Mechanics of Human Movement
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Lecture - 7 Part a
Muscle Action- Part I

So, last class we looked at the length tension relationship between you know for the whole muscle and there were some questions regarding that which I wanted to just address.

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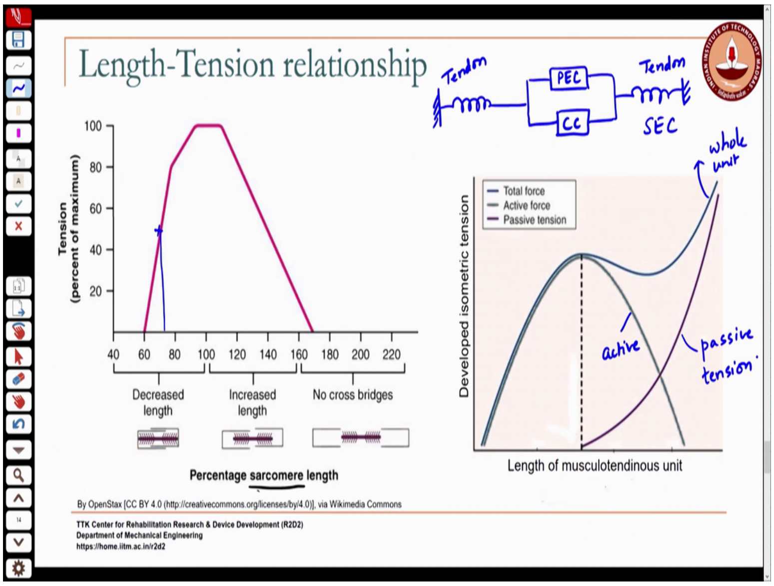

So, if you look at this one which is just for the one on the left, this is for the sarcomere. So, this is for the individual sarcomere here that you have the length tension relationship, and the sarcomere is essentially your active contributor to the tension. So, when it receives a signal from the nerves, then you have the active sliding happening; the sliding happening between the just the active portion of the muscle.

So, if you look at the total muscle using the hills tendon on either side which is the series elastic component, then I have the muscle itself the fibbers surrounding it you have a passive elastic component for that. And then you have the contractile component which is the only active compass figure here that we are drawing is for this. The total that we are drawing is for this so, this is whole unit.

So, when we look at the way in this at the sarcomere level also we took the sarcomere at a particular length and so, how much force it could develop, how much tension it would develop. And that is how you got this point, you got the different points on this curve we would not go into the experimental details of how these were determined. You keep the sarcomere at a particular length and see how much force is developed.

Now that is the same thing that we are doing now for the whole unit. So, initially when it is less than the resting length, the only thing that can develop tension is because of the stimulus only the active. That is the only part that can develop any tension. So, there is no contribution from the passive elastic component there.

Now, at a length that is past the resting length so, you have this muscle you stretch it past it is resting length, it develops some tension because of the connective tissue and the tendons and everything else that is your passive tension; and then on top of that.

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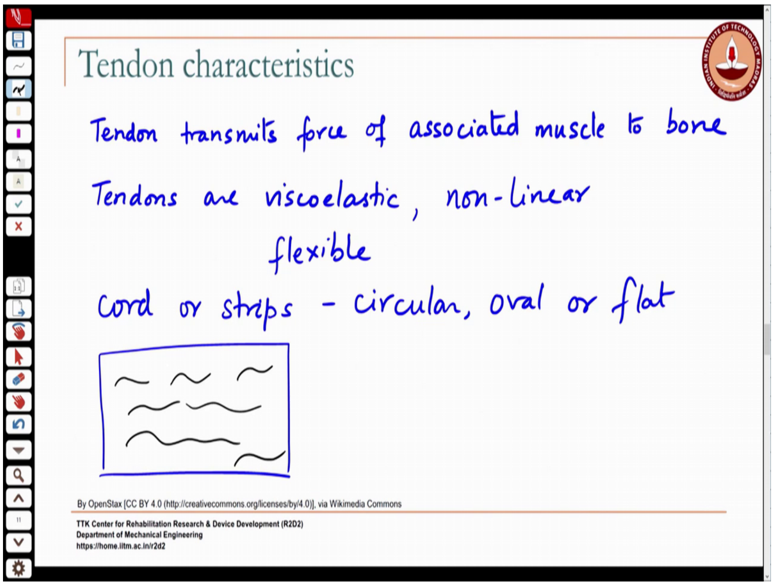

