Exercise & Sports Biomechanics
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Lecture 55
Digital Resistance Sprint Device

[Hello, friends! So, in this section, we are going to discuss another piece of equipment called the digital resistance sprint device].

Digital resistance sprint device:

A digital resistance sprint device is a motorized tether system that offers variable resistance control for sprint training and testing. It allows for precise adjustments and data tracking through a connected system, computer, or tablet. It provides athletes with a tool for improving speed and power.

It is a high-tech resistance training device that uses a motorized resistance system to dynamically modify sprint load. Unlike traditional sleds or resistance bands, it provides consistent, controlled resistance and real-time data tracking. It can be used for sprint acceleration training, maximal velocity training, injury prevention and rehabilitation, as well as for sport-specific speed development. These are the points that basically explain why it is important in sports biomechanics.

Sprinting is a complex movement requiring optimal force application, posture, and neuromuscular control. This kind of device allows athletes and coaches to analyze and optimize biomechanical efficiency in real time. It provides quantifiable metrics, including speed, power output, acceleration and deceleration patterns, as well as stride characteristics, including stride length, stride frequency, and contact time.

Now, let's talk about the **key biomechanical considerations of the device**:

The first consideration we are talking is the force velocity relationship. Sprint performance depends on the balance between force and velocity that we all know. So, the high force production is required during the acceleration phase. And the higher velocity is also needed for the maximum speed sprint. This kind of device allow for adjustable resistance to specifically target different parts of force velocity curve.

It has a several **biomechanical implications**, like the high resistance training and the low resistance training. So, the high resistance training like it developed the horizontal force production critical for sprint start and the acceleration. While like along with that it engages posterior chain muscle like the glutes and the hamstring muscle for powerful propulsion. While in case of a low resistance training it allow training at the higher velocities reinforcing the efficient sprint technique at top end speed. And it develops the stride frequency and turnover rate.

The practical implication of this consideration is like the football linemen may use the higher resistance to develop their explosive acceleration, and the track and the sprinters

they may use the lower resistance to refine their maximum speed mechanics. So, it all depends on the usage and the requirement of that particular event. Another consideration which we are discussing here is the kinetics and specifically the ground reaction forces and the sprinting efficiency. So, the ground reaction forces is the force exerted by the ground on the sprinters and the device allows athlete to increase horizontal force production which is crucial for faster acceleration, applying force more effectively into the ground results in better propulsion and speed.

The biomechanical consideration of the kinetics includes:

If too much resistance is applied, it can cause excessive breaking of the forces, and that may lead to an inefficient sprint mechanism. On the other hand, the optimal resistance, if applied, it may encourage proper force production and improve stride efficiency and acceleration mechanics. Another consideration is the kinematics, and here we are talking about sprinting mechanics and postural alignment. So, this kind of device allows precise analysis of sprint kinematics, which includes stride length versus stride frequency.

Finding the optimal balance is obviously important. The ground contact time—shorter contact time indicates efficient force transfer, and hip and knee positioning is key for optimal force output. The biomechanical consideration of the kinematics is the early expression phase, which requires a low forward lean and focuses on pushing the ground backward rather than reaching forward. While in the case of a maximal velocity phase, the transition to a more upright posture is needed, and maintaining high knee lift and active foot placement under the center of mass is required. And this kind of device basically helps in improving all these implications or considerations so that ultimately the running mechanism improves and speed increases.

Another consideration we are discussing here is **neuromuscular adaptation and coordination**. So, sprinting with resistance activates fast-twitch muscle fibers, leading to greater neuromuscular efficiency, improved rate of force development, and better muscle coordination for sprinting mechanics. The biomechanical consideration of this kind of device in neuromuscular adaptations is that it helps improve reactive strength by training the body to minimize ground contact time. It encourages efficient firing of motor units, which is crucial for speed development.

And an athlete can train eccentric control using this kind of device during the resistance, resisted deceleration phase. They are reducing the injury risk. Another consideration which we are discussing here is injury prevention. So, the digital resistance sprint device can help reduce common sprinting injuries by strengthening the posterior chain or the group of muscles like the glutes, hamstrings, and lower back.

