



Full length article

Inter-session agreement and reliability of the Global Gait Asymmetry index in healthy adults



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ABSTRACT

There has been a growing effort in restoring gait symmetry in clinical conditions associated with pronounced gait asymmetry. A prerequisite to achieve this is that the chosen approach can accurately assess symmetry and detect/impose changes that exceed the natural day to day variability. Global symmetry indices are superior to local and discrete indices because they capture the patient's overall gait symmetry. However, their repeatability is unknown. This study assessed the inter-session agreement and reliability of the Global Gait Asymmetry index. Twenty-three healthy individuals participated in two 3D gait analyses, performed approximately one week apart. The 95% limits of agreement, standard error of measurement, smallest detectable change, and intraclass correlation coefficient were analysed. The obtained values showed this index has poor agreement and reliability between sessions. Therefore, it cannot be used to assess the patient's progress overtime nor to compare symmetry levels among groups.

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1. Introduction

Gait symmetry is generally defined as the identical behaviour of the left and right limbs during gait [1]. Pronounced asymmetry levels have been associated with pathological conditions such as stroke [2], lower limb amputations [3], osteoarthritis [4] and arthroplasties [5], as well as anterior cruciate ligament injury [6]. Consequently, there has been a growing effort in restoring/increasing gait symmetry in several clinical conditions [7] back to those found in asymptomatic individuals.

Researchers have been studying the efficacy of gait retraining programs in improving gait symmetry [7]. A prerequisite to restore gait symmetry is the ability of the chosen approach to impose changes that exceed the between-session variability [8]. Hence, knowledge of the measurement error and reliability of symmetry indices is required. However, to the best of the authors' knowledge only two studies [8,9] have analysed the repeatability (i.e. agreement and reliability under identical conditions [10]) of

symmetry indices. Lewek and Randall [8] analysed the repeatability of the Symmetry Ratio in stance time, swing time and step length for stroke patients. Accordingly, symmetry was calculated by dividing each of these parameters from the paretic limb by the corresponding parameter in the non-paretic limb (i.e. a step length ratio of 1 indicates perfect symmetry; whereas a ratio of 0.5 means that the step length from the paretic limb is half the step length from the non-paretic limb). These authors reported inter-session Intraclass Correlation Coefficient (ICC) (2,1) values between 0.925 and 0.976, and minimal detectable change (MDC) percentages between 8% and 18%. One of the limitations in this study is the wide range of days between the two visits (between 3 and 36 days). Secondly, although the ICC and MDC values were very good, the calculation of the standard error of measurement (SEM), and consequently the MDC are questionable. The SEM cannot be calculated using a model of ICC that includes systematic error as this is not reflected in the pooled standard deviation. Moreover, the calculation of SEM from the ICC is not recommended as it highly depends on the sample's heterogeneity [11]. Senden et al. [9] examined the repeatability of step time asymmetry in healthy individuals, where step time asymmetry was the difference between the durations of successive left and right steps, divided by the mean duration between sides. These authors reported intra-

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session variation coefficients and ICC values from 29.25% to 47.88% and 0.509 to 0.787, respectively, and inter-session/observer ICC values between 0.010 and 0.351. These results suggest very poor inter-session reliability. Furthermore, the authors did not specify which ICC model was used, nor the measurement error, which are essential to interpret the ICC reported [12]. The interpretation of ICC values is also incomplete without its confidence intervals, which are lacking in both studies.

Besides these limitations, these studies assessed the repeatability of local symmetry indices. This type of indices quantify symmetry based on a single discrete metric (i.e. vertical ground reaction force, step length or knee sagittal angle, among others) that only relates to a portion of the gait cycle (i.e. peak value), therefore neglecting the temporal information of gait waveforms [13] as well as compensation strategies that affect other local parameters [14]. Consequently, some patients may be considered symmetric based on their step length symmetry, for example, even though their overall gait is highly asymmetric [15]. Alternatively, several local scores could be used, but it would be much harder for the clinician to assess the effectiveness of the intervention this way [16]. To overcome these limitations, global symmetry indices have been developed [16–18]. Contrarily to local indices, global symmetry indices can reduce the information from various continuous gait waveforms (for example, the joint angles from the entire lower limbs, at each percentage of the gait cycle) into a single numeric score. Hoerzer et al. [16] developed a global

