Pelvis Segment Angle

The Pelvis Angle typically refers to the orientation of the Pelvis relative to the Laboratory.

Sequence of rotations for pelvis angle

In the following Technical Note:

Baker R (2001) Pelvic angles: a mathematically rigorous definition which is consistent with a conventional clinical understanding of the terms. Gait and Posutre 13, 1-6 Richard makes a convincing (to me anyway) claim that the sequence of rotations for the Cardan angle description of the pelvis relative to the laboratory should be Axial Rotation, Obliquity, Tilt. This is the reverse rotation sequence of the conventional Joint Coordinate System definition of a joint angle commonly used to describe the angles of the hip, knee and ankle, which is Flexion/Extension, Abduction/Adduction, Axial Rotation.

This is accomplished easily in Visual3D. In the Visual3D default segment coordinate system, the default sequence of rotations for a Joint Angle is x-y-z. For the pelvis angle, change the sequence of rotations to z-y-x and you will be consistent with Richard Baker.

Note 1: the laboratory segment should be the reference segment.

Note 2: For the calculation of segment angles, it is assumed that the subject is moving such that the lateral direction in the laboratory is the same as the lateral direction of the subject. If the subject turns relative to the laboratory, you will get strange results. Visual3D allows you to define a Virtual Laboratory (see elsewhere on this page) to avoid this problem.

Examples

We have listed a few examples for your review.

Example 1: Pelvis Relative to Virtual Lab

Segment angles are often defined as the orientation of a segment relative to the laboratory. The calculations and parameters are equivalent to the Joint Angle calculations except that the reference segment is the laboratory.

For example, segment angles are often calculated for the Pelvis relative to the laboratory and for the Foot relative to the laboratory.

One of the problems with this measure is that the values are dependent on the direction the subject is walking in the laboratory. For example, if the subject walks in the +y direction for some trials and -y direction for other trials, the segment angles will be different because they are rotated 180 degrees about the vertical axis. This problem is compounded because Visual3D restricts joint angles to values between -180 degrees and +180 degrees; a pelvis angle calculated relative to a laboratory in which

the walking direction is 180 degrees to the laboratory anterior direction will show some values around -170 degrees and some values around 170 degrees and the signal will flip between positive and negative values.

To accommodate the comparison of these trials you can create a Virtual Laboratory segment that is aligned with the direction of walking in the movement trial. An example file (Example2) can be found on the Example: Virtual Lab page. In the example file, the foot and pelvis angles are defined relative to the laboratory (LAB) for walking in the +y direction and relative to the virtual laboratory (VLB) for walking in the -y direction.

Example 2: Pelvis Relative to Virtual Lab that Changes Direction

The subject is walking in the anterior direction of the laboratory in some of the trials and in the posterior direction of the laboratory in other trials. How can I set up a virtual laboratory that will consistently give the angle of the pelvis relative to the walking direction?

If the subject walks in the +y direction for some trials and -y direction for other trials, the pelvis segment angles will be different because they are rotated 180 degrees about the vertical axis.

To accommodate the comparison of these trials you can create a Virtual Laboratory segment that is aligned with the direction of walking in the movement trial. The Example: Virtual Lab That Changes Direction page will show you have to create a laboratory lateral landmark that is oriented in the same direction as the lateral direction of the pelvis. There you will find an example file to download (Example3).

Example 3: Pelvis Relative to Virtual Lab that is at 45 Degrees

I have recorded data of straight walking using lower limb markers and pelvis markers. As the medial-lateral offset of the two force plates has been insufficient for my subjects, they therefore decided to angle their straight walk in such a way that they hit the force plates in a slightly oblique manner. My subjects' straight walking direction is therefore not truly parallel with respect to the global coordinate system. How can I compute the pelvis segment angle (e.g. relative to the laboratory coordinate system).

The straightforward solution is to build a kinematic only segment, such that the segment coordinate system of this "virtual lab" is aligned with the direction of walking.

For example, the subject is walking along a unit vector 45 degrees (PI/4 radians) to the anterior y-direction (towards the x-axis).

Let's create the following landmarks:

Landmark Name= **Lab_Origin**
Starting Point= Enter nothing
Existing Segment= **LAB**
Offset Using the Following ML/AP/AXIAL Offset= X=**0** , Y=**0** , Z=**0**
Calibration Only Landmark= Leave Unchecked

Landmark Name= **Lab_Anterior**

Starting Point= Enter nothing
Existing Segment= **LAB**
Offset Using the Following ML/AP/AXIAL Offset= X=**0.707** , Y=**0.707** , Z=**0**
Calibration Only Landmark= Leave Unchecked

Landmark Name= **Lab_Z**
Starting Point= Enter nothing
Existing Segment= **LAB**
Offset Using the Following ML/AP/AXIAL Offset= X=**0** , Y=**0** , Z=**0.1**
Calibration Only Landmark= Leave Unchecked

Let's create the Virtual Lab Segment:

In the Segment Name combo box type **Virtual Lab**
Select Segment Type = **Visual3D**.
Check the Kinematic Only Check Box
Select the **Create** button

In the Segment dialog box, enter the following:
Define Proximal Joint and Radius
Lateral= None Joint= **Lab_Z** Medial=None Radius= **0.01**
Define Distal Joint and Radius
Lateral= None Joint= **Lab_Origin** Medial= None Radius= **0.01**
Extra Target To Define Orientation (if needed)
Location= **Anterior** and **Lab_Anterior**
Select Tracking Markers same as Calibration Markers

When creating the pelvis segment angle, select this Virtual Lab as the reference segment.

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