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Original article

Symmetry of postural tone in right homogeneous functional laterality evaluated by Fukuda test

Hafid Arabi[1], *Latifa Adarmouch*[2]

[1]Equipe de recherche clinique et épidémiologique de la pathologie ostéo-articulaire. UCH Mohammed VI. Faculty of Medicine and pharmacy. Cadi AAyad University. Marrakech BP40000 Morocco; [2]Laboratoire d'épidémiologie, médecine communautaire et santé publique. CHU Mohammed VI. Faculty of Medicine and pharmacy. Cadi AAyad University. Marrakech BP40000 Morocco.

Abstract. *Background:* To study the symmetry of postural tone in subjects with right homogeneous functional laterality. *Methods:* It was an observational study; we looked for the right homogeneous functional laterality by clinical tests on the eyes, feet and hands. Postural tone was evaluated by the Fikuda test. We measured the mean value of the Fikuda angle and in cm walking forward or backward compared to the A axis and the deviation to the left or right compared to the B walking axis. These two axes were perpendicular. *Results:* There were 80 homogeneous right-hand adult subjects. There were 52 males (63, 52%) and 28 females (36, 47%). The median age was 34, 85 years (23, 42- 47, 57). For the studied population the deviation angle according to Fukuda test was 0° (-15°; 15°), the subjects stepped 81 cm (52; 110) forward without deviation from the B walking axis 0cm (-14; 20). Male subjects remained on the walking axis 0° (-17°, 19°) while stepping 81 cm (51, 119) forward without right-left deviation 0 cm (-17, 19). Female subjects stepped (83 cm (52; 110) forward, and away from the walking axis (3 cm (-23; 21)), without deviation 0° (-17°; 19°). *Conclusion:* The functional homogeneous laterality did not influence postural tone. The lateralization is a complex phenomenon. (www.actabiomedica.it)

Keywords: Postural tone, symmetry, Fukuda test

Introduction

Even though the architecture of the musculoskeletal system respects closely the law of bilateral symmetry, a standing immobile human, shows to the attentive observer a number of asymmetry in the spatial distribution of his diverse bone segments and muscular mass in comparison with each other.

We can distinguish three types of asymmetries [1]: Cortical motricity asymmetries that are related to learned lateralization. It's essentially manual but can be ocular, spinal or podial; Structural morphological asymmetries which are known between the left and the right side, although the osteo-articular system is not as perfect as described in the anatomy book; Postural tonus asymmetries that's to say; muscular tonus asymmetries in a segment,a metamere or group of metameres. The postural control needs to integrate a number of sensorial information; visual, somatosensorial, proprioceptive or vestibular as well as the intentional mechanisms.

There are types of postural dynamics remarkably asymmetric in a functional perspective. The sociocultural behavior (writing, eating… etc), the daily manual handcraft for craftsmen like using the scalpel, mincer, shovel, rake, hammer… etc) long hours of work, cycling, sports, driving, are all witnesses of functional asymmetry that characterize the whole body and that are involved in specific actions. The motor segments are for every subject in the same global asymmetric scheme. The subject conjugates the partial segment in the perspective of either a higher strength

or a better adjustment for the trajectory in direction of a target. In all cases, it's the search for an even more efficient action that results in a better position of the segments.

We asked if these functional perspectives can create postural dynamics typologies, which can create in its turn either a tone asymmetry. Biomechanical factors are known to influence postural stability, the intrinsic differences between subjects in terms of their biomechanics, such us subject morphology (joints, muscle function, Body size and foot placement. These biomechanical factors have been identified to influence postural stability [2-5]. Pathologically, both central and peripheral diseases may cause deterioration of postural control and, especially in the case of lateralized disease, abnormal asymmetry in weight distribution between the legs [6-7].

Different measures are used to evaluate postural control. Romberg described a first test [8]. Romberg's test has subsequently become a commonly performed test in neurological studies to assess the functional integrity of the entire proprioceptive pathway [9]. Others measures are used to evaluate postural control [10, 11]; postural sways were measured by stabilometric platform, using centre of pressure (COP) [12-17].

