IOR Gait Overview

Acknowledgement

The IORgait is a protocol from the Istituto Ortopedico Rizzoli and in particular, through the collaboration of Alberto Leardini and Maria Grazia Benedetti.

IORgait Purpose

IORgait is a gait analysis protocol and report that is expected to be a
current clinical practice. Various clinical gait analysis software is ava
aimed at obtaining a compromise between the following contrasting cri

1. Protocols for clinical gait analysis should pursue a thorough and r segment and joint kinematics based on subject-specific anatomical rapid, simple, and practical procedures of data collection and redu particularly when children are analysed.
2. Anatomical reference frames should be defined using anatomical la be chosen to be identified easily, preferably by external palpation
3. Report gait results using current international recommendations.

IORgait is comprised of three published protocols (described below):

1. IORgait
2. IORfoot
3. IORtrunk

The IOR protocols have been validated clinically with links to the vari
section.

IORGait Marker sets and associated models are described and implemented in
tutorials, as detailed here

IORgait

Leardini A, Sawacha Z, Paolini G, Ingross
Nativo R, Benedetti MG.(2007)

A new anatomically based protocol for gai
in children.

Gait Posture. 2007 Oct;26(4):560-71

Human movement analysis still suß ers fro weakness of the currently used protocols collection and reduction. Reliable data co and precise functional assessment require anatomically based deß nitions of the refe and frames, and therefore careful identiß tracking of the landmarks. When impaired are analysed, the marker-set and other measurement procedures have to be minim reduce the time of the experiment and ens patient collaboration. A new protocol is p the analysis of pelvis and lower limb moti obtained as a compromise between these requirements. A marker-set is proposed w involves the attachment of 22 skin marker calibration by a pointer of 6 anatomical la and the identiß cation of the hip joint cent prediction approach. Anatomical reference and joint rotations are deß ned according recommendations. The protocol was asses analysing a single child in several repetit diß erent examiners, and a population of 1 children, mean age 9.7-years-old. The ent analysis was repeated after subtraction o by static posture angles. The minimum an maximum means of the standard deviation ß ve examiners of the same child were res 2.1 degrees in pelvic obliquity and 6.8 de knee rotation. The minimum and maximum of the standard deviations from the 10 he children were 2.1 degrees in pelvic obliqu degrees in knee internal-external rotation protocol is feasible and allows 3D anatom measurements of segment and joint motion data sharing according to current standar

IORfoot

Leardini A, Benedetti MG, Berti L, Bettinelli D, Nativo R, Giannini S.(2007)

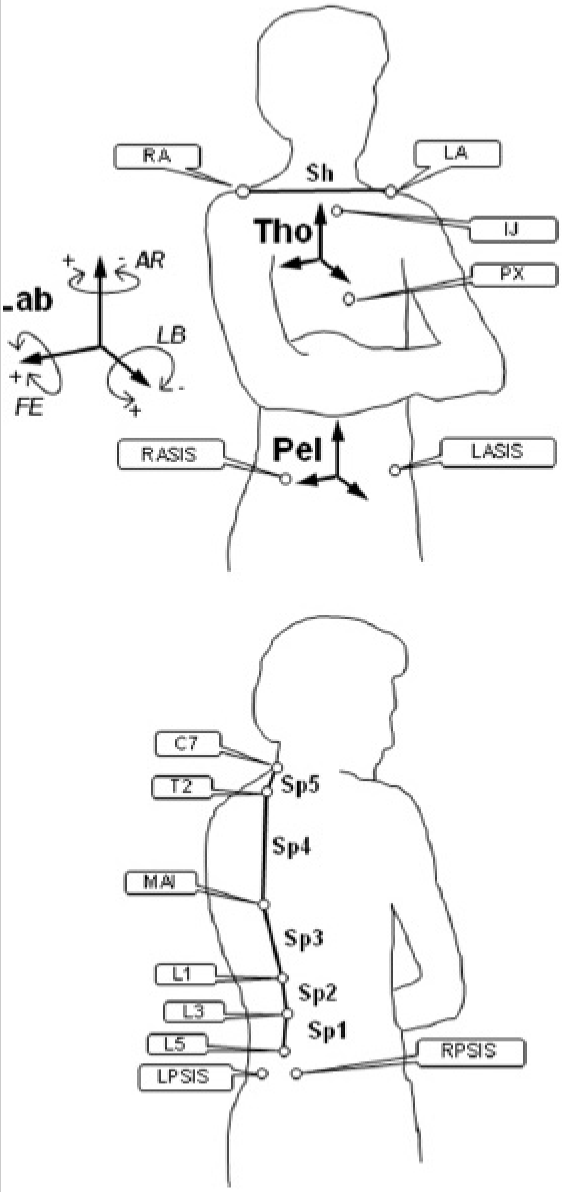
Rear-foot, mid-foot and fore-foot during the stance phase of gait.

