Mechanics of Human Movement
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Lecture – 11 Part b
Static Analysis of Spine- Part II

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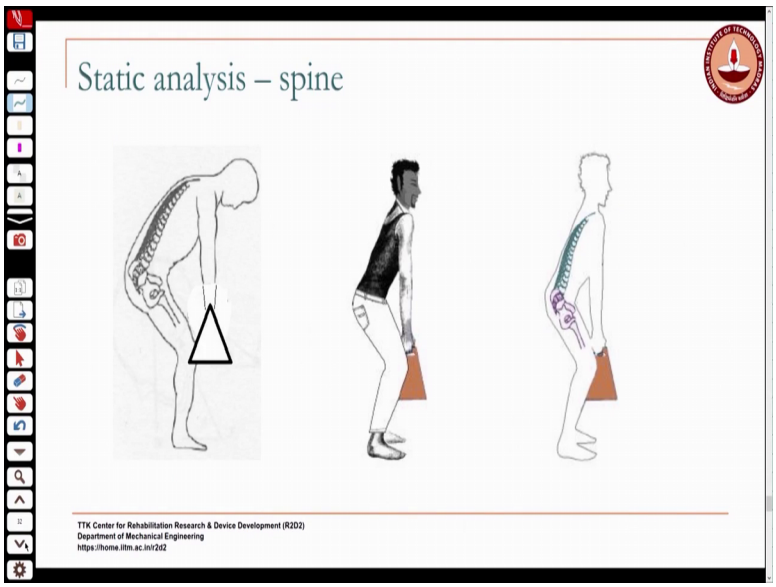

So, a lot of problems with the spine happen from lifting loads or bending right. So, these are 2 activities, that we do on a regular basis in our everyday life and you will hear about back large number of people will say they have pain in their back at some point or the other ok. So, let us s look at what are some of the loads that arise you know why is the back such a problem area and how with the simple static analysis we can look at, what would be the right way to lift a load? What is the wrong way to lift a load?

And how you know, what sort of loads is the spine seeing? What sort of a joint forces and what sort of forces do the muscles have to exert? When we either bend or lift loads? So, the first analysis that we will do is for a case, where you can see there is a difference in the way the lifting of the load is happening in these 2 cases, you may have heard people say do not bend down to lift a heavy load lift it bend your knees and then lift the load ok. So, we will look at these different ways of lifting loads.

And see why bending your knees and then lifting the load is actually more beneficial is or less harmful to your spine than doing it from than just bending down to lift a load as I mentioned.

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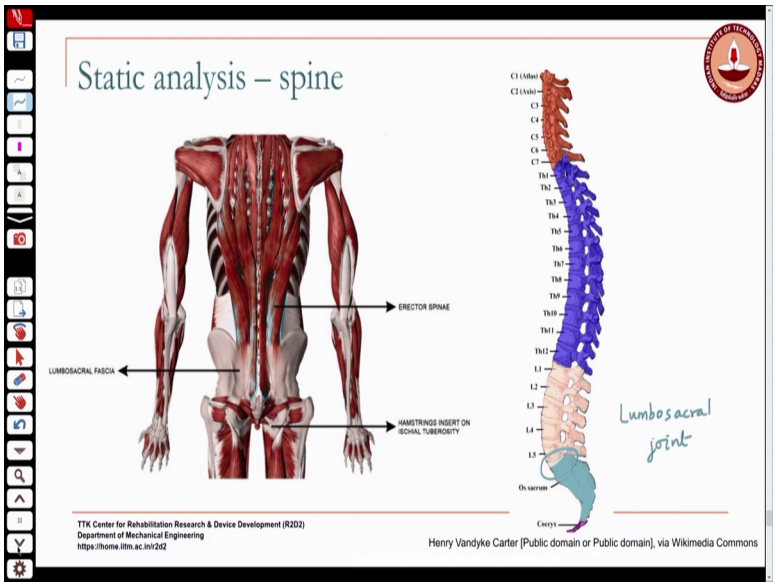

The erector spinae these muscles will be the ones when you are lifting the load those will be the muscles acting when you bend your trunk, those are the muscles that are acting to prevent you from falling forward. So, that will be the muscle that we will consider in our model and then of course, you have and we will look at this joint.