Now, if you are apply a interaction to that apply a stimulus to that is an additional component that comes up because of the active. What is transmitted at the end through the tendon is the total because those two are in series, but the contribution is from the initial stretch because of the elastic nature of the connective tissue you have a resistance and that is your passive a muscular. And that is why the two add up to give you the tension through the whole unit; is that clear now I think there was some confusion the other day I just wanted to clarify that.

So, moving on so muscle action that.

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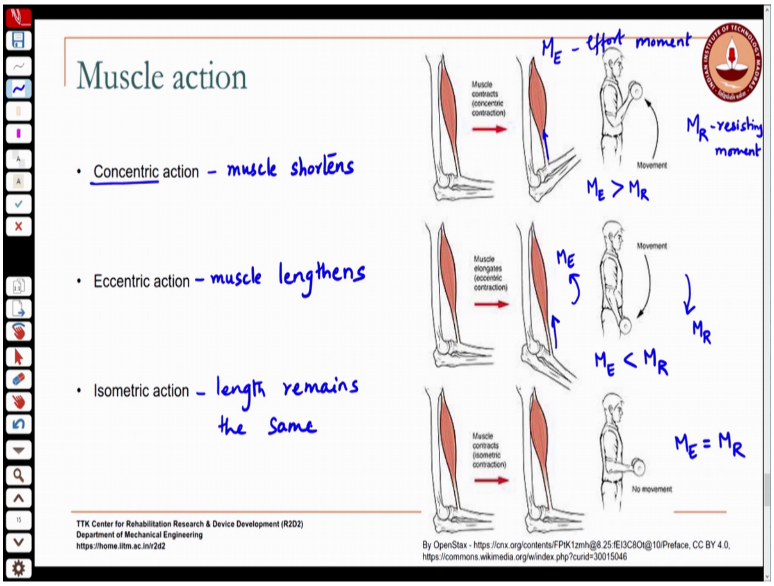

Within these cases when you say it is at a particular length and then you activate it I use the term isometric. I already use that term isometric which is what you know these where the length does not constant. So, there are three types of muscle action that are possible, you have what is concentric action, where the muscle actually shortens the muscle shortens. So, you have so, the muscle is the one applying attention to the bone that it is connected to ok, which in turn is when you have a joint it creates a moment about that joint right.

So, let us call the moment due to the muscle M E. So, this is the effort. Now if the effort moment and the resisting moment to have motion in the direction of the effort and that kind of the muscle that has caused that has provided that effort moment is under concentric action. A lot of places you will see concentric contraction instead of action, but I will tell you why I prefer the term action, but you will also like in this figure here you say it says concentric contraction, the angular movement are in the same direction.

Sometimes so, here in the next case you have the resisting moment, see acting like this. And so, if you have a weight and if I did not have the muscle, what would happen; it would just go down like there is no resistance to it. But this muscle may actually exert tension be activated as it is lengthening to kind of slow down the movement of the load.

So, this kind of action where the muscle is lengthening, but it is still active; the muscle is active, but it is lengthening that is called an eccentric action.

