Hip Joint Landmarks

Estimates for the Right and Left Hip Joint Center are represented as Landmarks relative to the CODA and V3D_Composite pelvis segment coordinate systems.

You should notice the following for all equations:

1. The left and right side landmarks are defined exactly the same, except the ML direction for one side is negated.
2. The only difference between the equations for the CODA and V3D_Composite pelvis segments is that there is an offset (0.5*RPV_Depth-Target_Radius_ASIS). This is because the origin of the V3D_Composite pelvis is 50% of pelvis depth compared to the CODA pelvis origin.

Model Metrics

You will see the following model metrics used in the equations below. These model metrics are automatically created when you create the CODA or V3D_Composite pelvis.

ASIS_Distance	The 3D distance between the Right and Left ASIS
RPV_Depth	The 3D distance between the Mid-Point of the ASIS and the Mid-Point of the PSIS
Target_Radius_ASIS	The radius of the marker placed on the ASIS landmark

NOTE: RPV_Depth is included in the subject metrics starting in Version 5 and the Target_Radius_ASIS is included in the subject metrics starting in Version 6. In previous versions, these metrics must be added manually.

Bell and Brand Hip Joint

When you create the CODA or V3D_Composite pelvis, the hip joint landmarks are automatically created using the Bell and Brand regression equations.

- Since the pelvis depth is defined differently between the CODA and V3D_Composite pelvis, use the set of equations which corresponds to the pelvis type you are using.

Bell & Brand		
	CODA Coordinate System	V3D_Composite Coordinate System
RHJC		
ML	0.36*ASIS_Distance	0.36*ASIS_Distance
AP	-0.19*ASIS_Distance	-0.19*ASIS_Distance + (0.5*RPV_Depth-Target_Radius_ASIS)
Axial	-0.3*ASIS_Distance	-0.3*ASIS_Distance
LHJC		
ML	-0.36*ASIS_Distance	-0.36*ASIS_Distance
AP	-0.19*ASIS_Distance	-0.19*ASIS_Distance + (0.5*RPV_Depth-Target_Radius_ASIS)
Axial	-0.3*ASIS_Distance	-0.3*ASIS_Distance

Bell AL, Pederson DR, and Brand RA (1989) Prediction of hip joint center location from external landmarks. Human Movement Science. 8:3-16: **Bell AL, Pedersen DR, Brand RA** (1990) A Comparison of the Accuracy of Several hip Center Location Prediction Methods. J Biomech. 23, 617-621. **Note that if the ASIS markers have been placed medial or lateral to the palpated landmark because the subject is overweight or because the markers can not be placed at these locations, it is important to measure the inter-ASIS distance and enter this value into the Subject Properties TAB.**

Note that in the 1990 article the ML distance is listed as 0.14 instead of 0.36 as used by Visual3D. The confusion lies in the location of the origin of the pelvis used in the article. Visual3D uses the mid-point of the ASIS, the article uses the Right ASIS location.

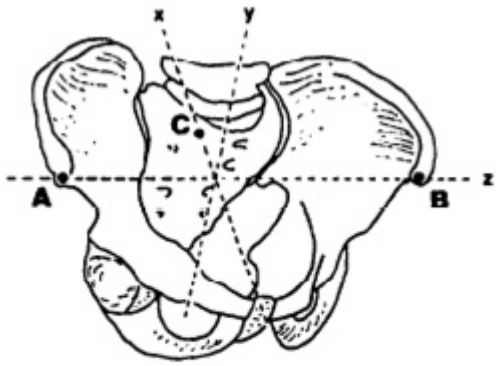

Fig. 1. Pelvic marker reference frame. Defined by markers over the right ASIS (Point A), the left ASIS (point B), and the midpoint between the PSISs (point C). The mid-PSIS marker is behind the sacrum, and would not normally be visible in this view.

Table 3. Hip joint center location from ASIS as a percentage of inter-ASIS distance (with estimated *x* direction marker/soft tissue correction of 2–3 cm)

Subject	*X* (%)	*Y* (%)	*Z* (%)
1	−24.7	−29.0	−15.4
2	−30.7	−33.3	−9.7
3	−20.0	−32.2	−13.3
4	−25.0	−29.8	−11.9
5	−9.4	−31.1	−16.9
6	−10.9	−25.9	−18.8
7	−14.2	−31.2	−13.0
Ave. (2 sig. figures)	−19 S.D. − 8.0	−30 S.D. − 2.4	−14 S.D. − 3.1

Harrington Hip Joint

Harrington provided two regression equations for the hip joint landmark

- The second set of equations requires the user to manually measure leg length. If you do not plan to manually measure leg length, use the first set.
- Since the pelvis depth is defined differently between the CODA and V3D_Composite pelvis, use the set of equations which corresponds to the pelvis type you are using.