Gait Posture. 2007 Mar;25(3):453-

This paper proposes a new protoco designed to track a large number o segments during the stance phase with the smallest possible number markers, with particular clinical fo coronal plane alignment of the rea transverse and sagittal plane align the metatarsal bones, and changes medial longitudinal arch. The shan calcaneus, mid-foot and metatarsu assumed to be 3D rigid bodies. Th longitudinal axis of the ßrst, secon ßfth metatarsal bones and the prox phalanx of the hallux were also tra independently. Skin markers were on bony prominences or joint lines the course of main tendons. Trajec the 14 markers were collected by a camera motion capture system at 1 on a population of 10 young volunt Three-dimensional joint rotations a planar angles were calculated acco anatomically based reference fram marker set was well visible throug stance phase of gait, even in a ca conßguration typical of gait analys full body. The time-histories of the rotations and planar angles were w repeatable among subjects and co with clinical and biomechanical kn Several dynamic measurements we originally taken, such as elevation the medial longitudinal arch and o metatarsal bones, rear-foot to fore rotation and transverse plane defo of the metatarsus. The information from this protocol, consistent with clinical knowledge, enhanced our understanding of the dynamics of t human foot during stance.

For more information about other multi-segment feet, here's a summar Multi-Segment Foot Models and Kinetic Segment Foot Models.

IORtrunk



Leardini A, Biagi F, Merlo A, Belvedere
Benedetti MG. (2011)

Multi-segment trunk kinematics during l
and elementary exercises.

Clin Biomech (Bristol, Avon). 2011 Jul;2

BACKGROUND: Motion of human trunk se
healthy subjects during activities of dail
been described either with oversimplißed
with cumbersome techniques of isolated
complex. This study describes multi-segr
motion based on a new technique which
compromise between technical limitation
with the experiments, and clinical releva

METHODS: The thorax segment was track
optimal spatial matching of four thoracic
separate bi-dimensional shoulder line ro
translations with respect to the thorax w
by markers on the two acromions. Spine
characterised by a 5-link-segment model
additional four skin markers, in the anat
reference frame based on four pelvic spi
These 14 markers were tracked in 10 hea
and one clinical case during static uprig
chair rising-sitting, step up-and-down an
walking, and also during elementary ßex
extension, lateral bending, and axial rot
movements of the entire trunk.

FINDINGS: Intra-subject repeatability ov
repetitions was found to be high for mos
measurements, with average standard de
less than 1.8° for all planar rotations at
less smaller than 1mm for shoulder trans
motion, albeit with dißerent patterns, wa
subjects, also revealing interesting coup
three anatomical planes.

INTERPRETATION: Considerable subject
motion occurs at each of these dißerent
segments in all three anatomical planes,
exercises and in motor tasks of daily liv
Measurements taken with the present ne
model in pathological subjects shall reve
corresponding patterns and ranges of mo
abnormal conditions.

IOR Marker Sets

The IOR Marker Sets page contains a detailed description of the markers that body and foot marker sets.

A tutorial describing the IORgait model explicitly as a Visual3D model can be found here	

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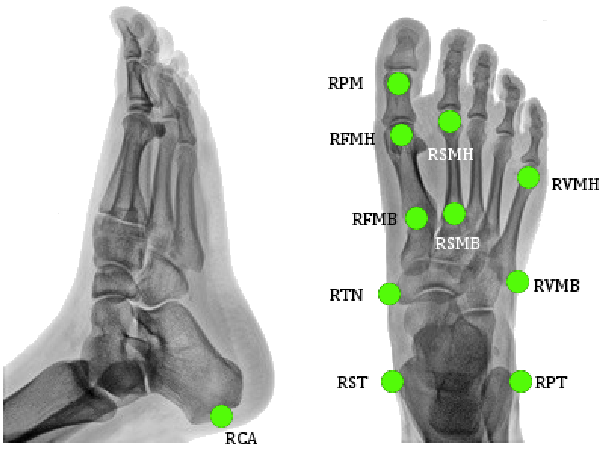

IOR Tutorials

The IOR Marker Set and associated models are described and impleme
detailed below:

Tutorial	Description
2006 IOR Foot Model	Building the IOR Foot Model as described in the 2006
2007 IOR Foot Model	Building the IOR Foot Model to reflect updated names
IORFoot 2014 Modifications	Building the original IOR Foot Model with all modifica 2014 paper.
IOR Gait Full Body Model	This tutorial explains how to implement the IOR Full Visual3D. The IOR Full Body Model is a combination Segment Trunk, and the IOR Lower Extremity Model.
IOR Gait Joint Angles	This tutorial is a continuation of the IOR Gait Full Bo tutorial goes through computing different joint angles Gait model.
IOR Gait Planar Angles	This tutorial is a continuation of the IOR Gait Full Bo tutorial goes through computing planar angles with th

