while postural sway is significant over anterolateral dominant side.

Keywords: Leg dominancy, Foot Pressure, Postural sway

INTRODUCTION

Postural stability or balance is defined as ability to maintain the projected center of motion within the limits of base of support; researches which have been done showed various strategies to control the stability and orientation of posture. There are three strategies namely hip, ankle, and knee to control the postures. Research had been done on postural control which showed asymmetry of postures by using various strategies as mentioned above.[1] The control of standing balance is a task of maintaining body's centre of mass within the limit of base of support achieved by producing forces on the supporting surface predominantly by the feet.[2]

Lateral dominance is the preferred use and superior performance of one side of the body as compared to the other side.[2] This preference is apparent in the upper extremity, where the preferred arm is usually stronger and more versatile.[3] Contrary to hand dominance minimal attention has been given to concept of leg and foot dominance.[2,3] Asymmetry between both the lower limbs has also been noted, When we step on the ground we produce a vector of force that is generally downward and backward. The ground produces an opposite force that is upwards and forwards and this is Ground Reaction Force (GRF). Exertions of ground reaction forces are widely used as an index of balance control.[4]

Postural sway is a rhythmical symmetrical movement of body components in anterior, posterior, medial, and lateral directions.[4] It is a complex phenomenon that occurs as a result of many interacting factors such as visual, vestibular, and proprioceptive sensations.[4,5] Some researchers have analyzed the lateral fluctuation of postural sway during unipedal or bipedal stance results in swaying of the body center of motion from the equilibrium position. Postural sway asymmetry may serve as a veridical measure of postural stability and can be used for early diagnosis of age related decline in postural control.[6-8] Balance impairment in elderly persons may contribute to falls resulting in serious physical and psychological consequences. Deteriotion of balance is a dominant intrinsic cost of falling due to lateralization of center of gravity and base of support.[7] It is well documented that balance deteriorates with aging; many researches had been done showing profound postural sway in the elderly population.

As age progresses there is increase amount of postural instability which may ultimately leads to falls, which is a serious problem for older adults. A progressive deteriotion of postural balance due to aging raised the relative information and role of vestibular, visual and somatosensory inputs. Though, this three inputs are interlinked it is inter co-related and organized to control the postural balance. Aging is a process which starts from middle age group which have potential effects on balance and equilibrium. In the process of measuring postural sway and foot pressure which have definite impact on balance resulted in studying dominancy, foot pressure & postural sway in middle age group.[9]

Proper balancing movement of body segment are essential in maintaining the upright stance, firstly to stabilize the body segment and secondly to enable the necessary dynamic changes of body. The impudence of lateralization of the human body on upright stability control during quiet standing has received scarce research attention, leading to the aim of our study to find lateralization of foot pressure and postural sway.

METHODS

Subjects

Thirty two subjects (15 males and 17 females) were recruited randomly from community dwelling middle age population. Inclusion criteria were both the gender between age group of 30-40 years. Exclusion criteria were subjects having any low back pain, congenital leg deformity, lower limb fractures, associated musculoskeletal pain in lower quadrant and other neurological conditions which aid in postural imbalances.

Materials and procedure

The ethical clearance from the institution (SKNCOPT/2013/35), and written subject consent were taken, moreover patient information sheet were also provided. A detailed demographic data were drawn, followed by assessment of leg dominancy, Foot Pressure and postural sway.

Leg dominancy

Participants' dominant lower limb was ascertained by using the Leg preference questionnaire suggested by Butle and Kempson (1989).[10]

1. Which leg would you kick a soccer ball with?

   Left Right

2. Which leg would you step on an object with? (e.g., step on a bug)

   Left Right

3. Which leg would you use to smooth out sand with?

   Left Right

This was repeated three times and the preferred leg was recorded as the dominant leg.

Foot pressure

Foot Pressure was calculated using 2 weighting scale mounted on a fixed base of support with a leveler. Subjects left leg was placed over left side weighting scale and right leg will be placed over right side weighting scale. Subject was made to stand on weighting scale for 30 seconds and after 30 seconds, both the weighting scale readings was recorded. 3 trails were taken and the mean of all 3 trails was taken as foot pressure of both the legs. The foot pressure was calculated with eyes open as well as eyes close.[11-13]

Postural sway

Postural sway was calculated using postural sway meter. The Sway meter recorded displacements of the body in the horizontal plane at waist level. The device consisted of an inflexible 40-cm-long rod with a vertically mounted pen at its end. The rod was mounted on a 20 cm wide metal plate which was fitted over the participant's lower back (level of the posterior superior iliac spine) by a firm belt so that the rod extended posterior. The pen recorded participant's postural sway on a sheet of millimeter graph paper, fastened to the top of an adjustable-height table .The sway path length was manually determined as the number of millimeter squares traversed by the pen. The Antero-Posterior (AP) and Right side to left side, peak-to- peak sway displacements were also calculated from the extremes of sway length in these two planes.[14]

Data analysis

Data obtained were analyzed by Statistical Package for Social Science (SPSS) version 20.0, two way ANOVA was used to compare the means. Homogeneity of sample was established and a priori alpha level of 0.01 was set to determine statistical significance.