Harrington 1

Harrington Equation 1		
CODA Coordinate System		V3D_Composite Coordinate System
RHJC		
ML	0.33*ASIS_Distance + 0.0073	0.33*ASIS_Distance + 0.0073
AP	-0.24*RPV_Depth - 0.0099	-0.24*RPV_Depth - 0.0099 + (0.5 * RPV_Depth - Target_Radius_ASIS)
Axial	-0.30*ASIS_Distance - 0.0109	-0.30*ASIS_Distance - 0.0109
LHJC		
ML	-0.33*ASIS_Distance - 0.0073	-0.33*ASIS_Distance - 0.0073
AP	-0.24*RPV_Depth - 0.0099	-0.24*RPV_Depth - 0.0099 + (0.5 * RPV_Depth - Target_Radius_ASIS)
Axial	-0.30*ASIS_Distance - 0.0109	-0.30*ASIS_Distance - 0.0109

Harrington 2

Harrington Equation 2		
CODA Coordinate System		V3D_Composite Coordinate System
RHJC		
ML	0.28*RPV_Depth + 0.16*ASIS_Distance + 0.0079	0.28*RPV_Depth + 0.16*ASIS_Distance + 0.0079
AP	-0.24*RPV_Depth - 0.0099	-0.24*RPV_Depth - 0.0099 + (0.5 * RPV_Depth - Target_Radius_ASIS)
Axial	-0.16*ASIS_Distance - 0.04*Leg_Length - 0.0071	-0.16*ASIS_Distance - 0.04*Leg_Length - 0.0071
LHJC		
ML	-0.28*RPV_Depth - 0.16*ASIS_Distance - 0.0079	-0.28*RPV_Depth - 0.16*ASIS_Distance - 0.0079
AP	-0.24*RPV_Depth - 0.0099	-0.24*RPV_Depth - 0.0099 + (0.5 * RPV_Depth - Target_Radius_ASIS)
Axial	-0.16*ASIS_Distance - 0.04*Leg_Length - 0.0071	-0.16*ASIS_Distance - 0.04*Leg_Length - 0.0071

Harrington ME, Zavatsky AB, Lawson SE, Yuan Z, Theologis TN.(2007) Prediction of the hip joint centre in adults, children, and patients with cerebral palsy based on magnetic resonance imaging. J Biomech. 2007;40(3):595-602. Epub 2006 Apr 3.

Davis Hip Joint

If no clinical measurements are taken, the following values are calculated:

Estimates for the Right and Left Hip Joint Center are represented as Landmarks that are created

automatically when the Helen Hayes pelvis segment is created. The location of the landmarks are defined in the Pelvis Segment Coordinate System as:

Davis	
CODA Coordinate System	
RHJC	
ML	- (C * sin(theta) -0.5 * ASIS_distance)
AP	(-Xdis-Rmarker) * cos(beta)+ C * cos(theta) * sin(beta)
Axial	(-Xdis-Rmarker) * sin(beta)- C * cos(theta) * cos(beta)
LHJC	
ML	(C * sin(theta) -0.5 * ASIS_distance)
AP	(-Xdis-Rmarker) * cos(beta)+ C * cos(theta) * sin(beta)
Axial	(-Xdis-Rmarker) * sin(beta)- C * cos(theta) * cos(beta)

Davis - Metric Values	
If LegLength is measured manually:	
LegLength	Measure leg length manually (must be updated for each subject)
If LegLength is NOT measured manually:	
RightLegLength	DISTANCE(RASIS,RLA) [NOTE: LASIS and LLA should represent the name of your left ASIS and lateral ankle target names in your marker set]
LeftLegLength	DISTANCE(LASIS,LLA) [NOTE: LASIS and LLA should represent the name of your left ASIS and lateral ankle target names in your marker set]
LegLength	0.5*(RightLegLength + LeftLegLength)
C	0.115*LegLength - 0.0153 (in meters)
theta	28.4*PI/180.0
beta	18.0*PI/180.0
If Xdis is measured manually:	
Xdis	anterior/posterior component of the ASIS/hip center distance in the sagittal plane of the pelvis and measured during the clinical exam
If Xdis is NOT measured manually:	
Xdis	0.1288*LegLength - 0.04856
Rmarker	marker Radius (in meters)

These equations are adapted from the article:

Davis RB, Ounpuu S, Tyburski D, Gage JR. (1991) “A Gait Analysis Data Collection and Reduction Technique.” Human Movement Science, 10: 575-587.