Biomechanics
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Lecture - 07
Insertion Point and Torque

Welcome to this class on biomechanics. Let us continue our discussion on basic mechanics on Statics and dynamics specifically statics.

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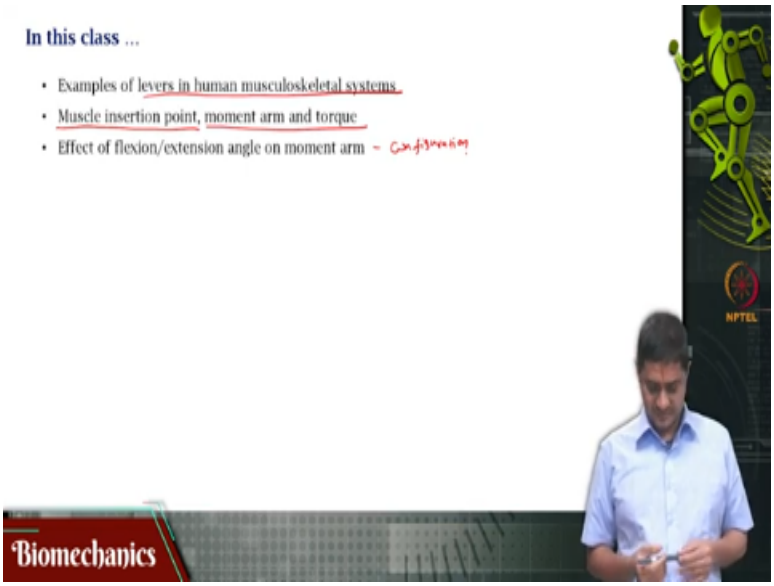

In this video we will be focusing on examples of livers in the human musculoskeletal system. What is a muscle insertion, what are momentum and torque and how change in the configuration can affect the momentum and further the force that needs to be produced by the muscle? Consider a couple of examples.

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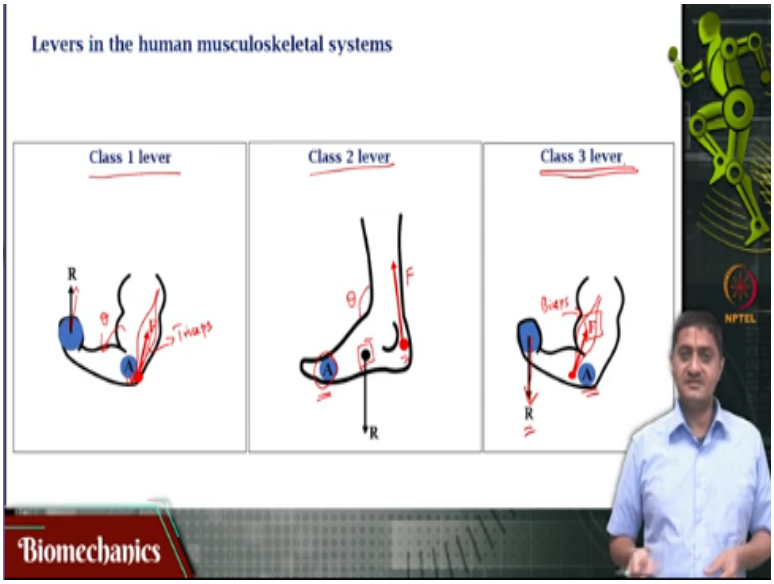

We were discussing the case of class 1, class 2 and class 3 levers in daily life. Here are some examples of these types of levers in the human body. So, here in this case let us say the person is trying to extend the arm or if I consider this to be two rigid bodies and let us say this is something he is trying to increase theta. Theta goes up. He is trying to do that and that is achieved with the help of this muscle that is found on the back side on the posterior side of the upper arm.

This is called as the triceps muscle. The axis of rotation in this case is the elbow joint, but force is applied here at this point and the resistance that needs to be overcome. So, this angle will have to be increased now so, the resistance is acting in this direction. So, in this case the axis of rotation is between the force and the resistance. This can be considered to be a simple example of a class 1 lever. This is what we saw as class 1 only.

Then consider the force produced in the human ankle when the person is trying to overcome this weight. So, the resistance is stuck between the force and the axis about which the rotation is happening when you are trying to just lift up or rather that angle will be increased. In this case the resistance is between the axis and the force. This is an example of a class 2 lever. Then we have the class 3 lever.