RESULTS

Descriptive statistics of age, sex, BMI and Dominancy are enlisted in Table 1. Samples are homogeneous which were considered for two way ANOVA. The Foot Pressure (FP) showed significant difference between dominant and non-dominant side as when eyes are closed as shown in table -2 of P value <0.05 .On the other when eyes are open there is no difference in (FP) among dominant and non-dominant side. Similar differences were found in medial lateral postural sway too. There is a significant anterior postural sway when eyes are closed P value <0.001, as compared to posterior sway both in eyes open and closed, as shown in Table 2.

Table 1: Descriptive statistics.

Variables	Mean ± Standard Deviation
Age	32.40 ± 4.25
Sex	Male - 15 Female - 17 (N-32)
BMI	23.49 ± 3.87 kg/m^2
Dominancy	Right - 24 Left - 8

Table 2: Two way ANOVA - Dominant versus non-dominant.

Variables			Mean ± Standard Deviation	F-value	P value
Eyes open	Foot pressure (kg)	Dominant side	31.34 ± 5.38	0.54	0.24
		Non dominant side	29.42 ± 3.24		
Eyes closed	Foot pressure (kg)	Dominant side	30.41 ± 4.34	1.20	**0.03***
		Non dominant side	26.25 ± 3.43		
Eyes open	Medial lateral sway (mm)	Dominant side	15.51 ± 13.74	1.25	0.204
		Non dominant side	10.68 ± 11.14		
Eyes closed	Medial lateral sway (mm)	Dominant side	16.70 ± 13.47	2.32	**0.002***
		Non dominant side	8.52 ± 3.26		
Anterior sway (mm)		Eyes open	9.38 ± 7.54	3.08	**0.0001****
		Eyes closed	16.35 ± 12.33		
Posterior sway (mm)		Eyes open	10.36 ± 9.71	1.08	0.23
		Eyes closed	12.47 ± 7.32		

*P<0.05; **P<0.001

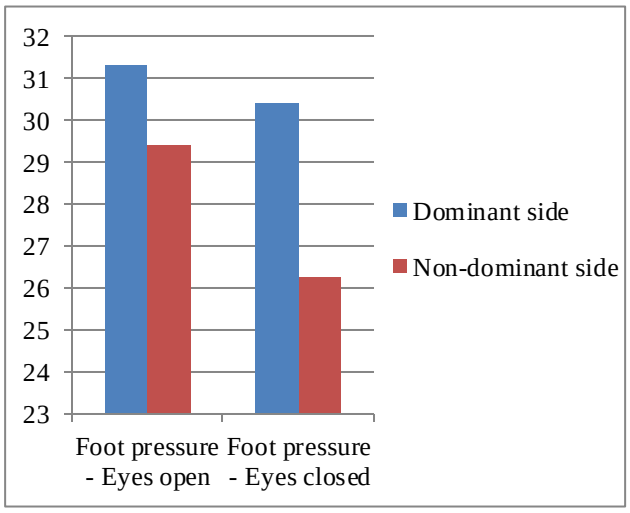

Figure 1: Comparison of foot pressure: dominant vs. non-dominant side.

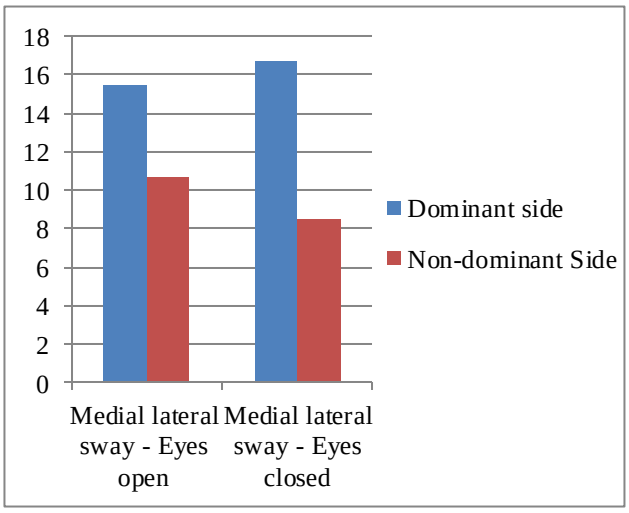

Figure 2: Comparison of medial lateral sway: dominant vs. non-dominant side.

