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**Week 11**  
**Lecture 53**  
**Isokinetic demonstration**

Let us have a **demonstration of knee flexion and extension using the isokinetic dynamometer:**

So, I have this interface ready with me, and I have already created a profile here. You can still see the—you can see that the interface still refers to it as 'patient' only. Because earlier, the device was used for the clinical population.

But now, since they have increased the force production capacity and the torque production capacity, we can use it for the athletic population as well. These are the number of tests we can do here. You can see we can test the ankle joint here, with different extensions, we can test the movement of the chest, forearm, hip, knee, and shoulder.

All the possible joints can be tested. So, for now, I am just moving to the knee test. You can see for the knee, I can go for extension and flexion. I can go for extension and flexion in the prone position, or even I can go for internal rotation and external rotation, which can be like the T-belt torsion test. So, for now, I am going for simple extension and flexion for the demonstration that we are doing in a sitting position. So, when I press OK, the device is basically asking me to create a protocol. So here, I will be doing the two-speed protocol. For the demonstration, I will be doing it at 120 degrees and 60 degrees per second. So, let me just delete this first again.

While adding the things, there are different things that are coming. So the device is capable of performing the CPM. CPM is nothing but continuous passive movement. Isometric, isotonic, isokinetic. So we can choose any of the things.

For now, we are going for isokinetic. Alternatively, we can go for zero gravity to eliminate the effect of gravity as well. In the action, as told in the slides, we can go for concentric-concentric. You can see it is for extension and flexion. We can go for concentric-eccentric, so concentric extension and eccentric flexion or we can go for eccentric flexion and concentric flexion or we can go for eccentric-eccentric.

For now, I am going for the 10th repetition as a trial rep so that we can have a specific warm-up after the general warm-up. And after that, I will take a break for, let us say, 30 seconds. Then, this particular set will be there for 5 repetitions and again the break will be there for 30 seconds. That you can decide as per your requirement or not. So, first I will be going for, so this is the speed, so I will be going for 120 degree per second for both flexion and extension. And this is the torque limit, like this is for the threshold level, we can decide as per our requirement. So, as the athlete is healthy and all, so I am going for the full capacity, that is the 675 Newton meter of torque can be produced by one group of the muscle.

These are the possible feedback that I can get, so I can get based on the torque, position, velocity, work, power. So, like the torque versus time, I can get here torque versus position, I can get here the single torque bar for all the repetition, I can get or the per rep torque bar, I can get here for the position also, I can get the position versus time, the single position the per rep position velocity versus time. You can see here, but as far as my understanding, the best is basically the torque versus position, where in one axis we are getting the torque and the other axis we are getting the position. So let us have this only and okay. So, you can see our first protocol is is fixed here that is isokinetic concentric concentric and that is 120 120 degrees per second for both flexion and extension, and it is for five repetitions 30 second hold was there and the feedback that we are taking is the torque versus position ground. Let us say another protocol, so that is again i am going for same isokinetic concentric concentric in this i am not going for any trial because i am already into the motion. I am going for 5 repetitions only and again I will be terminating the test after this so there will be zero rest.

In this the speed will be 60 degree per second for both flexion and extension. I am using the same feedback here. So you can see I am having the two protocols here. The isokinetic concentric concentric 120, 120 and 60, 60 here. Both 5 will be there above 5 repetitions.

You can see, you must have noticed that the trial reps are not coming here. That is basically there for the warm-up. So, I can rename it as a two-speed protocol: 60 and 120. So that it will be easy to recall whenever I want to, and press OK. Then, this is taking me to another window where I need to do the process, like if I need to test for the left and right.

Let us test for the left first. And I can go for a single set or all the sets at a time. So, since we are going for two sets, we can go for one set at a time, and then we need to do the process again. But here, I am going for all the sets. So, this is reaching a new window.

Where you can see the device has given you the tentative setting of the machine. The device is asking us to position the range of motion stop at G black and the M teal. This is the dynamometer in which these are the mechanical stops. So, the device is asking us to go for G black. So, black is this only, this is the G or this is the M teal.

You can fix it something like this. Then, the next setting that is required is. The software itself is telling us some of the prerequisite or some of the extensions which is needed. So we require a knee hip pad. We require a contralateral limb stabilizer-[something like this]. We require the knee hip adapter [something like this], and we require a lumbar cushion [something like this].

Even the interface is giving us a basic position and it is rather giving us a detailed thing like how to do a preparation, how to position the patient and everything. And these are the tentatively setting for the chair. So it is asking us a chair rotation scale at 40, back angle this, fore of this. So you can see at the chair, there are some markings, there are some ratings there at the end.

We have already set it for the left side at 40 using all the settings given here. The dynamometer settings, the adapter settings. Now let us position the patient. First let us adjust the dynamometer settings. So, this dynamometer has to be set around.

