# SPINE LENGTH EXCURSION DURING WALKING


**Veronica Farinelli (1), Chiara Palmisano (2) (3), Federica Camuncoli (2), Alessandra Favata (2), Carlo Albino Frigo (2)**

*1. Human Physiology Section of the De.P.T., Università degli Studi di Milano, Milan, Italy;*

*2. Department of Electronics, Information and Bioengineering, MBMC Lab, Politecnico di Milano, Milan, Italy;*

*3. Department of Neurology, University Hospital and JMU Würzburg, Würzburg, Germany.*


## Introduction

Human locomotion has been thoroughly analyzed in many aspects, but most studies refer to lower limbs [1], and do not pay much attention to movements of the spine [2, 3]. It is however well known that chronic- or disease-related reduction of trunk mobility may significantly affect the locomotor pattern.

In the present study we aim at describing the typical behavior of the spine during walking in healthy controls, by analyzing few synthetic parameters that can easily be obtained from gait analysis.

## Method

Ten healthy young subjects, 5 males, 5 females (aged 25 ± 2 years; body mass 68.2 ± 14.2 kg; body height 171.2 ± 12.2 cm; data shown as average ± standard deviation) were analyzed while walking barefoot at their natural cadence along a straight pathway. The experiment was performed in a gait analysis laboratory equipped with six TV-cameras and a Smart-E motion analyzer (BTS, Milan, Italy). Kinematic data were collected at 60 frames/sec. Retroreflective markers were positioned on the lower limbs, pelvis, and column according to the LAMB protocol [4]. In particular, the cervical process C7, the point of maximum kyphosis, and the Sacrum were considered. In order to include the lower extremity of the spine in our model, an additional virtual point was created in the local reference system of the Pelvis. This point approximately corresponded to the Coccyx, and together with the markers located on the Sacrum and maximum kyphosis, allowed to derive a schematic representation of the lumbar curve. The kyphosis curve was schematically represented by the segments defined by the Sacrum, the point of maximum kyphosis and C7. To synthetically represent spine mobility, we analyzed the time course of the distance between C7 and Coccyx (spinal length) over the gait cycle. Data were averaged across strides and over at least three walking trials for each subject.

## Results

Figure 1 represents the time course of the spinal length of one representative subject (25 years old, 1.72 m height, 72 kg of mass). The range of motion of the average curve is about one centimeter, and two peaks of appear at approximately the ipsilateral (0%) and contralateral (50% of stride cycle) heel strike.

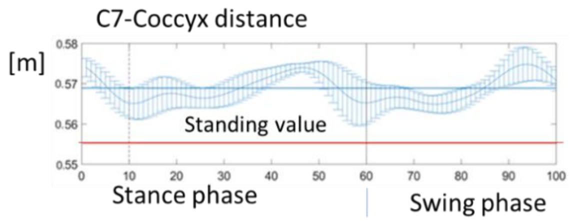


*Figure 1: Time course along the gait cycle of the spine length of a normal young subject during walking at natural velocity. Average curve (blue line) and +/-SD (blue band) over three trials are represented. The red line displays the average value of column length obtained during upright standing.*

Interestingly, the average spinal length along the walking cycle was considerably greater than during standing upright. From a group level, spine length was on average 1.6% longer during walking than standing (Student's t-test, $p<0.05$). Accordingly, the angle of lordosis decreased from standing to walking on average by 3.5 deg (Student's t-test, $p<0.05$), while the angle of kyphosis did not show significant variations across conditions.

## Discussion

During walking, spine length was increased in correspondence of the beginning of the double support phase. Spine length was longer during walking than during upright standing. Lengthening of the column was associated to decreased lumbar lordosis and not to spinal kyphosis. The retroversion of pelvis can be responsible for this phenomenon. The relationship between these biomechanical variables describing spine mobility during walking may be relevant in investigating gait alterations related to spinal musculoskeletal diseases and low back pain.

## References


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