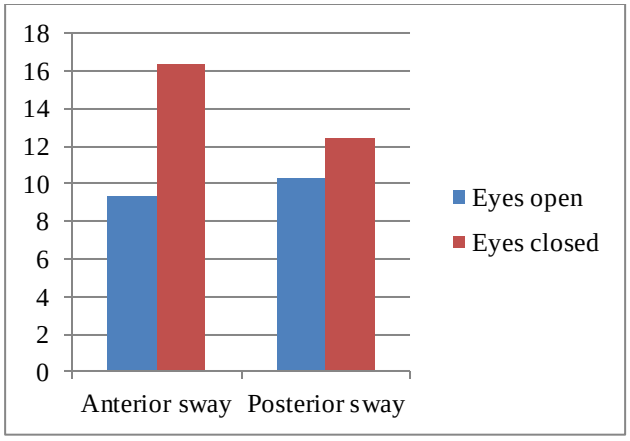

Figure 3: Comparisons of anterior and posterior sway: eye open vs. eyes closed.

DISCUSSION

The aim of the study was to find out dominancy of the limb, the difference in dominant and non- dominant foot pressure and postural sway in middle age community dwelling individuals via dual weighing scale and postural sway meter. The subjects were randomly selected and their measure of dispersion for age is 32.40 ± 4.25, a total of 32 subjects were enrolled whose body mass index is 23.49 ± 3.87 kg/m^2 (Table 1). Gender and age were addressed due to their potential impact on the results of the present study. Levy and Levy[15] observed right-handed males with larger right feet and right-handed females with larger left feet suggesting that sex steroids govern cerebral and pedal asymmetrical maturation. Since structural asymmetries in the legs may be influenced by gender, keeping gender consistent may eliminate this potential confound. The present study examined males and females to obtain a better representation of the population. Additionally, since the sample of convenience consisted of 15 males and 17 females, combining the two genders increased sample size.

Age related asymmetries have also been noted previously. Gentry and Gabbard[16] observed choice of foot preference in 956 males and females of different age groups between 4 and 20 years of age and suggested that footedness in the younger groups was nonspecific. However, they noticed a significant shift towards right-footedness between 8 and 11 years old, after which preferences remained stable. In the present study, also the dominancy is mostly of right limb as compared to left limb.

In the current study there is no difference in force pressure when the eyes are open on the other hand when eyes were closed the foot pressure is more over the dominant leg (Table 2 & Figure 1). This follows Previc's Theory, postural control performed by stance/support leg (nonpreferred leg) developed as a result of fetal position. The right side vestibular dominance leading to a left-otolithic advantage saves the left side for postural control while the right side perfects motor functions.[17]

MacNeilage's[18] postural origins theory suggests an evolutionary influence where instinctive traits of early primates such as hanging from tree branches with one leg, are passed down to modern primates who sometimes support themselves on one leg and manipulate with the other. Beling et al.[19] examined lower limb task performance while standing and sitting and suggested that dynamic activity is typically lateralized . In contrast to the present study, several studies reported significant differences in the lower limbs vertical ground reaction force. Boris Gutmik et al.[20] in his study demonstrated that 60% of the time, right leg loading was significantly greater than left leg loading. This confirms earlier findings that the majority of normal adults do not stand with exactly half their body weight on each foot.[6,13] Based on the data in the literature, we suggest specific factors affect postural control, possibly due to some anthropometrical factors, based on the fact that the right side of the human body is often slightly heavier that the left.[21,22] We could not make specific inferences on lateralization of foot pressure because no significant literature pertaining to middle age group were revealed.

In context to the postural sway, lateralization of postural sway is observed while the eyes are closed and the subject sway more of anterior as compared to posterior sway (Table 2 and Figure 2 & 3). This pattern may be explained by some neural mechanisms of postural control [2, 4]. The human body may be imagined as a multi-segmented structure, giving the body a large number of degrees of freedom, which can mitigate postural disturbances. The maintenance of postural stability in response to different disturbing influences may utilize many neurological and biomechanical compensatory strategies.[1,4,23-26]

Limitation

Though all the musculoskeletal dysfunction are excluded, Muscle strength and flexibility were not taken into consideration. In addition force platform and posturography can used to evaluate the ground reaction force and postural sway which are the gold standard measurement tools where by type II error can be averted which can be one of the confounding factor in the present study.

Clinical implication

Postural control is altered because of prolonged standing on uneven weighing of limb, resulting in asymmetry of leg dominancy and associated biomechanical changes causing low back pain, OA and other musculoskeletal dysfunction. On an average 30-40% of muscular dysfunction results due to biomechanical changes such as limb asymmetry and postural sway. Early identification of these biomechanical markers helps us to correct

attenuates and rehabilitate the changes which acclimates the musculoskeletal dysfunction.

CONCLUSION

Lateralization of Foot Pressure is significant over dominant leg while postural sway is significant over anterolateral dominant side.