You can see the dyna height is 8 and the dyna rotation is 40. We will fix it up. As mentioned, the dyna can be moved in any direction, up and down. So, this is a rotation scale on the end. The horizontal and vertical adjustments control the height of the dynamometer.

Now you can see the dynamometer is fixed at 8 and 40 here. These are the extensions. See, this is the knee and hip adapter. This is the pad, and this is the footrest. This is the footrest, and this is the lumbar cushion we talked about.

Let us position the patient first. So the subject is there to test the left side. Once the athlete is positioned, we need to stabilize and fix everything. You can see this belt is needed to stabilize the knee first.

We will stabilize the joint. The opposite side leg will be stabilized by the contralateral limb stabilizer, and the testing limb will be attached with the extensions here. We need to adjust the height of the dynamometer. It is recommended to attach the extensions just above the malleolus, one or two inches above. As you can see, it is a bit far, so by pushing the monorail, I will move the patient slightly forward so that the attachment will be fixed firmly. Once this is done, we need to fix the upper body.

There are some belts that help stabilize the upper body. The upper body can be fixed [something like this]. Now the athlete is in position to test.

But before that we need to do one more test. That we need to check whether the joint axis of rotation is matching up the joint axis of rotation for the dynamometer or not. So to do that we can use a pencil or we can use any other equipment which is available with us. So, I am testing it here and I am finding that this is not matching up the things. For that I need to bring the athlete more forward.

Once the athlete more forward I can see it is now matching up the things. A little more forward yeah. Now, the joint axis of rotation is matching up with the axis of rotation for the dynamometer and in this position only I can ask athlete to perform a movement, so that we can check whether the athlete is in comfortable position or not. The athlete is finding it a comfortable position, and we can see that the range of motion which we can achieve is somewhat good So the tentative position which was given by the software is definitely the tentative not the final one. The final one will be there once the athlete is settled here. And we can change this setting so that for the next time when the athlete comes, we can use the same setting straight away and we can save the time. Now, the athlete is set, so we can go for OK.

So when by pressing OK, the device is asking us to set the anatomical zero first. Okay, so it is asking us to move the limb to anatomical zero. So we all know for the knee joint, the anatomical zero is the complete extension. So we will ask the athlete to go for the complete extension first. Athlete went for the extension and we are setting it as in anatomical zero here.

And now the device is asking us to set the extension and the flexion range of motion. So the anatomical zero itself is considered to be the extension for the new joint. So we are setting it as an extension. We are setting it for the extension here.

For the flexion, we ask Athlete to go for the flexion here. And you can see the flexion range of motion is coming somewhere around 107 here. But this is again too much range for the test. So we can ask him to first release a bit and we can test somewhere around 95-96. And then we will set the range of motion here.

Once the range of motion is set, you can see we can get the new value here for the mechanical stop that is called H and W. So we can change our mechanical stop setting here to H and W so that is the actual thing. The previous one was the tentative one and apart from that there is another automatic stopper, which basically the machine in use and that is set at the range of motion which is set here So, now we are all good to go for the test. So when I press OK, the device is asking me to reach to a particular position. That is current position is 92 and reach to 96. And, the 96 was the flexion. So I will ask the athlete to go to the full flexion first. And once I reach there, you can see the interface change here.

And I will ask the athlete to perform the test. So this is extension and you can see. And this is the warm-up test. So I will ask my athlete to perform with a bit lower force only - Extension and flexion. The command to my athlete will be, you need to apply force both the side and apply the force incremental with all the repetition. So the warm-up is done. And you can see the 30 second timer started here.

Now we will be going for our first test. First set that is at 120 degree per second and the 5 reps will be there. Timer is over, again it is asking us to reach to the 96.

That means the full flexion. And we will ask the athletes this time to apply at least 60 to 80% of their strength. Because this is another set we are going for. So again, the timer for 30 seconds starts. The second timer is also going to get over. And now, the athlete will be there for the final set, which is 60 degrees per second. Again, reaching the full traction position, you can see as the speed decreases, the resistance increases. The athlete is applying force in both directions. So, the first one, the left side, is for extensors, and the right one is for flexors—that is torque versus position parameters. And we are done.

.So, once we are done, we can basically always go to the preview here. And we can test. You can see the red color is the left side. So, only one data point is there, that is for the left side. And the right side, all the values are 0 here. This is for 60 degrees. And the above one is for 180 degrees. Sorry, 120 degrees.

Let us go to the right side as well the right side again the athlete will be there the only need we need to do is we need to remove the dynamometer extension first. We need to push the monorail a bit back side and since the chair position was 40 degrees black We need to change it to 40 degree teal . So for that, we just simply need to pull off the lever like this and rotate the chair something like this. And the 40 degree teal will be the position for the right side. The similar way, we need to do it for the dynamometer.

The dynamometer was there for the left side. We need to rotate it towards the right side now. Just need to pull up the lever and need to rotate it in right direction and fix up for the right side position. So, the next is as earlier we did for the left side. So, now we are moving to the right side here and we are going for all the set as we are going for the left as well.

