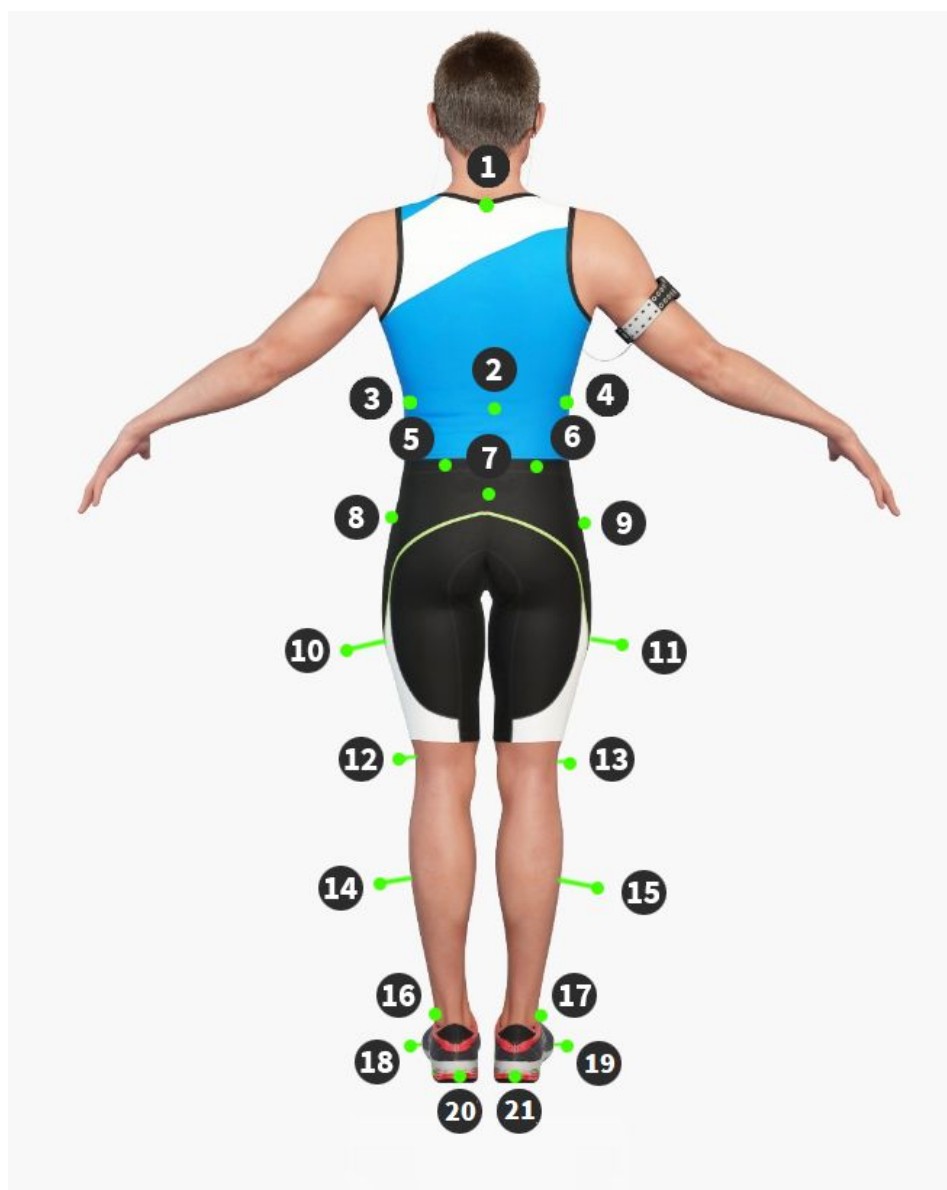


RunDNA - GAIT ANALYSIS

Marker placement - overview

A total of 21 markers are used. Among them, 15 are fixed directly on the body and the remaining 6 are mounted on light, plastic extenders (markers 10, 11, 14, 15, 18 and 19 use long extenders).



