

# Trunk Reference

## IORtrunk References

**Leardini A, Biagi F, Merlo A, Belvedere C, Benedetti MG. (2011)** "Multi-segment trunk kinematics during locomotion and elementary exercises."

[Clin Biomech \(Bristol, Avon\). 2011 Jul;26\(6\):562-71.](#)

### BACKGROUND:

Motion of human trunk segments in healthy subjects during activities of daily living has been described either with oversimplified models or with cumbersome techniques of isolated anatomical complex. This study describes multi-segmental trunk motion based on a new technique which is a compromise between technical limitations, implied with the experiments, and clinical relevance.

### METHODS:

The thorax segment was tracked by the optimal spatial matching of four thoracic markers. The separate bi-dimensional shoulder line rotations and translations with respect to the thorax were calculated by markers on the two acromions. Spine motion was characterised by a 5-link-segment model from additional four skin markers, in the anatomical reference frame based on four pelvic spine markers. These 14 markers were tracked in 10 healthy subjects and one clinical case during static upright posture, chair rising-sitting, step up-and-down and level walking, and also during elementary flexion and extension, lateral bending, and axial rotation movements of the entire trunk.

### FINDINGS:

Intra-subject repeatability over ten repetitions was found to be high for most of the measurements, with average standard deviations of less than 1.8° for all planar rotations at the spine, and less smaller than 1mm for shoulder translations. Large motion, albeit with different patterns, was found in all subjects, also revealing interesting couplings over the three anatomical planes.

INTERPRETATION:  
Considerable subject-specific motion occurs at each of these different trunk segments in all three anatomical planes, in simple exercises and in motor tasks of daily living. Measurements taken with the present new trunk model in pathological subjects shall reveal corresponding patterns and ranges of motion in abnormal conditions.

**Leardini A, Berti L, Begon M, Allard P. (2013)** "Effect of trunk sagittal attitude on shoulder, thorax and pelvis three-dimensional kinematics in able-bodied subjects during gait.."

[PLoS One. 2013 Oct 29;8\(10\)](#)

It has been shown that an original attitude in forward or backward inclination of the trunk is maintained at gait initiation and during locomotion, and that this affects lower limb loading patterns. However, no studies have shown the extent to which shoulder, thorax and pelvis three-dimensional kinematics are modified during gait due to this sagittal inclination attitude. Thirty young healthy volunteers were analyzed during level walking with video-based motion analysis. Reflecting markers were mounted on anatomical landmarks to form a two-marker shoulder line segment, and a four-marker thorax and pelvis segments. Absolute and relative spatial rotations were calculated, for a total of 11 degrees of freedom. The subjects were divided into two groups of 15 according to the median of mean thorax inclination angle over the gait cycle. Preliminary MANOVA analysis assessed whether gender was an independent variable. Then two-factor nested ANOVA was used to test the possible effect of thorax inclination on body segments, planes of motion and gait periods, separately. There was no significant difference in all anthropometric and spatio-temporal parameters between the two groups, except for subject mass. The three-dimensional kinematics of the thorax and pelvis were not affected by gender. Nested ANOVA revealed group effect in all segment rotations apart those at the pelvis, in the sagittal and frontal planes, and at the push-off. Attitudes in sagittal thorax inclination altered trunk segments kinematics during gait. Subjects with a backward thorax showed less thorax-to-pelvis motion, but more shoulder-to-thorax and thorax-to-laboratory motion, less motion in flexion/extension and in lateral bending, and also less motion during push-off. This contributes to the understanding of forward propulsion and sideways load transfer mechanisms, fundamental for the maintenance of balance and the risk of falling.

**Leardini A, Biagi F, Belvedere C, Benedetti MG.(2010)** "Quantitative comparison of current models for trunk motion in human movement analysis."

*Clin Biomech (Bristol, Avon). 2009 Aug;24(7):542-50*

A number of different models for human trunk kinematics during locomotion have been proposed, though mainly addressing specific clinical questions rather than general populations. These differ considerably for the skeletal segments considered, marker-set, anatomical axis and frame definitions, and joint conventions. The scope of the present study is to compare quantitatively these models on the basis of the same motion.

#### METHODS:

Ten subjects were analysed, instrumented with a single comprehensive marker-set of 14 markers identified from the union of the corresponding from eight current models for trunk kinematics. Activities of daily living (walking, chair rising/sitting, step-up/down), elementary trunk movements (flexion, bending and axial rotation), and isolated motion of the shoulders, both synchronous and asynchronous were collected. Resulting rotations in the three anatomical planes, both in the laboratory and in the pelvis reference frames, were calculated. FINDINGS:

In addition to the expected bias between the rotation angle time-histories, very different patterns and range of motion were found between the models. In chair rising/sitting, and in the laboratory global frame, the range of flexion averaged over the subjects was measured by the different models in the full scale from about 28 degrees to 44 degrees. In elementary trunk rotation and in the pelvis anatomical reference frame, three models measured about 10 degrees excursion of the coupled bending motion, other two about 38 degrees and 49 degrees on average. INTERPRETATION:

In trunk kinematics analysis, it is recommended that all models, both in terms of markers involved and of reference frame definitions, are understood carefully before interpreting the results in clinical decision making.

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