

Exercise & Sports Biomechanics
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Week 01
Lecture 03

Fundamental Directions

Hello everyone, welcome back to this course. In the previous lecture, you explored different methods of research in biomechanics and how to interpret them. Irrespective of the field, without trial and error, it is not possible to progress either in concepts or in research. I hope you understand how complex human movement is. So let's start from scratch-

If I ask you to bend your elbow, based on your muscle memory, some will bend by keeping the palm facing upward, and some will rotate the forearm and then bend. It is a natural process, right? However, when scientists started analyzing the movements, they found it difficult to interpret the data. To avoid this confusion and eliminate ambiguity, scientists introduced the concept of reference position. **There are two reference positions to describe joint movements, which are the fundamental reference system and the anatomical reference system.**

The anatomical position is the most commonly used for understanding human movement. Look at the model on the screen. The subject is standing in an upright posture. The head is facing forward. The feet are parallel, shoulder-width apart, toes are facing forward, and palms are facing forward.

So, this is the anatomical position. The fundamental position is essentially the same as the anatomical position. Look at the animation. In the forearm, you can see the changes. The palm is facing toward the body. This is the difference between **fundamental position and anatomical position.**

[Next, we move on to Anatomical jargon]

Anatomical jargons (anatomical directions and lines):

Anatomical jargon is the anatomical directions and lines that help us describe the position of the structure in relation to the anatomical position because in biomechanics, without a

reference, we cannot quantify the movement or even identify the direction of the movement.

Let's look into the model, the first one is the anterior and posterior: [also see the video].

Anterior and Posterior:

The first one is the anterior and posterior. The anterior is also known as ventral, and the posterior is also known as dorsal. If anything describes the front part of the body, it is known as anterior. If anything describes the back side of the body, it is known as posterior. If anything in the front is anterior, anything behind is posterior.

Let me zoom in on the animation a little bit. I am drawing a line on the sternum. Now, if we want to give an example in the anatomical reference, the sternum is anterior to the spinal cord, right? The sternum is anterior to the spinal cord. The spinal cord is the posterior. It is a reference line. So, I am drawing an anteriorly. It is an anterior. If I rotate the model a little bit and adjust the spinal cord reference line, and if you notice the scapula, the scapula is at the posterior to the spinal cord, Right? So, based on the reference line as a spine, we can give a reference. The sternum is anterior and the scapula is posterior.

[Next, we move on to superior and inferior]

Superior and inferior:

Here, I will take the clavicle as a reference line. If anything is described above the clavicle line, it is known as superior, and anything below the reference line, which is the clavicle, is inferior.

Superior is also known as cephalic, and inferior is also known as caudal. In this example, we will take the head as superior to the clavicle line and the pelvis as inferior to the clavicle line.

[Next, we move on to proximal and distal]

Proximal and distal:

If anything is closer to the origin point, it is known as proximal, and if anything is away from the origin point, it is known as distal. Let us look into the model.

So, imagine that we take the shoulder joint as the origin. Then, the elbow joint will be proximal, and the wrist joint will be distal. If anything is closer to the origin point, it is

known as proximal. If anything is away from the origin point, it is known as distal. Distance means distal.

[Next is the midline]

The midline:

The midline is the imaginary vertical line that crosses the center of the body. This is the center of the body.

Medial and lateral:

Any segment that is closer to the midline is the medial. If any segment is away from the midline, it is known as lateral. Here, we will take ulna and radius as an example. So, where are the ulna and radius? A simple tip to remember. With the thumb, you can see there is a U shape forming. It is like this U shape is forming. The opposite side of the U is the ulna and radius.

The lateral side is the radius, which means the ulna is the medial side and the radius is the lateral side. Again, I am repeating, if any segment is closer to the midline, it is known as medial, and if any segment is away from the midline, it is lateral. In this example, the ulna is the medial and the radius is the lateral side.

Superficial and Deep:

It describes the position of the segment: if it is closer to the surface, it is superficial, and if it is further away from the surface, it is known as deep. For example, here I am taking this rib cage: here, the sternum is at the surface, which is known as superficial, and if I move inside the rib, which is further away from the surface, the surface is the sternum. I mean, moving away from the surface, I am moving inside the rib, which is known as deep.