It enhances eccentric control, which lowers the hamstring injury risk, and it allows controlling the load progression by preventing overuse injuries. This table indicates common sprinting injuries and prevention strategies using the digital resistance device. So, for example, if a person or an athlete has a hamstring injury, the common causes would be overstriding and weak eccentric control. These are common causes, not the only or the utmost causes. This may be one of the reasons.

This device can help by strengthening the hamstrings through controlled resistance training, so that the athlete may avoid overstriding and develop eccentric control as well. In the case of an injury like lower back pain, the majority of the causes are excessive lumbar extension under load, and this kind of device helps coaches monitor trunk alignment during resistance training sprints. In the case of ACL injuries, the majority of the causes are poor deceleration mechanisms, and this kind of device—the digital resistance sprint device—can help train braking force safely while allowing monitoring. Talking about specificity and sport-specific performance enhancement, the usage of equipment like digital resistance sprint devices can be beneficial. So, we can use the same kind of device in football for acceleration out of stance development.

In soccer, short bursts of speed with changes in direction are common, so we can use the device to develop that ability as well. And mostly in track and field, to improve the top speed mechanism. Talking about the overspeed consideration. The digital resistance sprint device can provide assisted sprinting. It helps athletes exceed their normal maximum velocity. But caution needs to be taken, as overspeed training should not cause mechanical breakdown.

So, the **takeaway points from these slides** are that the digital resistance sprint device is a versatile tool for sprint biomechanics. By providing data-driven sprint training, the optimal resistance selection enhances force application, sprint technique, and neuromuscular coordination. Proper biomechanics must be maintained to prevent compensatory movements and injury risks. It can be used for acceleration training, maximum velocity improvement, injury prevention, and return-to-play protocols. As part of the demonstration, here we are discussing the device called 1080 Sprint. That device has key features like variable resistance and an assistance mode.

This device offers both resistance and assistance training modes, allowing athletes to simulate different movement patterns and intensities. The resistance can be adjusted incrementally, as precise as 0.1 kg, ranging from 1 to 30 kg. So, there is a good range of resistance that can be provided. It enables tailored training sessions to cater to specific athletic needs. The real-time performance metrics allow athletes and coaches to monitor data including force, speed, time, power, and position detection.

This immediate feedback facilitates the analysis of performance and the identification of areas for improvement. The device is very portable, as it weighs somewhere around 25 kg, and it is very easy to move from one place to another. The device is versatile. It has versatile training applications, as the device supports a wide range of training activities including sprinting, skating, swimming, and changes of direction movements. It is particularly effective for on-field resistance training and testing. It provides a portable lab experience for athletes.

Data analysis and storage are another key feature of the equipment. So, the accompanying control app connects seamlessly to the device 1080 Sprint, allowing for the storage and comparison of historical training data.

Talking about the **Components of the device**, the device has main hardware components. There are, I think, four main hardware components, one of which is called the motorized

resistance unit. This is the core of the system, generating variable resistance for the sprint. It uses an electrical motor and a pulley system to adjust resistance dynamically.

It provides consistent and smooth resistance, unlike traditional sleds, and it can generate resistance from 1 kg to 30 kg, finely tuned to 0.1 kg increments. It has biomechanical relevance, as it allows athletes to train at different resistance levels to target acceleration or maximum velocity phases, ensuring smooth resistance application and preventing excessive braking force.

Another component under the hardware category is the **cable and attachment system**. A high-strength retractable cable connects the athlete to the resistance unit, extending and retracting smoothly to ensure continuous tension. It comes with an adjustable belt and harness attachment for different body parts and movement patterns.

The biomechanical relevance of the cable and the attachment system is that it ensures uninterrupted spin motion by maintaining a constant force application and the direction of pull can be adjusted for different sport specific drill. For example, the forward sprint or the lateral movement it can be done very smoothly here.