	#	NAME IN SOFTWARE	ANATOMICAL POSITION
BACK	1	<i>neck</i>	This marker is placed on the C7 vertebra .
	2	<i>right_lumbar</i>	This marker is placed up to 4 inches to the right of the L1 vertebra .
	3	<i>left_lumbar</i>	This marker is placed up to 4 inches to the left of the L1 vertebra .
	4	<i>lumbar</i>	This marker is placed on the L1 vertebra .
PELVIS	5	<i>left_posterior_superior_iliac_spine</i>	The iliac crest can be found easily. Follow the left crest back to the rearmost point. That is the left posterior superior iliac spine .
	6	<i>right_posterior_superior_iliac_spine</i>	Likewise, follow the right crest back to the rearmost point. That is the right posterior superior iliac spine .
	7	<i>lower_sacrum</i>	Place the marker in the center of the Sacrum , around 2-3cm below the imaginary line formed by markers #2 and #3.
FEMURS	8	<i>left_greater_trochanter</i>	Left greater trochanter . Hint: find the imaginary spot that works as the rotation axis for the femur head.
	9	<i>right_greater_trochanter</i>	Right greater trochanter . Hint: find the imaginary spot that works as the rotation axis for the femur head.
	10	<i>left_lateral_thigh</i>	<i>(This marker requires a long extender, which is provided).</i> On the left thigh , just below the swing of the hand, the extender forms an axis that crosses the Longitudinal thigh axis and is parallel to the flexo-extension axis of the knee.
	11	<i>right_lateral_thigh</i>	<i>(This marker requires a long extender, which is provided).</i> On the right thigh , just below the swing of the hand, the extender forms an axis that crosses the Longitudinal thigh axis and is parallel to the flexo-extension axis of the knee.
	12	<i>left_knee</i>	Lateral epicondyle of the left femur . Hint: find the imaginary lateral spot that works as the rotation axis for the knee.
	13	<i>right_knee</i>	Lateral epicondyle of the right femur . Hint: find the imaginary lateral spot that works as the rotation axis for the knee.
	14	<i>left_calf</i>	<i>(This marker requires a long extender, which is provided).</i> On the left calf , the wand forms an axis that crosses the Longitudinal calf axis and is parallel to the flexo-extension axis of the ankle.
	15	<i>right_calf</i>	<i>(This marker requires a long extender, which is provided).</i> On the right calf , the wand forms an axis that crosses the Longitudinal calf axis and is parallel to the flexo-extension axis of the ankle.
	16	<i>left_ankle</i>	<i>(This marker is small).</i> On the left lateral malleolus along an imaginary line that passes through the transmalleolar axis.
	17	<i>right_ankle</i>	<i>(This marker is small).</i> On the right lateral malleolus along an imaginary line that passes through the transmalleolar axis.
TIBIAS			

18 *left_lateral_mt5*

(This marker requires a long extender, which is provided).

Placed laterally on the side of the 5th metatarsal head of the left foot.

19 *right_lateral_mt5*

(This marker requires a long extender, which is provided).

Placed laterally on the side of the 5th metatarsal head of the right foot.

20 *left_heel*

(This marker is small).

Placed on the **left calcaneus** at the same height as the lateral heel marker.

21 *right_heel*

(This marker is small).

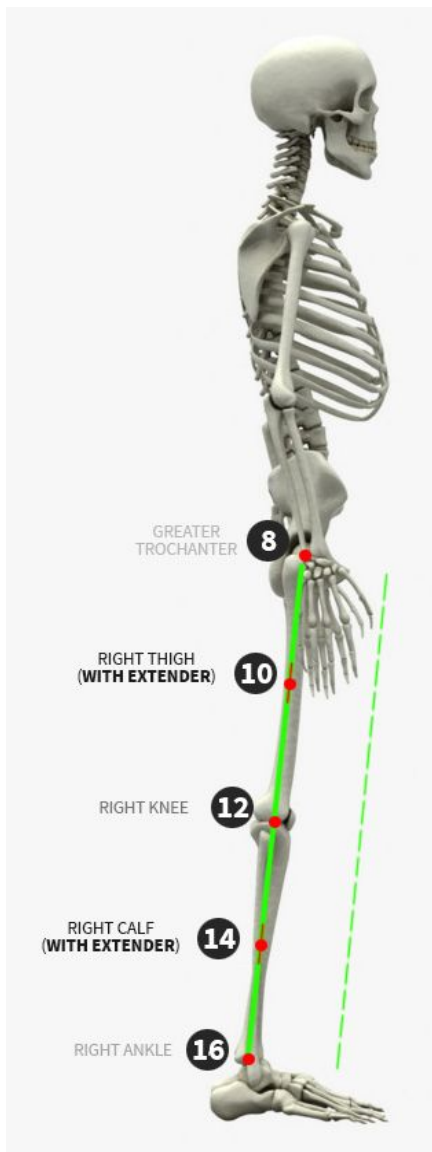
Placed on the **right calcaneus** at the same height as the lateral heel marker.