In this case this resistance is pulling the arm down that is a weight that I am having that is pulling my arm down. But I am trying to overcome that and keep it like this. In this case I am doing that is the biceps muscle in this case, the force is between the axis and the resistance. This is an example of a class 3 lever. These are just examples; there are examples of all these three types in the human body.

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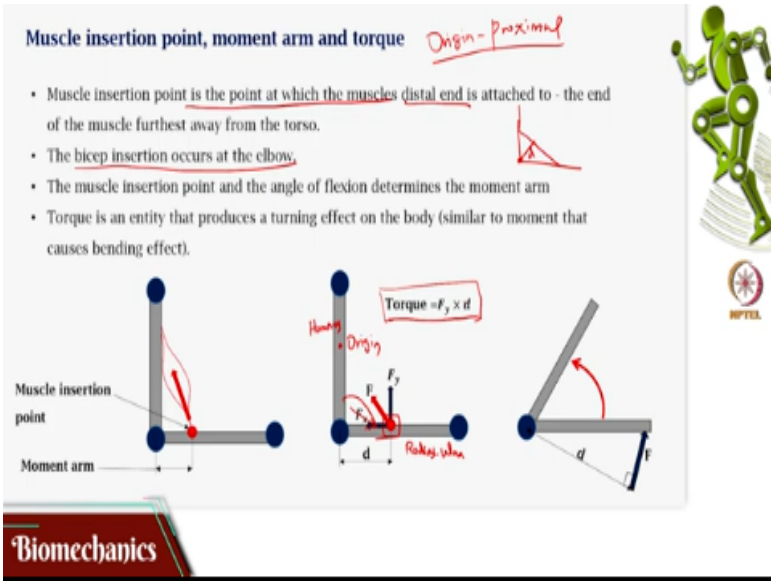

Now it might be useful for us to consider where a muscle is attaching in a bone and how is this affecting the mechanics of the function. There are two points at which a muzzle attaches. These are two different bones usually. It is assumed that is exactly one giant between these two bones but, this is not always true. That is there is one bone here which I am going to call as humerus. So, this is the elbow joint again that I am considering.

This is the radius ulna, which I am assuming to be a single bone in this case. And here the muscle that is under discussion is say for example the biceps muscle, it attaches to the two bones humerus and the radius ulna for example it attaches. The proximal point of attachment is called as origin. For example, what is origin? That is proximal attachment. What is insertion? It is the point at which, the muscle attaches under distal segment that is called as the insertion.

So, fundamental difference naming convention. The proximal attachment is always called origin and the distal attachment is always called insertion from the torso. This is again you know what

is proximal and what is distal is from the relative configuration. So, essentially, I am using this with reference to the torso. So, the biceps in insertion occurs very close to the Elbow. The moment arm, what is moment arm in mechanics?

Moment arm is the perpendicular distance between the axis of rotation and the line of action of force. So, suppose this was the system under discussion and that is the axis of rotation. Suppose that is the line of action of force this is the moment arm. Now this raises the question from this it means that the moment arm is not always the same, but so far, we have been speaking about this as if it is always the same.

That is because; we have assumed that the moment arm will remain. The same throughout the motion and as we learn more we realize that this is not actually true and then we add more assumptions to our analysis. So, the point at which the attachment happens and the all these configurations the elbow is at a 90 degree angle. But this need not be the case as we will see in a future slip.

Because, depending on the configuration the line of action of force will shift depending on that the moment arm will change, something to keep in mind. Torque will have to be overcome, when the resistance is produced. What is torque? Torque is something that produces a turning effect, is very similar to moment that we described in the previous cases, but not exactly the same.

For the purpose of this lecture and this course we can assume these to be same for example. So, torque is something that produces a turning effect on the body and that is essentially a product of the force and the distance. So, depending on the torque that needs to be produced either the force will have to change or the distance will have to change. So, you can change the torque produced by either changing the distance or by changing the force.

In some cases, you can change this distance in some cases you cannot. But force can of course be varied in almost all the cases. Let us consider some configurations that would change this.