Again the same setting will be coming. So, we have done all the settings and we have made the athlete position to test for the right knee here. And then again the device is asking me to set the anatomical zero. So, to test the anatomical position again, I will ask my athlete to do a knee extension. So, this is the anatomical zero, so I am setting a anatomical zero here, and then I am setting the extension that is the extension only, and I will ask my athlete to go for the flexion.

So, flexion again, it is going for more than 100 but for the left side we test around 96 degree. So for a sake of comparing the thing I think it is better to go for the same range of motion here as well. Set range of motion and we are all set to go for the testing. So you can see automatically the interface has been shifted to the trial set here. So in this phase, I usually ask athlete to increment the force like reach up to around 50 to 60% of their total strength.

The timer is reaching towards end and we ask athlete to ready for 5 repetition set that will be for 120 degree per second. So athlete is applying the force in that direction. You can see the torque and position graph is coming something like this. Again the 30 second timer starts.

Now we will be having the final set that is at 60 degree per second. So, athlete is set to go for that. You can see as the speed reduce you can see there is more resistance that it is filling. And done we are done with this with. Both right and left side straight away we can go to the preview section here and we can see the result here. So, You can see that we are getting two pages here. So, one is at the 120 120 degree per second and the other one is at 60 60 degree per second. So, for this demo, I will be interpreting this particular page like at the 60 60 degree per second.

We have already discussed everything into the slides. So, you have seen this particular part is basically for the quadriceps, this is extensor, and this part is for hamstring that is the flexors and the blue curve is for right side and the red curve is for left side. You can see like for the right side the person has applied the torque of around 207 Newton and for the left the athlete has applied for the 188 Newton. There is total 9% deficit we can observe here.

You can see there is less coefficient of variation in the right compared to that of the left. And we can see that in the graph as well. The left graph is somewhat more scattered than that of the right one. This is the percentage of the body weight. So, for the right it was like 1.91 times body weight and for the left it is 1.73 times body weight.

For the hamstring also, you can see there is 23% deficit in the right and left. And you can see the difference here as well. So the red curve is a bit lower than that of the right curve. This may be the area which can be expressed to the SNC course that there is a 23% asymmetry in the hamstring. Right is stronger than the left or I can say the left is weaker than the right.

We can focus on that. You can see the coefficient of variation is also less here. So I can trust the values here and this is the percentage of body weight. Again the percentage of body weight that differs from the area of interest like if you are testing for strength. So we

want for the quadriceps the percentage of body weight should be somewhere around 250 and all.

And for hamstring we want it to be around 180. So both the values are less. So my first suggestion to the SNC would be we need to increase the strength and we need to focus more on the left hamstring in order to match up the symmetry. And coming to the ratio, so this ratio is flexor is to extensors or I can say this is hamstring is to quadriceps ratio, H Q ratio. So this is 60 for the right and 51 for the left.

You can see the ratio is left here that is basically again indicating the same thing that the left hamstring is somewhat weaker than compared to the right side. The same way we are getting the work per repetition, the average power per repetition, we can get the position parameters, so we can get the quadriceps for the right side, the quadriceps peak torque reach at 61 and the hamstring is around 30 and for the left we are having 54 and 38 respectively. And we can get all the time parameters here as well that we had already discussed during our slides. You can see that this is the setting for ankle inversion and eversion.

The athlete is lying on the seat here and the foot is placed on the foot plate, which is fixed into the dynamometer. And the setting which i told you in the slide was that this is the axis of rotation and this axis of rotation need to be matched with the axis of rotation for the inversion and eversion. So, this is the current setting, so where we need to set the anatomical zero first, so to select the anatomical zero, i first check the position which is coming and then we need to check the inversion and eversion. So the inversion range is going somewhere around 46 degree.

And the eversion range will be coming somewhere around 34 degree. So this is the the range of motion that we are achieving and by doing this, the device can have an automatic lock in this particular range of motion. This is the second node. So we will start with this. So first we will do the 10 repetition which is for warm up and then we are going for two sets, one for 120 degrees per second and one for 60 degrees per second, five repetitions each.

[And we will start] Set where we are going for 60 degree per second, by repetition. You can see the efforts are more this time. As it was mentioned that resistance is inversely proportional to the speed.

The athlete is again set for the other limb. That is the left side now. The same test we are performing. The range of motion is already set. Neutral position is already set.

So again we are going for 10 repetitions as a warm up set. You can see the left side is coming as invertors and the right side is coming as evertors. So that is the torque versus friction torque, 30 second break.

The athlete is set to go for the repetition at 120 degree per second -And start. 1 2 3 4, and this is the repetition at 60 degree per second. As soon as the test finish we can get the preview of the report something like this. This is at 120 degree per second. You can see it here: 120 degrees per second, and similarly on the next page, you can get it for 60 degrees per second.

[Thank you, and see you in the next video.]