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Ethical approval: The study was approved by the institutional ethics committee (SKNCOPT/2013/35)

REFERENCES

1. Fujisawa N, Fukuoka H, Inaokay, Ishida A, Masuda T, Minamitani H. Human standing posture control syatem depending on adopted strategies. Med Biol Eng Comput. 2005;43:107-14
2. Craig R. Denegar, Jay Hertel, Michael R. Gay. Differences in postural control during single- leg stance among healthy individuals with different foot types. J Athl Training. 2002;37(2);129-32.
3. Augustyn C, Peters M. On relation between footedness and handedness. Percep Motor Skills. 1986;63:1115-8.
4. Balasubramaniam R, Wing AM. The dynamics of standing balance. Trends Cogn Sci. 2002;12:531-6.
5. Barry C. Stillman, Joan M. McMeeken. The role of weight bearing in the clinical assessment of knee joint position sense. Austr J Physiother. 2001;47:247-53.
6. Takala EP, Korhonen I, Viikari-Juntura E. Postural sway and stepping response among working population: reproducibility, long-term stability, and associations with symptoms of the low back. Clin Biomech (Bristol, Avon). 1997;12:429-37.
7. Kannus P, Haapasalo H, Sievanen H, Oja P, Vuori I. The site-specific effects of long-term unilateral activity on bone mineral density and content. Bone. 1994;15:279-84.
8. Fujisawa N, Masuda T, Inaoka Y, Fukuoka H, Ishida A, Minamitani H. Human standing posture control system depending on adopted strategies. Med Biol Eng Comput. 2005;43:107-14.
9. Blaszczyk JW, Prince F, Raiche M, Hebert R. Effect of ageing and vision on limb load asymmetry during quiet stance. J Biomech. 2000;33:1243-8.
10. Gabbard C, Hart S. A question of foot dominance. J General Psychol. 1996;123(4):289-98.
11. Mary Josephine Hessert, Mitul Vyas, Jason Leach, Kun Hu, Lewis A. Lipsitz, Vera Novak. Foot pressure distribution during walking in young and old adults. BMC Geriatr. 2005;5:8.
12. Murray MP, Peterson RM. Weight distribution and weight-shifting activity during normal standing posture. Phys Ther. 1973;53:741-8.
13. Dickstein R, Nissan M, Pillar T, Scheer D. Foot-ground pressure pattern of standing hemiplegic patients. Major characteristics and patterns of improvement. Phys Ther. 1984;64:19-23.
14. Daina L. Sturnieks, Ria Arnold, Stephen R. Lord. Validity and reliability of the Sway meter device for measuring postural sway. BMC Geriatr. 2011;11:63.
15. Levy J, Levy JM. Human lateralization from head to foot: sex related factors. Science. 1978;200:1291-2.
16. Gentry V, Gabbard C. Foot-preference behavior: a developmental perspective. J General Psychol. 1994;122(1):37-45.
17. Previc FH. A general theory concerning the prenatal origins of cerebral lateralization in humans. Psychol Rev. 1991;98(3):299-334.
18. MacNeilage PR. The postural origins theory of primate neurobiological asymmetries. In: N. Krasnegor, D. Rumbaugh, M. Studdert-Kennedy, eds. Biological Foundation of Language Development. 1st ed. Hillsdale, NJ: Earlbaum; 1991: 165-188.
19. Beling J, Wolfe GA, Allen KA, Boyle JM. Lower extremity preference during gross and fine motor skills performed in sitting and standing postures. J Orthop Sports Phys Ther. 1998;28(6):400-4.
20. Boris Gutnik, Jonathan Leaverb, Clive Standena, Christopher Longleya. Inferred influence of human lateral profile on limb load asymmetry during a quiet standing balance test. Acta Med Okayama. 2008;62(3):175-84.
21. Pyoria O, Era P, Talvitie U. Relationships between standing balance and symmetry measurements in patients following recent strokes (3 weeks or less) or older strokes (6 months or more). Phys Ther. 2004;84:128-36.
22. Kannus P, Haapasalo H, Sievanen H, Oja P, Vuori I. The site-specific effects of long-term unilateral activity on bone mineral density and content. Bone. 1994;15:279-84.
23. Ekdahl C, Jarnlo GB, Andersson SI. Standing balance in healthy subjects. Evaluation of a quantitative test battery on a force platform. Scand J Rehabil Med. 1989;21:187-95.
24. van Soest AJ, Haenen WP, Rozendaal LA. Stability of bipedal stance: the contribution of cocontraction and spindle feedback. Biol Cybern. 2003;88:293-301.
25. Caron O, Fontanari P, Cremieux J, Joulia F. Effects of ventilation on body sway during human standing. Neurosci Lett. 2004;366:6-9.
26. Maki BE, McIlroy WE. The role of limb movements in maintaining upright stance: the "change-in-support" strategy. Phys Ther. 1997;77:488-507.

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