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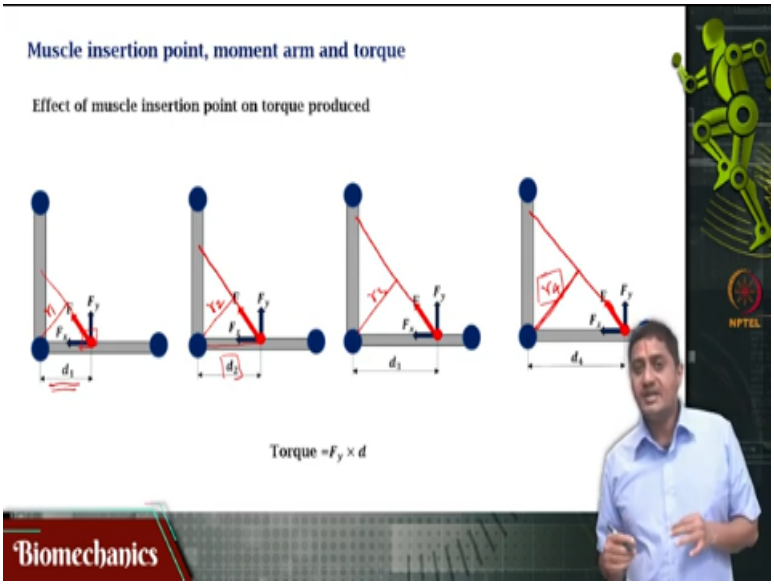

What happens when the insertion is close to the elbow in this case close to the axis? So, this is the line of action of force and this is the moment arm, which I am going to call as some r1. Suppose that attachment or the insertion is happening farther away at that point, that is the distance and that is the line of action of force and that is the moment arm, which I am going to call as r2 likewise. Suppose it is even farther away this is r3 and it is even more away this is r4.

You can visually look and check if r1, r2, r3 and r4 are equal. Are they equal? The answer is no, which is higher? r4 is obviously the highest looking at it. So, depending on the point of insertion your moment arm will change. So, this can vary due to the point of insertion but that is not the only thing that causes the change. Suppose I change the configuration like this.

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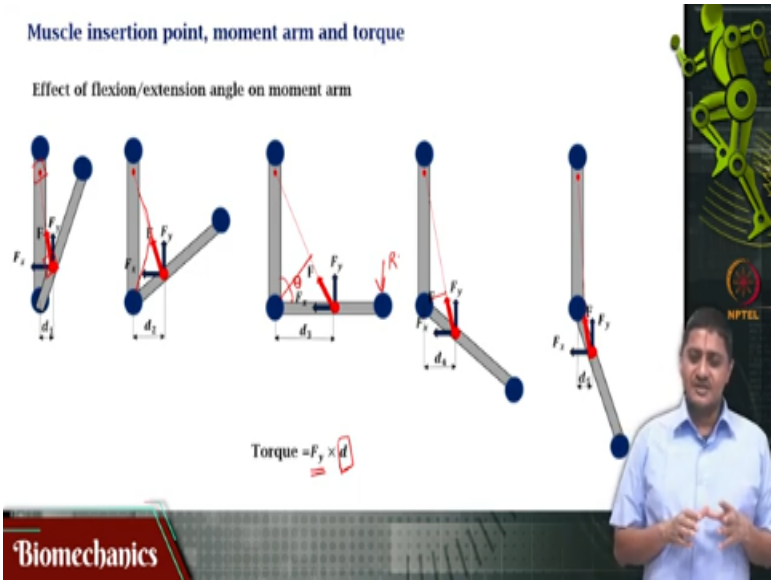

Now in this case, the point of attachment at the proximal end and the point of attachment at the distal end do not change. But the configuration of the arm changes and because, moment arm is the perpendicular distance between the line of action of force and the axis, obviously the moment arm will change as a function of the distances that you are looking at. So, the moment arm goes through a range depending on which configuration you are?

I am at this configuration the momentum is small then it becomes bigger at some point it is going to become smaller. So, depending on that the force that you can produce to overcome a resistance changes. So, again remember that the force is what is being controlled by the system. The force is produced by the muscle. The configurations this theta is something that is that may be a desired function that maybe you want to keep your arm at a particular configuration.

For example, depending on the d will change but the torque that needs to be overcome is a function of all this and the resistance that needs to be overworked. So, from this what we realize is that there are two things that control the torque that will be produced by a muscle. One is the point of insertion; the other is the configuration of the joint. Of course, point of insertion is not changed, so easily as I discussed in the previous slide.

This is not something that happens really in physiology. But this does happen. The configuration change is something that happens all the time something to note.

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So, with this we come to the end of this video. So, we saw some examples of levers in the human musculoskeletal system and how muscles insertion point and the moment arm and torque are related and how the angle of the fraction or action chart in other words the configuration affects moment arm and further the torque that is produced. Thank you very much for your attention.