Here we will look at the joint between at the is called the lumbo sacral joint, at the base of the vertebra because from the sacrum it connects to the pelvis and transfers the load to the ground through the lower limbs. So, the spine the L 5 passes on the loading to the sacrum, which then passes it on to the pelvis at the lower limbs. So, we will consider this junction this lumbosacral joint we will consider that as a hinge joint and look at the analysis of a bending or a bending and lifting task.

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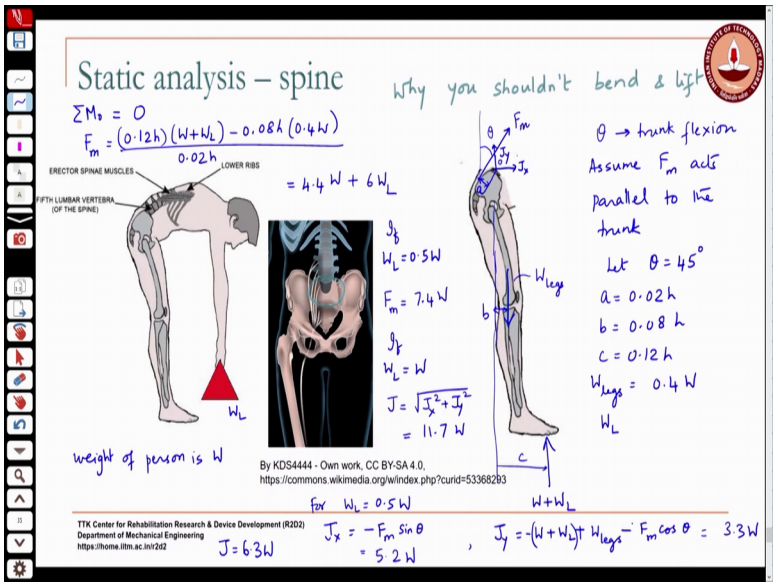

So, here is a person whose bending the trunk to lift the load, person has a fairly you know it is not bending his legs he sees a load he just bends down to pick it up ok. Now, let us look at what the effects and this is the, this is a picture to show you the joint that I am talking about the lumbosacral joint here that is the junction that is the place, where we are considering it here right. Here where you are saying that it is pivoting about pivoting meaning, it is a hinge joint there in the sagittal plane I should not use the word pivot because in the context of the body we talk only about the rotational, all those structurally both the hinge and the pivots are one and the same ok.

So, we will consider a hinge joint at this at the base of the fifth lumbar vertebra with the sacrum ok. So, the question we are trying to answer is why you should not bend and lift what is. So, if we draw here, if you look at this you have the erector spinae muscle which acts like that then you have the joint force. So, I could say 2 components J x and J y add the base of the spine and then if I take the free body I am taking this as my free body so; that means, I am isolating this part from the rest of the body what are the forces do I have on this, what other external forces are there on this, where will that act weight of the segment ok.

So, weight of use a different color so, this is the weight of the legs, there is a ground reaction right and what is that ground reaction going to be. Let us say this is W L and

weight of the person is W. So, what is the ground reaction going to be, it is W plus W L ok. So, that is how the weight of the body becomes.

Student: (Refer Time: 06:40).

Yes that so, when you look at the whole body ok, you look at the whole body and you figure out where on the foot this will act ok. If you take your free body if you just separate it from the ground then you have the weight of the whole body plus W L acting at a point and this reaction will be directly along that line. So, where it acts on the foot will take care of that moment due to the upper body ok.

So, this is now your so, my free body diagram is complete, these are the only forces that are acting on this and let us assume that let us say my trunk you saw the erector spinae muscles right they are almost parallel to the trunk. So, if my trunk is flexed a certain angle theta I can assume that these muscles act at that angle theta that is the line of action of that muscle.

So, theta is your in this case your trunk flexion, the amount you have bent to pick up the load and that is also the line of action it also determines the line of action of the erector spinae muscle. Now let us say I know these distances, I know the distance between the point of muscle insertion and the joint. Then let us say I know the distance between the joint and where this force acts let me call that b. So, say if this point is o my fulcrum the joint, then I know the distance b and then I also know this distance c from that to where the ground reaction acts.

So, here we are assuming F m acts parallel to the trunk and therefore, that is the direction in which ah. So, whatever is the trunk flexion that is the direction in which F m acts. So, now, let us take some values let theta equal to 45 degrees and I will give you these in terms of the height of the person a equals this, b equals 0.08 h, c equal to 0.12 h the this weight of the legs equal to 0.4 times the body weight and then I have the load some load that I am lifting.