We don't know what's the effect of the lateralization (manual, podial, ocular) on the tone for subjects who do different types of professions or have a sedentary life style. The goal is to study the symmetry of postural tone for subjects having homogeneous functional lateralization by a simple clinical test: Fukuda test. In this condition the inertial properties of the body, dependent on "height" and "weight", may become preponderant because of the removal of the visual afferent input to the postural control system. In fact, the loss of visual input has been shown to force, in most subjects, an increase in muscle stiffness [17].

Material and methods

Sample

It was an observational study; he studied population was composed of people aged between 18 and 70. This study is done in Physical rehabilitation department at the hospital during 2 month. All experimental protocols in this study were designed according to the principle of the Helsinki Declaration and approved by the Institutional Review Board of Kyushu University. All participants were informed of the experimental procedures and gave their written informed consent before participation. All participants gave their written informed consent for publication before participation.

Two conditions were required: comprehension of the test and consent of the subject. The static exam had the goal of eliminating the structural asymmetry related to static troubles of the spine and inferior members as well as the eliminations of neurological pathologies that can occur. We excluded a bunch of pathologies that can cause structural asymmetry such as: amputees; fractured, neurological and neuromuscular pathologies, ataxia, and patients who had surgeries on their lower limbs. To identify the characteristics of the studied population, the exam we did was supervised by a specialized physician in physical and functional rehabilitation.

Methods

We questioned the gender, the weight and the height and we calculated the body mass index. To determine the lateralization (manual, ocular, and podial), a lot of tests were used. Handedness was determined by two questions: do you write with your left or right hand? Do you throw the ball with you left or right hand? The dominance of the feet was determined in two ways: static (standing up on one foot) and dynamic (squash or beat an object). The ocular dominance was determined while searching for a preference or a dominance (the eye used in monocular activities such as targeting and acuity (the eye with the better vision). We looked for the postural tone asymmetry with Fukuda test (Figure 1): we drew two lines that meet perpendicularly on a 90° angle A and B, the test consists on standing about 50 feet in the center of the crossing, arms wide open at 90° , vision on the horizontal, eyes closes, and head in neutral position. We observed the patient's spin deviation which means the deviation angle while walking eyes closed. We also measured in cm walking forward or backward compared to the A axis and the deviation to the left or right compared to the B axis (Figure 2). The test was performed in a quiet and bright room with neutral ground.