Another hardware component is the **control unit and the interface**, so the device itself has one interface and that is called a control unit. So, a digital touch screen panel that allow use to adjust resistance the track performance and the stored data. It displays the real-time metrics including the speed, acceleration, force, power output, stride characteristic like the contact time and the stride time and it includes the preset training modes for various sprinting drills. So, it is not needed to have a tablet or the laptop at the time of the testing. This particular digital touchscreen panel can work for the training purpose.

The biomechanical relevance of this is it help monitor sprint techniques and power output in real time and it enable individualized training adjustment based on the data feedback.

Talking about another hardware component and that is called the **portable casing and the wheel** which is an important component here. So, a compact 25 kg casing houses the motor and the control system and it is equipped with wheel and a telescopic handles for easy transport. It is designed for use on the various surfaces like the indoor track, grass field and the synthetic turf. The biomechanical relevance of this component is it ensures the device is suitable during the high speed sprint and the portable design allow for on-field resistance sprint training making an ideal for team sports and track athletes.

Another component is the **software and the data analysis component**. So, the software name called the **1080 motion control app**, which can be connected via a laptop or a Windows tablet. So, a mobile and the desktop compatible software that connects with the Wi-Fi or the Bluetooth can accommodate this kind of application, and it allows coaches or the trainer or the biomechanics to monitor and compare athlete performance over time. It set custom training protocol and resistance profiles and it analyze stride mechanics power output and the sprint symmetry. The biomechanical relevance of the software in the data analysis component is it enables data-driven training by tracking improvement in force application and sprint velocity and it provides objective feedback helping coaches fine-

tune an athlete's biomechanical efficiency. So, this is the equipment i was talking about this is called 1080 sprint.

This comes with this particular box, and this is a very compact and portable piece of equipment. We can—it has a wheel case, a pulley case, and we can move it in and out. It comes with something like this. So, this is the motorized machine with the string, and it basically comes as something like this. And along with that, it has certain attachments here. These attachments are a kind of harness. Where the string attaches, it has an adjustable belt so that we can adjust it to the athlete very easily.

Another kind of harness that we have here. And we do have some adapters here. It has a small screen here, as discussed in the slides, and this is a touchpad. So, there is no need for a laptop or tablets to conduct the test. We can do that from here only. But a laptop and tablet are needed in order to sync the data and store it for analysis purposes. You can see that we have different modes here.

We can go for the resisted sprint, we can go for the assisted sprint, change of direction, even we can go for some repetitions also isokinetic movements, and we can opt for the open turning as well. So for example, if I go for the resisted sprint here, so first thing which I need to do is I need to, you can see this yellow string, this is the string, it is somewhere around 120 meter. So, I need to first set a zero position. So, this string can come out something like this.

If I pull it out like this and like, for example, if I am just starting it, okay. And the starting position and let us say this could be my, this could be my starting position. So I just place it as an, so this is all the starting position done for me. Till this distance, there will be no resistance or no assistance. So, this will be point number 0 for me now. And from here onward only, I can set the load here. So, you can see, I can set the load into the form of kgs, like, I can go for the assisted. It is around 3 kg of the load on the string, so I can increase it by 1 kg something like this or directly by 5 kg something like this or I can reduce it something like this, or if I want to add or reduce the very fine amount of weight so I can go for 100 gram as well. This is done, and we are all set to go.

So, the athlete just needs to harness the things, and he or she needs to just run. As you can see, just start and go. So, let us start with the resistance sprint here. So, the device will basically ask me to set up the zero position first. So, let us say this is the zero position. So, zero position means, yeah, I need to set the zero position first. So, just pull it and set the position. This will be the zero position first. And now the device is in the ready condition. So, it is a quick start, basically.

As soon as the string pulls, you can see the time starts here. And we are getting the result straight away: the speed was 1.96 meters per second. The total time was 5.53 seconds, and the distance covered was 6.78 meters. So, we can set the distance and accordingly we can basically do the testing and the training part. So, along with that, if I go, I can have an assisted sprint as well.