Repeatability

Seo SG, Lee1 DY, Moon HJ, Kim SJ, Kim J, Lee KM, Chung CY and Ch

Repeatability of a multi-segment foot model with a 15-marker set in h

Journal of Foot and Ankle Research 2014, 7:24

Background: Several 3D multi-segment foot models (MFMs) have been analysis of dynamic foot kinematics. However, reproducibility of a mod ascertained before clinical utilization of a MFM. The purpose of this s reliability of recently introduced MFM with a 15-marker set by assessi stride (intra-session) and visit-to-revisit (inter-session) repeatability.

Methods: Twenty healthy adults with a mean age of 28.9 years (10 ma tested. Three representative strides from ßve separate trials were use session. Kinematic data of foot segmental motion was collected and tr Segment Software (Motion Analysis Co., Santa Rosa. CA). A retest wa manner at an interval of 4 weeks. Coeßcients of multiple correlation (correlation coeßcient (ICC) were calculated in order to assess the int repeatability.

Results: Inter-segment foot angles from healthy adults from a MFM wi narrow range of variability during the gait cycle. The mean intra-sess which was interpreted as excellent. The mean intra-session CMC was interpreted as very good repeatability. The mean inter-session ICC wa inter-session CMC was 0.801 (–0.077), which were interpreted as exce respectively.

Conclusion: We demonstrated a MFM with a 15-marker set had high int repeatability, especially in sagittal plane motion. We thought this MFM evaluation of the segmental foot motion during gait.

Arnold JB, Mackintosh S, Jones S, Thewlis D (2013) Repeatability of stance phase from a multi-segment foot model in people aged 50 years and older.

Gait Posture. 2013 Jun;38(2):349-51..

Conßdence in 3D multi-segment foot models has been limited by a lac particularly in older populations that may display unique functional fo aimed to determine the intra and inter-observer repeatability of stanc multi-segment foot model described by Leardini et al. [2] in people ag healthy adults participated (mean age 65.4 years SD 8.4). A repeated used with data collected from four testing sessions on two days from and between-day) and inter-observer coeßcient of multiple correlation excellent similarity of stance phase joint range of motion (0.621-0.97 motion (ROM), mean dißerences (MD) between sessions were highest f for all planar ROM at the metatarsus-midfoot articulation (sagittal pla coronal plane ROM 3.9 vs. 3.1°, MD 2.3°; transverse plane ROM 6.8° v Consequently, data from the metatarsus-midfoot articulation in the Ist foot model in adults aged over 50 years needs to be considered with r study.

Deschamps K, Staes F, Bruyninckx H, Busschots E, Jaspers E, Atre A, K.(2012) Repeatability in the assessment of multi-segment foot kinema
Gait Posture. 2012 Feb;35(2):255-60.
A recently published systematic review on 3D multi-segment foot mode repeatability studies providing evidence for appropriate clinical decis current study was to assess the repeatability of the recently publishe et al. [10]. Foot kinematics of six healthy adults were analyzed throug including two therapists with diß erent levels of experience and four te the parameters moderate or good repeatability was observed for the w sessions. A trend towards consistently higher within- and between-day the junior compared to the senior clinician. The mean inter-session va rotations ranged between 0.9-4.2° and 1.6-5.0° for respectively the se whereas for the absolute angles this variability increased to respectiv inter-therapist standard deviations ranged between 2.2° and 6.5° for t between 2.8° and 7.6° for the absolute 3D rotations. The ratio of inter ranged between 1.8 and 5.5 for the relative 3D rotations and between 3D rotations. Absolute angle representation of the planar angles was Observations from the current study indicate that an adequate normati in gait laboratories, however, it should be stressed that experience of laboratories should therefore be encouraged to put eß ort in training t

Caravaggi P, Benedetti MG, Berti L, Leardini A. (2011) Repeatability of a multi-segment foot protocol in adult subjects. Gait Posture. 2011 Jan;33(1):133-5 Despite the numerous protocols for multi-segment kinematic analysis scarce regarding relevant measures of reliability. The aim of the pres inter-trial, inter-session and inter-examiner variability of one of these method. The kinematics of the joints of the foot of two volunteers wer with diß erent degrees of experience in three sessions, two-to-four we data of ß ve trials of level walking were collected and the rotations in between foot segments were calculated. The mean value over stance p deviation of these rotations was calculated for groups of trials accord in Schwartz et al. [6]. For each rotation, the inter-examiner variability session, and the latter larger than the inter-trial. The inter-session va order of magnitude for standard lower limb protocols for the two exper for the inexperienced examiners.