Supine and prone:

If any segment or a body is facing up, it is known as supine. If any object or body is facing down, it is known as prone. Anything facing up is supine. Anything facing down is prone.

Ipsilateral and Contralateral:

Ipsilateral refers to the same side, and contralateral refers to the opposite side. If I am working on the right hand and the right leg, it is ipsilateral. And if I am working on the

right hand, the left leg is contralateral. For example, here we will take a segment. If I am taking the left hand and the left foot, it is ipsilateral. If I am taking the right hand, then the left foot is contralateral.

[Next, we move on to anatomical lines]

Anatomical lines:

The midline:

The first one is the midline. The midline is an imaginary vertical line that crosses the center of the body. With the help of the midline, we have identified which segment is closer or further away, which is known as medial and lateral.

The mid-axillary line:

This is a line running vertically down the surface of the body, and passing near the apex of the axilla, which is the armpit.

Clavicular line:

Clavicular line is related to the clavicle. Now we need to identify the mid part of the clavicle, and from there, we can draw an imaginary line known as the mid-clavicular line.

The vertebral line:

This line runs vertically down through the spinous process. It is known as the vertebral line.

The scapula line:

The inferior part is known as the inferior angle of the scapula. So, the imaginary line is passing through the inferior part, which is the inferior angle of the scapula. These lines will help us to understand the fundamental movements in the next chapters.

Let us apply the anatomical jargon in actual sports scenarios. The first one is the anterior and posterior. We have two models on the left. [please see the video]

Anterior and Posterior:

The goalkeeper is catching the ball, and on the right, the player is performing the scissor technique. In both cases, we will take the ball as a reference point. On the left, the model is catching the ball. It is in front of the body. Here, the body is the reference line to describe the position of the ball.

On the right side, the ball is moving from left to right. So, which is the anterior and posterior? If this is moving in this direction, this is the anterior side, and this is the

posterior side. So, the player is kicking the ball on the posterior side of the ball to score the goal. Anterior means front. Posterior means back.

Superior and Inferior:

Superior and Inferior describe above and below in relation to another segment. Here, we have two models from MMA kicking.

One is high kicking. And another one is the low kick. Imagine the opponent is standing in front of both models, and we consider this as the head. Pelvis and foot. Similarly, this side: pelvis, head, and foot.

In a high kick, the fighters kick the head, which is the superior part of the body. And in a low kick, the fighters kick the foot, which is the inferior part of the body.

Proximal and Distal:

Proximal and Distal describes the position closer to or further away from the origin point. In this example, we will take the pike walk as an example. Here, we consider the foot as the origin point. And as he walks further away from the foot, which is the origin point, it is considered as distal. And if the model walks back towards the origin point, it is known as proximal.

Medial and Lateral Distal:

Medial and Lateral Distal describes the position closer to or further away from the midline. You can see the image. I am placing an EMG sensor on one of the international athletes. So, what is the midline? The midline is an imaginary vertical line that crosses the center of the body.

You can see the EMG marker 1 over here, which is in the vastus medialis. Another one is the vastus lateralis. If it is closer to the midline, it is known as medial. And if it is away from the midline, it is known as lateral. So, two sensors we have placed in the vastus medialis and vastus lateralis.

One in the medial and another one in the lateral. The next one is the superficiality. Superficial means something closer to the surface of the skin. So, I have kept the EMG sensor at the surface of the skin to measure the muscle activity. Right? It is on the surface of the skin.

[Next is deep]

Deep:

Deep is further away from the surface of the skin. We have taken needle EMG as an example, where it involves inserting fine electrodes to measure the deep muscle activity.

Supine and Prone:

If the body is facing up, it is supine, and if it is facing down, it is prone. In this example, on the left, the model is performing crunches, facing up, which is supine. On the right, the model is performing push-ups, facing down, which is prone. Lastly, the ipsilateral and contralateral relate to the same side and opposite side. On the left, the model is performing with the same hand and the same foot, which is known as ipsilateral. And on the right, the model is pitching with the right hand and the left leg, which is contralateral.

Note:

[From now on, whenever you exercise or watch exercises, try to incorporate these anatomical terms for better understanding. Thank you very much for your attention.]