symmetry index which uses information from the three components of the ground reaction force, as well as the hip, knee and ankle joint angles, moments and velocities in all three planes of motion. Instead, the global symmetry index developed by Nigg et al [17] includes data from the vertical and anterior/posterior components of the ground reaction force as well as the angular positions and velocities at the hip (in all three planes of motion), the knee (sagittal plane only) and ankle (sagittal and frontal planes). However, these two indices only include information from stance phase, therefore neglecting toe clearance and the preparation for the heel strike. Additionally, the combination of quantities with different physical units requires normalization, which may mask or artificially inflate the level of symmetry [19]. The AsymGPS, a global symmetry index proposed by Lundh et al. [18], overcomes these limitations by including data from the entire gait cycle and by limiting the analysis to the lower limb joint angles. However, this index does not include certain angles in the frontal and transverse planes which can be valuable to clinicians. Hence, the Global Gait Asymmetry (GGA) index was recently developed to include all three components of the joint angles at the lower limbs and trunk throughout the gait cycle.

Global symmetry indices may be more appropriate for gait retraining purposes as they provide information on overall gait symmetry in a single score, thus facilitating the assessment of a patient's progress and therefore of the effectiveness of a chosen intervention [16]. However, their repeatability has never been

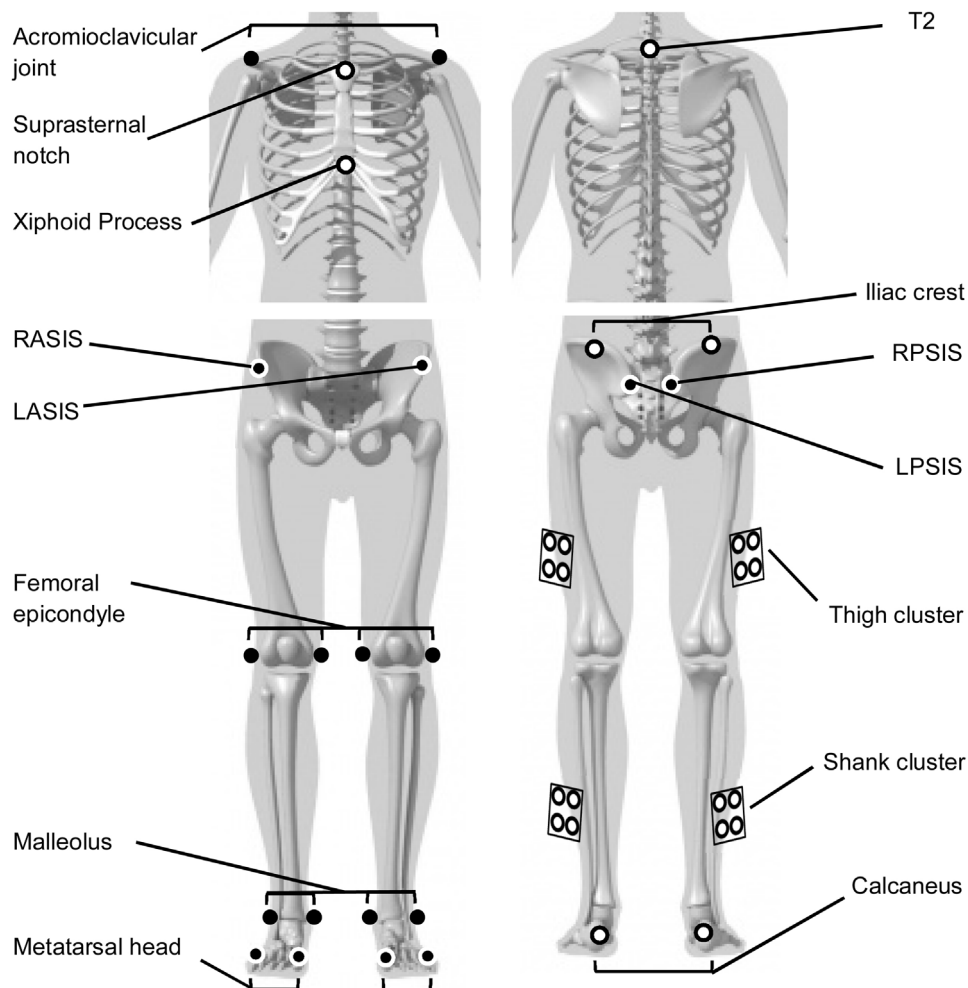


Fig. 1. Anterior (left) and posterior (right) views of the marker placement. The rigid clusters (squares with 4 markers) were placed on the lateral aspect of the thighs and shanks. Anatomical markers are in black, tracking markers are in white with a black outline, and anatomical markers also used for tracking are in black with a white outline.

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