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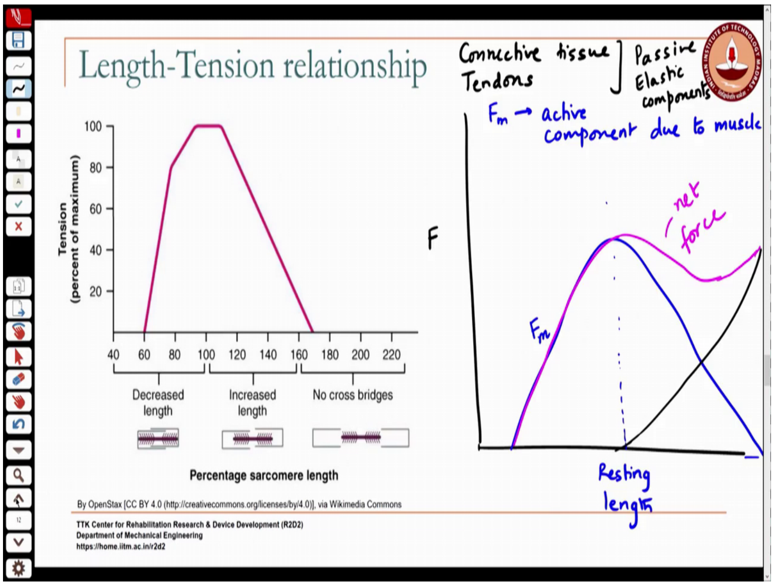

And the movement is in the direction of the resisting moment, it is opposite to the direction of the, because the muscle is still pulling here the muscle can only exert tension. So, the muscle moment is still applied in this direction; the muscle cannot push. And this kind of eccentric the lengthening is usually done by some kind of an external load; the muscle itself cannot lengthen on it is own it cannot activate to lengthen it. So, it there has to be an external load. And then the third kind of action is your so, here the muscle lengthens. The third kind of action is your isometric contraction sewing moment are equal and there is no movement about that joint.

In the biomechanics literature you will also see the word torque being used all the time. As mechanical engineers we differentiate between moments and torque we usually talk about torque when we talk about twisting about a longitudinal axis, and we talk about moment when we are talking about like a bending type. Here in biomechanics they do not really make that differentiation. So, you will always hear about joint torques think about is the joint moments; moments that produce rotation about the joint, but you will see it used throughout the literature. So, in the isometric action the length remains the same. Now in most cases will.

So, in the case of this action itself I might have the triceps muscle which is at the back also influencing this action. So, what happens is as these contracts that muscle may be lengthening to allowed discontraction. So, this muscle is causing that muscle to lengthen remember the muscle cannot lengthen on it is own. So, the action of this muscle causes the lengthening of the other muscle, but that muscle may it may just be a passive lengthening it may not activate because of that so, it could be a passive lengthening or sometimes in many cases when you want to slow down. So, here essentially this muscle is the relaxing to allowed this other muscle to contract ok.

In the case of this eccentric contraction in the second case where you have the biceps doing the eccentric action, here it may just happen that the moment of the load itself is enough to make this arm move down or it could be an active extension I could actively extend my forearm using my triceps muscle. This could be because of the action of gravity or it could be I could actively use my triceps to extend the forum. So, here you have the biceps as your flexors and your triceps as your extensors and in various cases they may or may not come into play depending on the requirements at that for that particular task.

So, now that we know the difference between these types of actions.

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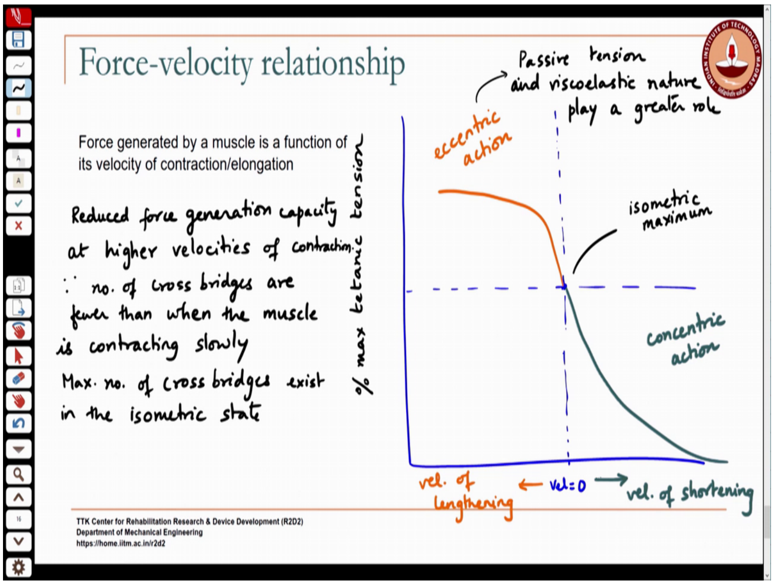