An assisted sprint also, I will be having a zero position. Zero position is somewhat, which is somewhat near to me. Okay, let us say this is a zero position now. This is a zero position. So you can see that the spring is very loose now here.

If I just ask the athlete to go back to from where he just want to have the assisted sprint so like this. And as soon as the athlete start running you can see it is being assisted so assistance is also for let us say 3 kg assistance the athlete was getting here so although we are doing in a lap setting so the distance is less but we can do it for around 120 meter as well. This system comes with a software that we have discussed in the slides. So, The software name is called control app 1080 motion control app. And we are having a lot more feature than the touch panel in the control app. So here we need to connect the device first. It looks after the device, the thing is both the device should be connected to a same Wi-Fi, Or else there should be the connection with the wire. There is a type C to USB cable connection is there. So, the device is having a type C connection somewhere here.

We are here, and from here we can have a USB data connection to the laptop or to the tablets. So, this is our device here. Sprint 2, and we are connecting it. So, we need to accept it on the panel.

We are connecting it. And it is done. You can see here it is coming as remote control by side. So, SAI is the laptop's name. And we are already connected here. So, here. That is the login. So this is the interface, t is being logged in with my institute name and the device which is connected here. So, we can have a look that the battery percentage is also coming here.

We can have the previous data here, we will be having a quick look at the previous data, some pending test if their ongoing test is there, or we can create the new session straight away from here. So, if you go to the new session, it asks us to add clients. So if you already have a list of client, okay, so it will be showing up here. So, we can add every one of them there on our pool of testing or training or else we can add the new as well.

We can add a new client straight away from here. So, to add what we need to have we need to just add the name, height, weight. So, height and weight is supposed to be the perfect because it basically calculate the force velocity from the height and weight only right and this way we can create a new profile. So, I am already having some clients added here. So, I am adding up the client from here.

Let us say this first and the XYZ first. So, I am having two clients on the pool now and from straight away selecting the things, the system will be showing me the demographic data, the height and weight of the particular client, and from the plus I can add the exercises or the tests which I am supposed to do. So, you can see there are various type of tests are here.

The change of direction, so in that we are having a various tests like 5-0-5 assisted start. So, these are the preset tests that the system is having. So and we are not limited to this. We can customize the test as per our requirement as well. So, these are the number of tests including the shuttle run, 5-0-5, 5-10-5 kind of thing.

And we can have a linear test like linear bilateral, linear unilateral, running and running to left and right. We can have the single like the set like we can have a bilateral overhead training, anterior push, we can have the anterior push unilateral test, So the rotational pull, rotational pull, unilateral drag, the single bilateral. So, there are various, various amount of like kind of tests that we are having and we can customize that as well.

So, we can just add from here to the list. We can have a synchronization test like the bilateral to the unilateral. And we can have a synchro Smith test as well. So, like we can go for the bilateral squat, counter-moment jump test, the unilateral squats, many tests are there. So, let us say, for example, we are just going for the running, the simple test.

I am just adding it here and the system and the test will be added to my testing pool. You can say the running test is coming here straight away. Okay, so for Soham, for example, if i am going for the new run so it basically brings me to this particular phase. So, where i can have a start condition like the auto or the manual condition. So, in auto condition wherever point we are setting the zero for the particular string, okay. From there if the minimum load that is 0.2 kg, if applied to the string, the time automatically gets started and the calculation will automatically get started. In the manual, I need to just press the start here, start here and then the system will start measuring the data.

Let us say we are going for manual first. So, the finish condition, we are going for 20 meter or we are going for plus or minus, we can do it here. We can basically do it as the auto. So, auto means when the application of force gets stopped, the software itself stops measuring the data. So, we can have a finish condition based on the distance.

We can have a finish condition based on the time and manually also we can do that like from the stop button. So, let us say, let us have it at auto condition only because we are currently doing into a lab condition and we are having a limited amount of space here. And the directions also we can go for the resisted, we can go for the assisted or we can go for the auto whatever we can set. Okay. And so the load I can get from the previous test if I have done or I can take from the body weight.

