Mechanics of Human Movement
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Lecture – 04
Skeletal Muscles: Structure Part – I

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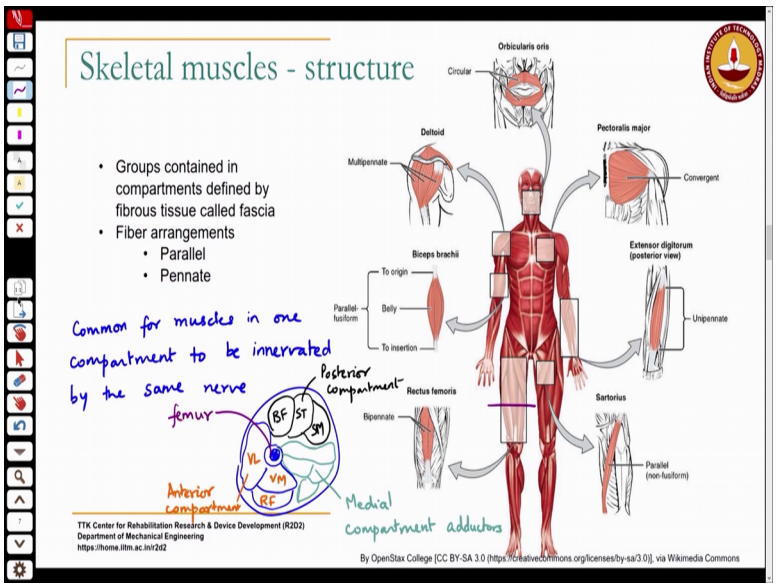

So, when you look at muscles. If you look at the physical organization ok, they are usually contained in groups in what are known as compartments ok. They are contained in like different compartments. So, if you look at your thigh ok, you will have an anterior compartment ok. Remember anterior in the front. So, those will be what muscles do you think will be there, I just pointed out to you; the anterior compartment would be your quadriceps muscles.

The quadriceps muscles would form the anterior compartment, then in your medial compartment. Medial is towards the inner part of your thigh, you would have a compartment, which has some muscles that are responsible for adducting the thigh right. Because imagine, if that muscle contracts how is your thigh going to move with respect to the hip joint. So, you have in the medial compartment, you have the adductors.

So, usually the muscles in one compartment have a similar function, they performance. So, you have all the knee extensors which are the quadriceps ok. Quadriceps would be in the anterior compartment. Then in the posterior compartment ok, the posterior

compartment you have the hamstrings, hamstrings which are the flexors, knee flexes. So, they are usually the muscles in a compartment are innervated by the same nerve ok; that is how they form these are, and they are, the compartments are defined by fibrous tissue which are called fascia. So, it is common for muscles in one compartment to be innervated by the same nerve ok.

So, if you look at a cross section of the thigh for instance. So, if you have that, you would have the femur and then you would have the muscles in a compartment like that. So, these maybe one set of muscles then I could have. So, these would be say in the. If these are the anterior compartment, then these would be the quadriceps. So, you would have the vastus lateralis, the vastus medialis and the rectus femoris and somewhere the intermedius also.

And then you have in the posterior compartment a group of muscles which would be the biceps femoris, the semitendinosus and the semimembranosus and then you have, you have some compartment and this is nowhere close to the actual anatomic structure, but you get the idea. So, you have these would be the medial compartment and they would be the adductors. So, each group would be extensors or flexors or adductors or abductors that. So, this is your posterior compartment.

So, this is the case, if I am giving you a cross section of this and this is your femur; the, that is your femur, femur is your thigh bone. So, which leg am I, is this a cross section of. From what I have marked here, it is the right leg. So, I have taken like a cross section here, taking a slice there and that is what it looks like from the top ok, because if this is the right leg this is the medial. I have told you this is the medial compartment, this is anterior this is posterior. So, you know what I am referring to ok.

So, now if you look at the overall fiber arrangements in these muscles, there are two types that you will see. You have two kinds of fiber arrangements; one is called the parallel arrangement, where the fibers are parallel to the length of the muscle and then to the long axis of the muscle.