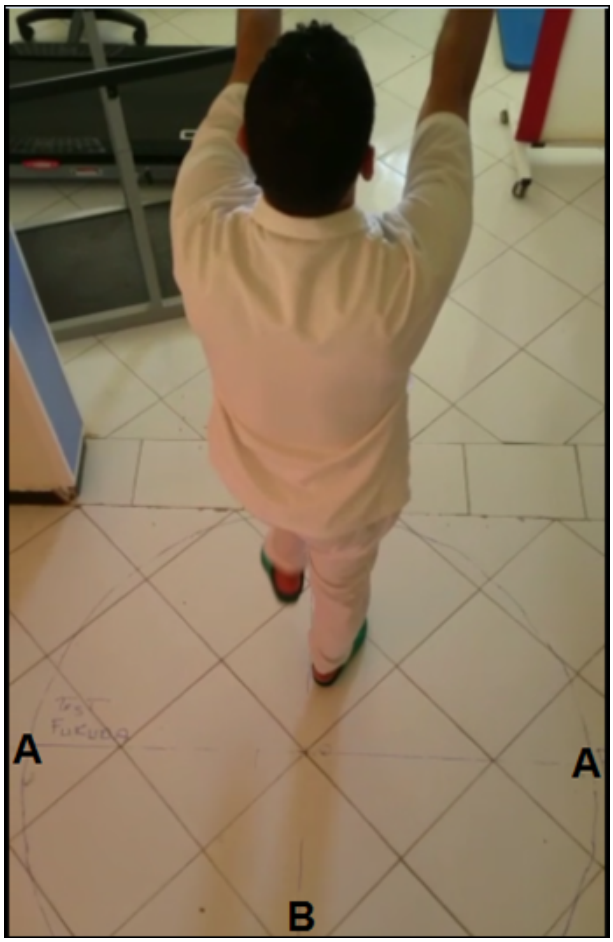

Figure 1. Fukuda test

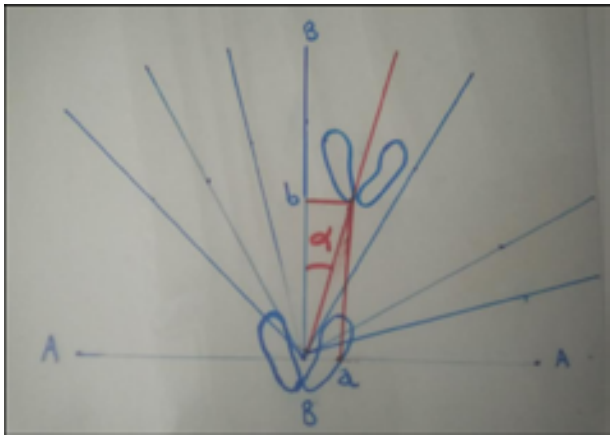

Figure 2. How to do the measurements:
Angle alpha: Fikuda angle
a: Deviation of the axis B in cm
b: Walking forward the axis A in cm

Statistical analysis

The collected data were analyzed via SPSS 13.0. The quantitative variables of the asymmetric distribution were expressed by medians and quartiles. A significance threshold less than 0, 05 was adopted for all of the statistical analyze.

Results

The descriptive study

100 subjects were recruited, there were 80 adults with a right homogeneous functional laterality (Right Eye, Right Hand, Foot Growth: HRH), 52 males (63, 52%) and 28 females (36, 47%).

Fukuda Test

For the whole studied population, both genders considered, the mean Fukuda angle is 0° (-15 °; 15 °), the mean deviation from the B axis was 0 cm (-14; 20) and the mean stepping forward on the axis A was 81 cm (52; 110) (Table1).

Discussion

Based on the Fukuda angle, the subjects were symmetrical tonic, with the exception of females who moved away from the axis B to the right, testifying to postural tonic asymmetry at her's. Therefore, homogeneous right-handers (HRH) did indeed tonic postural symmetry.

The population had postural tonic symmetry, Fukuda's mean angle was at 0 °, all subjects remained on walking line B except for females who even had a Fukuda angle 0º, deviated to the right of the line B. Currently, we don't know exactly what types of link between the postural asymmetry and the lateralization, the matter seems to be controversial and the results are contradictory. The advantage of this study, In addition to, the Fukuda angle, we have interpreted another parameter which is the deviation of the axis A and B walking axis.

Table 1. Fukuda test in all population, males and females

Variables	Males and Females 80	Males 52 (63, 52%)	Females 28 (36, 47%)
Angle in degrees	0° (-15°; 15°)	0° (-15°, 15°)	0° (-17°; 19°)
Deviation to the left or right compared to the B walking axis	0 cm (-14; 20)	0 cm (-17, 19)	3 cm (-23; 21)
Walking forward or backward compared to the A axis	81 cm (52; 110)	81cm (51, 119)	83 cm (52; 110)

The postural asymmetry was studied several times [18-23], some authors involve the vestibular system disequilibrium [24-25]. Others had stated that the deviation towards the center of gravitation to the left while standing up, which was observed in more than 70 % of the studied subjects [26], the hypothesis, is as simple as the dominance of the right muscular segments [27]. According to some authors, the deviation to the center of gravity is due to a dominance of the left vestibular, which results a deviation of the torso to the left [19,28,29]. According to Lacour and Coll. this left handed vestibular dominance is responsible for increasing of the tone of the left leg for right handed people. This approves the results that state the role of the right hemisphere in the stability of the body [30]. If we admit, today, that the stability of the body is one of the functions of right hemisphere, it seems that the lateral prevalence that came from the left hemisphere specifically, observed in right handed subjects are facilitated by this left stability coming from the right hemisphere, in order to allow a directed action towards a goal. This double division of central functions on the locomotors system is well illustrated in predominance formula (70% of right handed homogenous subjects) of the studied population (HRH).