Now, I can write I can find F m by using the moment equation. So, I take moments about the joint. So, if I do sigma M o equal to 0 to eliminate the joint forces I will have only the F m left. So, I will have F m equal to 0.12 h into W plus W L minus 0.08 h into 0.4 W

divided by 0.02 h. So, I get this to be 4.4 W plus 6 W L a is the distance between 0 and F m the point of insertion this should be a, a is the momentum for F m.

So, you can see that if the person lifts a weight equal to their body weight that is maybe too much, let us say only weightlifters would try to do, but no if you know if you look at maybe lifting a kid who is fairly grown up or you lift one of your friends about the same body weight right or let us say we lift a kid about half the body weight then you are looking at if W L equal to half of W then the muscle force equals 4.4 plus 3, 7.4 times the body weight.

What is your quickly compute F j and F, F J x and F J y or total F j I have for W L equal to W, I have J equal to root of J x square plus J by square if I find the components, if W L equal to W I have that equal to 11.7 W. What is it for W L equal to half W can someone quickly compute that it is not very hard F J x is J x is minus F m sine theta and J y is W plus W L minus W legs minus F m cos theta why is it taking. So, long to compute it 3.3 is for J J x for which load W L equal to W L equal to 0.5 W for W L equal to J y is 3.3.

And what is J x 5.0 5.2 W. So, the net magnitude is the magnitude of J, J square root of J x square plus J y square is 6.0 are you sure (Refer Time: 14:04) 6.3. So, J equals 6.3 times the body weight. So, that is the load that is seen at that joint 6 times your body weight if you lift something that weighs half your body weight

So, you can do a lot of damage to your back if you lift very high loads and if you do not and if you bend while you lift ok, next class we will do the analysis for a better way of we look at so, you will see that even if you are not lifting a load the next analysis that we do we will see that just bending itself poses a lot of loading on the spine.

So, if you had to work all day you know if your workspace was not designed properly and you had to keep doing something in this bent position you will see that that can do a lot of damage to your back things have to be such that you can maintain good posture. So, if you have to bend anytime you have to your erector because to keep your trunk from falling forward due to gravity your erector spinae have to contract and keep the tension which leads to the joint loading yes yeah.

Student: W plus W L should be combined with the negative sign.

Yeah.

Student: Plus F m cos theta.

Student: Yeah plus F m cos theta.

W plus W L plus F m cos theta ok. So, I took a way is positive let me just do this and J y plus yeah minus F m cos theta after I move it to the other side yeah that is yeah 6 point.

Student: (Refer Time: 16:29).

This is 6.3.

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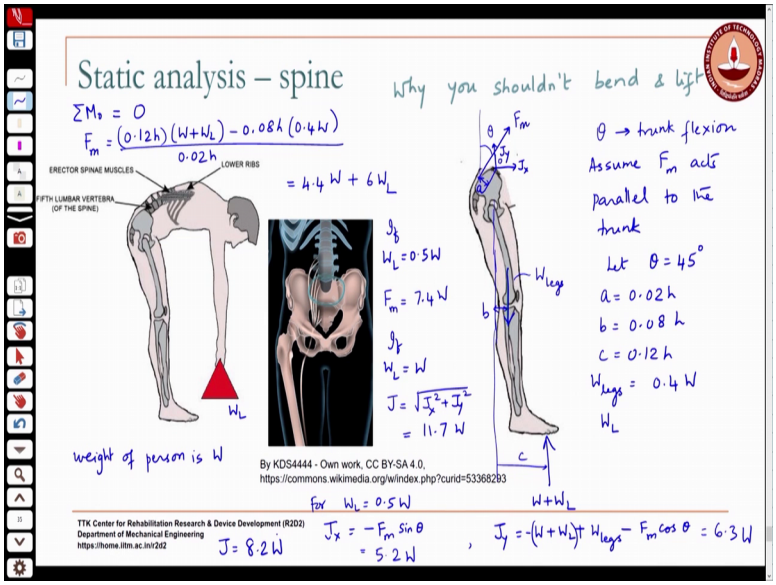

And what is the overall.

Student: 8.2.

8.2 that makes more sense yeah. So, it is only it is worse than we thought initially ok. So, that so, we will look at more analysis with the spine and why it is important for workspaces in the next class.