Let us look at the force really velocity relationship for a muscle. So, you know how the filaments they slide against each other the cross bridges that are formed and all that so, that is influenced by the velocity at which a muscle contracts. So, if I take a muscle and if I have velocity equal to 0, what is what kind of a action is that, it is an isometric action.

So, and I find out what is my maximal possible force that I can sustain had that for that isometric action. So, that is my, that is this point so, it is the symmetric. So, this is the let us do this forces percentage of the maximum technique tension you remember written when it comes when it is acting technically it is reached that steady state all the steady state.

So, this is your isometric you will see that the relationship between the velocity of contraction and the force that it can support is inversely proportional. So, if I contract faster I can only support I can only exert a smaller tension why is that. So, as you increase the velocity of shortening the screws bridges that are formed and you know they you do not have enough good cross bridging formed for it to sustain a larger force when it is slower when the velocity of muscle action is at the isometric level.

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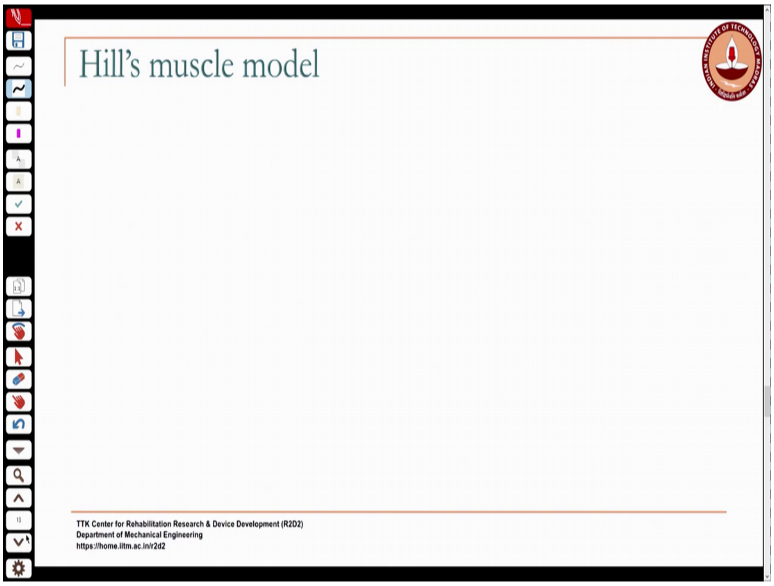

Now, for eccentric action it is sort of the reverse because so, if you look at and this is your velocity of lengthening. So, remember the eccentric action happens because of the because of some external agent causing the lengthening. So, initially the velocity of lengthening increases, because if you load it past the isometric capacity of the muscle, then the velocity starts increasing, but it also kind of flattens out after a point because you are not able to generate any more force to sustain the load and it also has to do with the passive elastic components, remember I mentioned that they are viscoelastic. So, as the velocity increases, they also start producing greater resistance to the length so, this relationship is called the force velocity relationship.

So, you have reduced force generation capacity at higher velocities of contraction, because number of cross bridges are fewer than when the muscle is contracting slowly, maximum number of cross purchasing exist in the isometric state. So, in the eccentric action it is the passive tension player that plays a larger role passive tension and the viscoelastic nature play great, if I have a light load I can only do something very fast no right so, I can choose to pick this up slowly ok.