In addition to the vestibular asymmetries, the asymmetries can be non-pathological related to the postural aplomb system [24-25] and the visual system [31-32]. These asymmetries can cause deviation to left or right while walking. There is a correlation between the postural asymmetry and the dominant eye [1], this is related to the involvement of the vision in postural control; would it be possible that the population of right handed homogeneous deviates from the B axis because of these right visual predominance.

Even though walking seem like a symmetric activity we can say that the asymmetry of the lower muscles are not related to the lateralization (ocular, manual, podial); the different intentional modalities (spontaneous walking, walking with divided intention, walking with led intention) don't modify the cinematic parameters of the subgroups (symmetric group, preponderant to the left, preponderant to the right) [33]. This asymmetry is not related to intentional phenomena or lateralization. It's related to the spinal walking generator [33].

The absence or the presence of the lateralization effect on the postural tone gave us second thoughts about the concept of lateralization. The tests are plentiful; would it be possible that this concept is senseless? For the foot lateralization there are two dominances: Static (Standing on one foot) and dynamic (squash and beat an object). For ocular lateralization: there are multiple tests to analyze the phenomena: which one to choose? : the visual test with the Goldman glasses (better vision, better palpebral motion), convergence test with Duane law, the hole in the paper with different forms (2 hands, 1 hand then the other, then no hands, 30° to the left then 30° to the right, after reflexing, immediately), these tests show how much the eye obeys to the preference of the subject, and the influence of the environment and the manual lateralization. The Fukuda test only has two options: arms outstretched in front or hands down the body.

Postural control is a complex mechanism involving neurophysiologically different mechanisms, such as the properties of the surrounding ankle muscles and the descending motor controls governing the ankle [34]. The effectiveness of postural control is influenced by cognitive tasks in the standing position, as the difficulty of the cognitive task increases, postural control becomes more complicated due to lack of attention. Older subjects are more sensitive to decreases in attention than younger subjects, and therefore experience more postural oscillations [35]. Our population is

young and free of any health problems; the elimination of cognitive tasks on the Fukuda test in this population with closed eyes is not so simple. The masticatory system, as a secondary factor, would probably be associated with postural control; this interrelation has been reported in different studies [36-39]. Sleep, a physiological need for our body, plays an important role in postural control. Indeed, from a neuropsychological point of view, sleep deprivation influences cognitive performance [40]. These three factors and the anthropometric data should be taken into account during the studies to standardize the evaluation protocols, particularly the instructions to be given to the subjects evaluated (do not chew on the test, before the test, sleep well the night before).

Last but not least, human beings adopt themselves to these asymmetries, although they can become pathological, especially, spinal or osteoarticular because of the asymmetries of mechanic constraints. These asymmetries had kind of pathogenicity that starts from a specific quantitative point. It seems like that the asymmetry of the locomotors system is highly deliberate because of the involvement of other factors. This study is just a promising start for other studies.

Limitations

This work presented a couple of limits: the sample was small, what we can say about other subgroups (Right-Left- Right, Right-Left- Right, Left-Left-Left …). There are some instruments that can evaluate the equilibrium like the statokinesimetric, baropodometry and Force platforms [10-17], although we preferred the clinical test (Fukuda).

Conclusion

The asymmetries exist but they are mastered. The association between the lateralization and asymmetries of orthostatic posture needs to be clarifies. Human beings adapt to asymmetries but they have tendencies to become pathological like scoliosis, piriformis syndrome, and levator Scapulae Syndrome and so on, and we don't know why? The lateralization is a complex phenomenon. Other studies are welcomed to analyze it.

Conflict of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article

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Correspondence:
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Hafid Arabi, Professeur agrégé en médecine physique et réadaptation fonctionnelle
Service de Rééducation et Réadaptation Fonctionnelle (MPR), Hôpital Militaire Avicenne Marrakech, Avenue de la Résistance – Gueliz- Marrakech. BP 40000 Morocco. Tel: 00212642404497, E-mail: drhafidhafid1111@gmail.com