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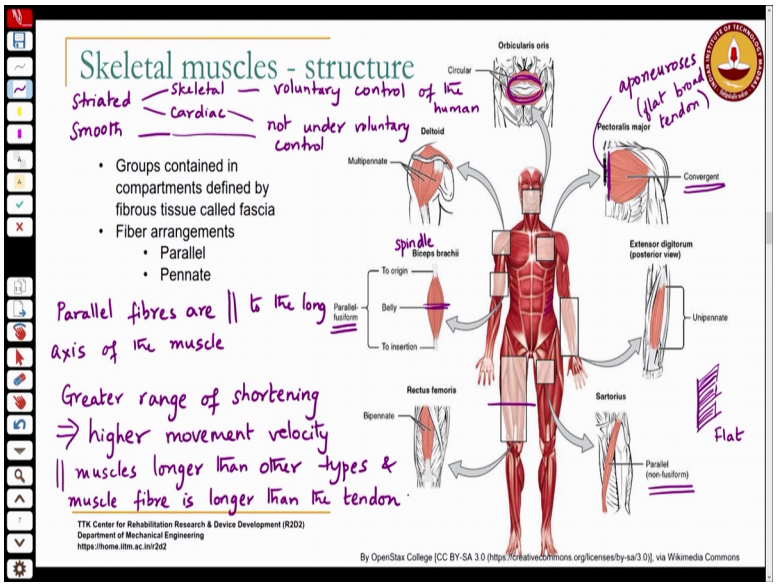

So, parallel fibers parallel to the long axis of the muscle. In the parallel type of muscle you have various kinds ok, the various shapes that you could have. So, you could have the fusiform type ok, where it is like a spindle you have a pronounced belly of this muscle ok. The middle of the muscle is bulging ok, it is like a spindle, it is shaped like a spindle, but all the fibers are parallel to.

So, you have the tendon on either side and you can see that the fibers are parallel to the long axis of the muscle. You could also have a non fusiform type of a parallel muscle. This is like the sartorius muscle which runs across your thigh and that is almost like a strap ok, like it is almost like a strap. So, it does not have a pronounced belly ok, does not have a pronounced belly.

Student: Can you please elaborate difference between fiber and muscles.

Fiber and ok. So, you have the muscles, the muscles are essentially groups of fibers, we will talk about the structure. So, you have the compartments. The compartments are bunches of muscles ok, which are covered by some connective tissue which is called the fasciae. Now if you look at a muscle itself ok. First of all you can have, the muscle can be what is known as a striated muscle or a smooth muscle. You may have seen that in your biology ok. The striated muscles you can see these striations right and the smooth muscle. So, skeletal muscle is the striated muscle, you actually have cardiac muscles also which are striated.

So, let me just mention that you have striated muscle, the first kind of differentiation and you have a smooth muscle and striated can be either skeletal or cardiac muscle and then you have of course, these smooth muscles. Now which are; which do not fall. The thing about the cardiac and smooth muscles is that they are not under voluntary control. They are under the control of the autonomous nervous system ok. You do not decide when your heart beats and it does not ok. The nerves system has complete control over these cardiac muscles and these smooth muscles in the body, you do not have.

On the other hand the skeletal muscles are under voluntary control of the human ok. So, these are the muscles, I decide how my hand moves, I can control my skeletal muscles, I decide how I move um. So, in these groups of muscles now we are talking about individual muscles and how they are ok. So, when I look at the muscle, I can classify them into parallel muscles or a penat muscle. Now I am only talking about skeletal muscles, in this course we will only focus on these skeletal muscles, because that is those are the muscles causing the movement.