This relationship only holds when you are talking about maximal effort that you are putting, when the muscle is subjected to the maximum isometric effort then from there on you have this usually the way are they must multiple actuators in parallel for power generation most of the time we are not even using our muscles to the full capacity. So, if I choose to pick up something that is light and I choose to pick it up slowly now as bridges are.

Student: Fewer.

Fewer number of cross bridges are fewer when many do I need to recruit to perform an action. And so, I am not really operating at the maximum particular muscle. So, this shape of this force velocity relationship is pretty uniform. So, the actual values may be different, this behaviour is fairly uniform across a number of muscles we have done experiments on many of these. And they found that the shape sort of holds good for most cases.

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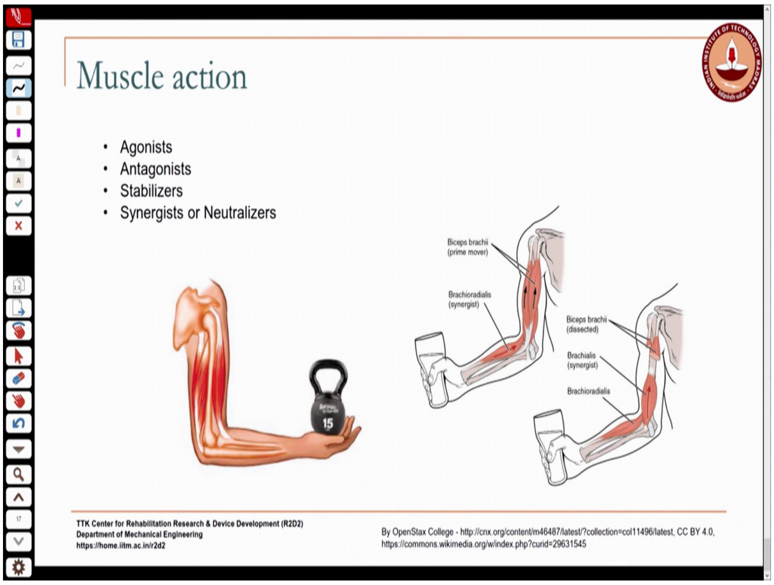

So, now you know what is concentric action, eccentric action and isometric action. There some terminology muscles are referred to based on the activity they are performing some terminology that is used to describe the muscle action.

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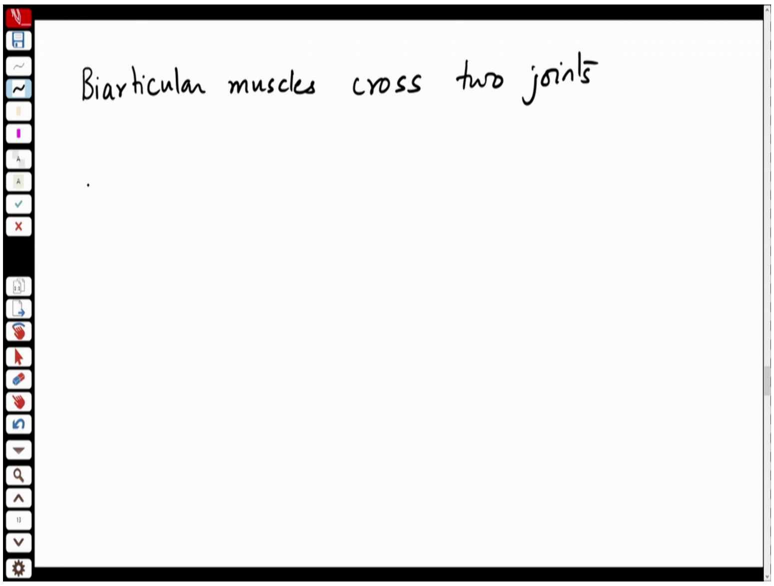

So, when a certain action is performed you may call some muscles the agonists, stabilizers or you also have synergies or neutralizers.

So, I will explain these terms.