Let us say if I am taking from the body weight. So, this is the percentage of body weight. So, currently the load is set as 10% of the body weight. So, we know the Soham weigh around 75 kg here right. So the 10% of body weight is coming around 7.5 kg.

We can go for concentric and eccentric both 7.5 kg. So, to use the eccentric overload, I need to give the check because eccentric is something which required more demand. I can add or remove the weight directly from here like this, and that is okay. I am having a different conditions here. This is for the weight. This is the setting which I want to do for or which I want to apply into my training order testing session. Applying the things and that is it. We are all set to go.

Now the thing is the same; you can see it is coming up here also. 7.5 kg concentric and 7.5 kg eccentric load—it is coming up here. The NFW is a no-flying-weight mode. And there is no pulley we are involving. A pulley is needed in case of a change of direction.

Now the thing is we need to set up the zero now, right? So, we are all set to go. So, as soon as the athlete pushes the string, you can see the time starts here. And as I have set it for the

10-meter finish condition, after 10 meters, the time automatically stops. So, this way we can conduct the test, and you can see the time is coming.

The result came as the total speed was 1.62 meters per second. For 0 to 5 meters, the total time taken was 4.13 seconds, and the total time he worked for something else only. And this was the first test which basically came here. Similarly, we can add on the test here and do the same for a number of athletes. If you want to see the result here, we can click here and straight away see the position and the speed curve here. So, at what particular position, what was the speed and all?

We can straight away see from this particular graph only. This is not possible on this particular screen. So, that is why the software interface is important.

This is a speed motion curve straight away. We can go for the force-position curve as well. So, this was the amount of force that has been applied, that was in Newton. So, the force applied here was around 73.8 Newton, and it basically moves something like this.

And we can have a power versus position curve as well. So, if you do not want the position thing, you can change the x-axis to time as well. So, this is the Ft curve which is coming up, this is the speed-time curve, and this is the power-time curve. So, this way, there are n number of possibilities that can be worked on. And the only thing is we need to exclude the system. So from here, if I can go to the modes, these are the different modes I can work on, called NFW. NFW is no flying weight, which combines isotonic and the normal mode.

On the other hand, I can go for the specific isotonic mode as well as the normal mode. And here, I can go with setting up to the zero position. So setting up a zero position basically requires me to go to a particular position, which will be considered as the zero position. So, let us start with this. And let us say this position, bring it a bit closer. Let us say this position; I will confirm it as the zero position. So, this is the zero position where I can see there is no load on the string; you can see the string is free. And this is my zero position. And from here again, if I go to the new run and start. You can see the timing is starting here. It will go up to 10 meters. Because we have set the finish condition up to 10 meters, it is coming back now, and because we have selected the direction as auto, it will measure both resisted and assisted.

We can go for specific resistance and assistance as per our requirement. And we are done with the test. So now after that, the test result will appear somewhere here. So, here we can have different parameters like the distance, time, top speed, what is the 0 to 5 meter speed— everything will appear here. And here we have a different graph.

This graph is like a speed and position curve. You can see, and if I roll over to the graph, you can see, I can see the position and the speed at that particular point. So, this was at 1 meter, this was at 2 meters, this was at 3 meters. So, instantaneous speed I can basically measure as per the position.

I can go for the speed and the, sorry, force and the position curve. And this is the force I applied at 1 meter, 2 meters, and 3 meters. In a similar way, I am having it for power. And even so, this is the y-axis and x-axis. Also, I can change the position, like instead of

position, I can have time. So, this is the power versus time curve, as per the force-time curve, and the speed-time curve.

These are the various possibilities that can be done here. And there are a number of things that can be applied. So, just need to explore the device more and more. So, this is one test that has been conducted. Apart from that, there are various other tests, like the change of direction.

We need to apply the pulley to the harness. And apart from that, we can go for some lateral hopping, counter-movement jump squats. We can basically go for the active resisted and assisted, both things.

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