So, if you look at the parallel muscles, the fibers, the structure of the muscle may be in different forms, which is what we are talking about now; structure of an individual muscle from the macro level. We are not going into the microscopic level, we are looking at the macro level. The macro level you have the parallel arrangement of the fibers of the muscle and that is, in that you have different types. So, you have what is known as the fusiform type which is the one that is shaped like a spindle with the pronounced belly of the muscle. So, you can see that the middle of the muscle is fatter than the ends ok

And then you have a non fusiform type which is more like a strap ok, you have again the fibers are parallel. So, if this is the muscle they are parallel to the length of the muscle, to the longitudinal axis of the muscle ok. So, that is like a strap, it does not have a pronounced belly of the muscle. Then you have what is known as, you also have some muscles known as the flat muscles ok. So, for instance these muscles here ok, this is another, it is not marked in this figure, but you have essentially muscles that are.

If this is how they are attached then you have, the fibers go like that and it is more or less flat ok. So, these are flat muscles and these are again parallel fiber arrangement, you have a flat arrangement.

Then you have what is known as a convergent arrangement. So, you have fibers that converge to a small cross section where you have the tendon. So, they start you know from a larger area and then converge to a small area. So, this is called the convergent type of parallel muscle fibers. So, this, this sort of a flat tendon ok, it is called an aponeurosis. It is basically a flat tendon over a large area ok. So, that is how it attacks to be.

So, there are three ways muscles could attach to the board, you could have your typical tendon kind of an attachment, it could attach directly to the bone or it could attach to this flat tendon like structure called the aponeurosis ok. So, these are different ways that it could attach to us. So, and then you have this muscle typically around openings, where its like a muscle that is found rounds, but it, the fibers are circular and they are parallel to one another along the axis of the muscle ok.

So, you have, its like this, that is how the muscle fibers go ok. So, this is around your mouth this is an example again of a parallel arrangement of the muscle fibers, but in the parallel arrangement it forms the circular configuration, circular configuration of the parallel arrangement. So, you have 5 different types of parallel arrangements. You could have the flat, the fusiform, the non fusiform, the convergent and the circular ok. These are the possible arrangements in the parallel arrangement of the muscle. So, a flat broad tendon is called the hippo neurosis.

Now, the thing about this parallel arrangement is you can get a greater range of shortening, because the muscle length is, especially if you look at this kind of a fusiform, the muscle length equals the fiber length. The fiber length and the muscle length are equal, so how much ever the fiber shorten the muscle also shortens ok. So, you get. So, these you get a high movement velocity, because you can shorten over a longer length. So, you get a greater range of shortening with the parallel arrangement and therefore, you can get a higher movement velocity.

So, you will see in your appendicular skeleton you will have muscles that are, which have these parallel arrangements with their extremities right, you can move, because you get more speed with the greater shortening. And typically in the parallel fibers, the muscles, the parallel muscles, I am using the symbol for the parallel are longer than the other types and the muscle fiber is longer than the tendon.

In the pennate fibers the structure is somewhat different. You have a central tendon and you have the fibers at an angle to that tendon. So, this is clearer here. So, you have a tendon that runs centrally and then your muscle fibers are, it is like a feather structure ok.

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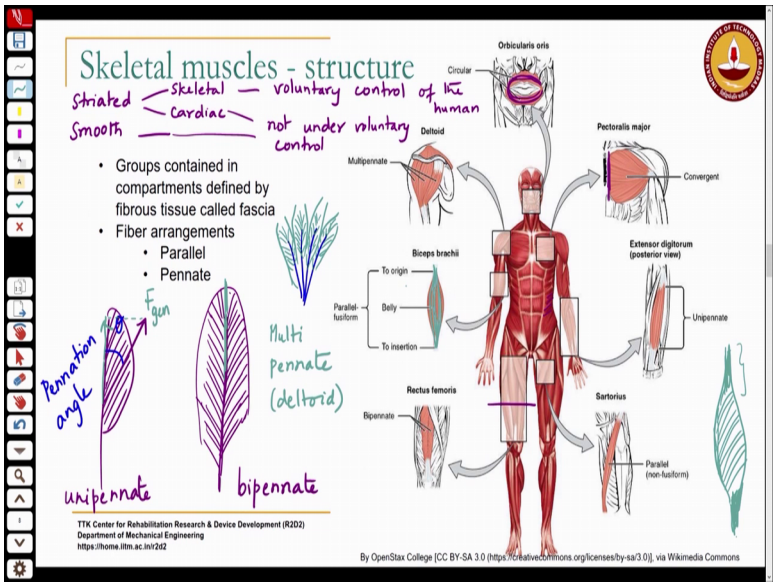

