

Exercise & Sports Biomechanics
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Lecture 04

Fundamental Movements Planes & Axes

What is meant by fundamental movements?

Fundamental movements in biomechanics are the building blocks of all human motion. By understanding these movements, we can analyze sports techniques and exercises to optimize muscle performance and reduce the risk of injuries.

[Let us dive into it in details]

Flexion:

If the angle between any segment decreases, then it is known as flexion. Look into this model. If you are bending your elbow (I am taking the upper arm and forearm), the angle between these two segments, if it is decreasing, then it is flexion. So, I am flexing the elbow. You can see the direction of the movement. The angle is decreasing.

Extension:

If the angle between any segment increases, then it is the extension. We are taking the same model but in a different direction. If the angle between these two segments increases, you can see the opposite direction. Now, it is increasing. If the angle decreases, it is flexion, and if the angle increases, it is known as extension.

Abduction:

If any segment moves away from the midline, it is known as abduction. In the previous videos, we have explored what the midline is, right? The midline is an imaginary vertical line that crosses the center of the body. Now, when it comes to abduction, you can see the animation. We are performing shoulder abduction. The shoulder joint is moving away from the midline [see video]. It is moving away from the midline. It is known as abduction.

Adduction:

If the segment is moving towards the midline, it is known as adduction. The same movement. Which is in the opposite direction. Which is moving towards the midline.

This is the adduction. So I am moving the model. You can see that. It is moving towards the midline. If it is away from the midline, it is abduction; towards the midline is adduction.

Internal rotation:

If the segment rotates towards the midline, it is known as internal rotation. Again, the middle line comes. So, I will draw a middle line first. You can see the animation. This is not the perfect view. I am taking it to the top view [see video]. So, that you can visualize the internal rotation perfectly. If the segment rotates towards the median line, it is known as internal rotation. Now, you can see the segment is moving towards the median line.

External rotation:

If the segment is rotating away from the midline, it is known as external rotation. Now, you can see that the model is moving away from the midline. If it is rotating towards the midline, it is internal rotation; and it is rotating away from the midline then it is external rotation.

Circumduction:

It describes the circular motion of a segment or a joint. It is a combination of flexion, extension, abduction, and adduction. For your better understanding, I have changed the background color of the model [see video]. I have highlighted the wrist joint, and if you notice, I am moving the segment. You can visualize the circular motion in the wrist joint or in the elbow joint. The circular motion is very clear here. So, as we discussed, it is a combination of all four movements. When we visualize it from the front view, you can understand it much better.

Let us start with flexion and adduction, followed by abduction and extension. We can visualize that in the front view again. It starts with flexion and adduction because the movement is closer to the midline of the body. As it reaches the top, it moves away from the midline, which is known as abduction, followed by extension. That is why circumduction is the combination of flexion, adduction, abduction, and extension.

[Next, we move on to **specific movements that occur in specific joints**]

Protraction:

Protraction is the forward movement of a segment, i.e. away from the midline, which typically occurs in a horizontal direction, this contraction occurs in two joints: one is the

jaw, and the second one is the scapula, in this example. From the midline, the movement takes place in the anterior direction, which is known as protraction.

Retraction:

It is the backward movement of a segment. Towards the midline, so the jaw is moving backward towards the midline, and the scapula, from the midline, will move outward. Protraction is when the scapula moves outward, and if the scapula moves inward towards the spine or the midline, it is known as retraction.

Supination:

It describes the rotation of the forearm. When the palm is facing upward, it is supination. Look at the animation. It is moving down and then moving up. The upward direction is supination.

Pronation:

It describes the same rotation of the forearm, but the palm will face downward. The palm will face down. If the palm is facing up, it is supination. If the palm is facing down, it is pronation.

[The next one is the radial and ulnar deviation]

The radial and ulnar deviation:

In the previous classes, we have already discussed how to identify the ulnar and radius. So, the example is the U shape forming here. The opposite side of this U shape is the ulnar, and the outer side is the radius.

What exactly is radial deviation and ulnar deviation?

From the midline, if the wrist joint is abducting, which is moving away from the midline, it is known as radial deviation.

What is ulnar deviation?

If the wrist joint is adducting, moving towards the midline, it is known as ulnar deviation.

[Next, we move on to the specific movements in the ankle joint].

Movements in the ankle joint:

Dorsiflexion:

Movement where the angle between the tibia and the foot decreases, it is known as dorsiflexion.

Plantar flexion:

If the angle between the shin bone and the foot increases, it is known as plantar flexion.
[Let us look into the movement] [see video].

The first one is dorsiflexion, where the angle between the tibia (the shin bone) and the foot decreases. If the angle between the shin bone and the foot increases, it is plantar flexion. Just to remember, if the foot is pointing towards the ground, it is known as plantar flexion. Since it is a specific movement, have you noticed that both movements, even if it is going towards the shin bone or moving away from the shin bone, are known as flexion? That's why we are emphasizing it. If the foot is moving towards the shin bone, then it is a dorsiflexion. If it is moving away from the shin bone, it is the plantar flexion. The

[Next one is inversion and eversion]

Inversion:

If the sole of the foot is moving towards the midline, then it is known as inversion.