LONG EXTENDER

General recommendations for marker placement

- Generally speaking, markers should be placed on the skin in order to avoid or minimize the relative motion between the marker and its target anatomical position. In many cases this is not possible, so the practitioner / Sports scientist will just try to place it as close as possible. It is a good idea to recommend wearing **tight clothes** if possible. Loose pants will introduce some error.
- The antero-posterior placement of the markers is critical for correct alignment of the knee flexion axis. Pay a special attention to the markers on the legs (showing only the right side – check the left side likewise):



✓ Markers #8, #10 and #12 should be aligned in the plane that contains the hip and knee joint centers and the knee flexion/extension axis.

✓ The tibial marker #14 should lie in the plane that contains the knee (#12) and ankle joint (#16) centers and the ankle flexion/extension axis.

✓ In a normal subject the ankle joint axis, between the medial and lateral *malleoli*, is externally rotated by between 5 and 15 degrees with respect to the knee flexion axis. The placements of the shank markers should reflect this.

Parameter description

Pelvis angles

- **Pelvis Tilt:** Angle between the vertical axis of the pelvis and the same axis at the calibration phase projected to the sagittal plane at calibration. Positive means that the Pelvis is tilting forward (Anterior Pelvic Tilt).
- **Pelvis Abduction/Adduction:** Angle between the vertical axis of the pelvis and the global vertical axis projected to the Frontal Plane at calibration. Positive means that the left hip is going up.

Hip Angles

- **Hip Flexion/Extension:** Angle between the vertical femur axis and the vertical pelvis axis projected to the sagittal pelvis plane. Positive means flexion.
- **Hip Abduction/Adduction:** Angle between the lateral axis of the femur and the lateral axis of the pelvis projected to the frontal pelvis plane. Positive means abduction.
- **Hip External/Internal Rotation:** Angle between the frontal femur axis and the frontal pelvis axis projected to the horizontal pelvis plane. Positive means external rotation.

Knee Angles

- **Knee Flexion/Extension:** Angle between the vertical tibia axis and the vertical femur axis projected to the sagittal femur plane. Positive means flexion.
- **Knee Abduction/Adduction:** Angle between the lateral tibia axis and the lateral femur axis projected to the frontal femur plane. Positive is valgus.
- **Knee External/Internal Rotation:** Angle between the frontal tibia axis and the frontal femur axis projected to the horizontal plane of the femur. Positive is external.

Ankle Angles

- **Ankle Plantar/Dorsal Flexion:** Angle between the vertical foot axis and vertical tibia axis projected to the sagittal tibia plane. Positive means plantar flexion.
- **Ankle Inversion/Eversion:** Angle between the lateral foot axis and the lateral tibia axis projected to the frontal tibia plane. Positive means pronation.
- **Ankle External/Internal Rotation:** Angle between the frontal foot axis and the frontal tibia axis projected to the tibia horizontal plane. Positive means external rotation.

Foot Angles

- **Foot Plantar/Dorsal Flexion:** Angle between the frontal foot axis and the horizontal plane projected to the tibia sagittal plane. Positive means plantar flexion.
- **Foot Rotation:** Angle between the frontal foot axis and the pelvic forward direction projected to the transversal plane of the pelvis. Positive means internal rotation.

Tibia Angles

- **Tibia Flexion/Extension:** Angle between the vertical tibia axis and the horizontal plane projected to the tibia sagittal plane. Positive means flexion.
Note that the tibia flexion and the knee flexion has contrary signus for the same movement.

Spine Angles

- **Trunk Flexion:** Angle of the vector that connects the pelvis marker s to the lumbar markers and the horizontal plane projected to the pelvis sagittal plane, calibrated so that the value is zero for the calibration position. Positive means spine flexion (forward bending).
- **Trunk Lateral Flexion:** Angle of the vector that connects the pelvis marker s to the lumbar markers and the horizontal plane projected to the pelvis coronal plane, calibrated so that the value is zero for the calibration position. Positive means spine flexion towards the left side.
- **Trunk Rotation:** Angle of the vector that connects the lumbar markers and the walking direction (treadmill) projected to the pelvis transversal plane, calibrated so that the value is zero for the calibration position. Positive means spine rotation towards the left side.

Other report parameters

Walking gait characteristics

- **Speed:** This is the given treadmill speed in mph.
- **Cadence:** Number of steps per minute.
- **Ground Contact Time:** Time in milliseconds that the foot is on the ground for each stride.
- **Stride length:** Distance in millimeters between the initial contact of one foot to the ground to the next consecutive initial contact of the same foot on the ground.
- **Double limb support:** Percentage of the gait cycle in which both feet are on the ground simultaneously.
- **Single limb support:** Percentage of the gait cycle in which only one foot is in contact with the ground.