So, imagine this is, you have this kind of a feather structure for the. If it is only on one side, this is called a unipennate. It is not very clear from this diagram and if it is on both sides of that central tendon, if the fibers are diverging out like that, then this is called a bipennate. In the case of the deltoid muscle, here you have from the central tendon ok. You have a central tendon like that and then you have these fibers going out like that ok. You have what is a multi pennate arrangement.

So, here the direction of the force applied by the muscle ok, on to whatever bone it is attached to, is in one direction, but the force generated by the fibers is in another direction and this angle is called the pennation angle.

Student: Mam tendons and fibers both compare is the muscles.

No a tendon is a structure that attaches a muscle to the bone; it is a different kind of connective tissue ok. Tendons are facile structures; muscles are the only active structures in this system that we are talking about right. Only the muscles have the capacity to generate force ok. The tendons only transmit the force to whatever structure they are attached.

Student: Mam the entire (Refer Time: 22:16) tendon.

In.

Student: Tendon.

Oh then, sorry the tendon should be here, the tendon should be its across the shoulder.

Student: For the whole bones (Refer Time: 22:33)

On. So, the deltoids are what are responsible for this movement right. I will try to get a better picture of the yeah of that arrangement, let me see. So, in the ok this is I have. So, the deltoids, this is not a very good picture, but really the deltoids look like this, you have tendons that go like that over that and then you have, and then you have the fibers that are like this; that is how the deltoid muscle structure is ok. So, this is. And all these tendons meet together here this.

So, this is the multi pennate arrangement of the deltoid. So, here how it looks actually is, you have the long axis of the muscle like that, but you have the fibers aligned like that ok, that is why it is a pennate muscle ok. So, the fibers are not aligned with the long axis of the muscle ok

Student: (Refer Time: 25:03).

For are you have a unipennate t muscle, but like I said this diagram does not show you very well it is more like this. It will be where all the fibers are at an angle to the long axis of the muscle, they are not parallel to the long axis of the muscle.

Student: (Refer Time: 25:23) tendon tendon.

It is, is from the tendon that you have this.

Student: (Refer Time: 25:30).

Yeah, because the tendon is that, that is how it is transmitted right. So, when you talk about the force transmission axis, it is the tendon is what is going to apply the force to the bone. So, that would be the axis of the force that is applied. Whereas, the actual force generated is different.

Let us, and if you look at the actual force that is transmitted, it will be whatever is generated times cos theta ok. We will continue with a little bit more discussion on the pennate muscles in the next class and we will then look at the muscle fiber structure ok. So, here this is the muscle part of it and this will be their tender ok.

So, the muscle you have the tendon, but the muscle has the fibers that are aligned in this angle, so wherever it attaches to the bone ok. So, if this is like a. So, it attaches to a bone here, it attaches to a bone here then this is your muscular tenderness junction then you have the muscle, but the fibers of the muscle are at an angle that is your unipennate. In this case you have the tendon which is central ok. So, it could be passing like that

So, you could have the long tendon; a tendon that is longer than the muscle fiber ok, but it goes through the central axis and then you have the muscles that are creating forces at angles from that central tendon.

Student: Mam this is the diagram for the parallel fusiform.

Which one.

Student: This one green coulour (Refer Time: 27:42).

This one no; this is not the diagram for the parallel fusiform, the difference that is a good question. The difference between the parallel fusiform this is the unipennate. The parallel fusiform the fibers are all parallel to that, the fibers are like this that is the difference between the parallel fusiform and the pinnate, unipennate. And in this case, in the pennate muscles, the tendons may actually be longer than the muscle fibers, which is not the case in the parallel muscles.