Eversion:

If the sole of the foot is moving away from the midline, it is known as eversion. Let us look into the movement. So, this is the midline. The sole of the foot is moving towards the midline. It is an inversion, and what is moving away from the midline is known as eversion.

[Next, we move on to planes of motion].

What is meant by a plane?

A plane is an imaginary two-dimensional surface that passes through the body. There are three different types of planes. One is the sagittal plane. The second one is the frontal plane. The third one is the horizontal plane. The first one is the sagittal plane. It divides the body into right and left halves. You can see a plane in the orange color line divides the body into left and right [see video]. So, now you can see the visualization where the sagittal plane is completely removed. One half of the skeleton. We can switch it, and you can see the other half of the skeleton, which is **known as the sagittal plane**. The sagittal plane is also known as the anterior-posterior plane.

Because this plane divides the body from the anterior direction to the posterior direction. That is why it is known as the anteroposterior plane. In this, all the flexion and extension movements take place in the sagittal plane. So, again, I am repeating, irrespective of the

joint, whether it is the neck, shoulder, elbow, wrist, hip, knee, or ankle, all the flexion and extension will take place in the sagittal plane.

[Next, we move on to the **frontal plane**].

The **frontal plane** divides the body into front and back. The frontal plane divides the entire body into front and back. Now, you can see the visualization. It divides the front half of the body from the side view, and I am switching to the posterior view where it divides the back part of the body.

Coronal plane:

Now, you can see the back part of the body, and this one is the front part of the body. It divides equally into front half and back half. This is also known as the coronal plane. All the adduction and abduction movements take place in the frontal plane. Next, we move on to the horizontal plane, which divides the body into Upper and lower half, so you can see these orange lines which divide the upper half and lower half of the body in the animation. It divides the upper half and lower half of the body. In this, all the rotational movements take place in the horizontal plane. The horizontal plane is also known as the **transverse plane**. So, in the sagittal plane, it divides the body into right and left.

All the flexion and extension movements take place. In the frontal plane, it divides the body into front and back. All the adduction and abduction movements take place.

[next is the horizontal plane]

Horizontal plane:

Horizontal plane divides the upper half and lower half. All the rotational movements take place here.

[Next, we move on to the axis of rotation].

The axis of rotation:

Whenever we perform any movement, it always rotates around an imaginary axis of rotation that passes perpendicular to the plane of motion. There are three reference axes to describe human motion. One is the anteroposterior axis. Second is the medial-lateral axis. And the last one is the vertical axis.

First, we go to the **medial-lateral axis, also known as the frontal axis:**

The medial-lateral axis which passes perpendicular to the sagittal plane. So, what is the sagittal plane? It divides the body into the left half and the right half. If the axis of

rotation comes perpendicular to the sagittal plane, then all the flexion and extension movements take place.

[Next, we move on to the anteroposterior axis].

Anteroposterior axis:

It is an imaginary axis that passes perpendicular to the frontal plane. So, what is the frontal plane? It divides the body into the front half and the back half. In this all the abduction and adduction movements take place.

[The last one is the longitudinal axis].

Longitudinal axis:

In this, the imaginary axis passes perpendicular to the horizontal plane. So, what is the horizontal plane? It divides the body into the upper half and the lower half. In this, all the rotational movements take place.

Let us apply the planes of motion and the axis of rotation in exercise and sports. First, we will take the squat as an example. The movement takes place in the sagittal plane and the frontal axis. Let us analyze this movement. The sagittal plane divides the body into the left half and the right half. If the movement takes place in the sagittal plane, the axis will pass perpendicular to the plane of motion, which is the frontal axis. In this plane all the flexion and extension movements take place.

Let us take a bottom-to-top approach. Now, the athlete is in a squat position. The first one is the angle between the foot and the shin decreases. It is known as dorsiflexion. Similarly, the angle between the thigh and the shin bone decreases, which is knee flexion. The angle between the trunk and thigh decreases, which is hip flexion, and finally, shoulder flexion. When the athlete comes back to the normal standing position, the shoulder, hip, knee, and ankle joints are completely extended. The next exercise is the jumping jack, where the movement takes place in the frontal plane and anterior-posterior axis. In this plane, all the adduction and abduction movements take place. If we analyze this exercise, the shoulder and hip joint moving away from the midline is known as abduction, and if the exercise is coming back to the normal position, which is moving towards the midline, both in the shoulder and the hip joint, which is adduction, movement takes place in this exercise. The last exercise is baseball pitching. In this technique, multiple planes and axes are involved, but we are focusing on the horizontal plane and

vertical axis, which divides the body into upper and lower halves, where the rotational movements take place around the vertical axis. If we analyze the exercise, when the athlete is executing the throwing action, There is internal and external rotation at the shoulder joint and hip joint. In addition, there is rotation at the torso to generate the torque force.

[So, we have reached the end of this video]

In this session, we have covered the fundamental movements and explored planes and axes with different sports examples. From now on, try to practice these terms in your everyday activities. So, thank you, and see you in the next video.