

Exercise & Sports Biomechanics
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Lecture 42
Importance of CoG Control Training

[Hello, friends]!

Importance of training to improve the Center of gravity control:

Have you ever given a thought just like the other trainings that the athletes are going for like the strength training, speed training, sports specific movements and all? Do the training for center of gravity control is also playing an important role? And why this training the control of center of gravity matters.

Why training center of gravity control matters?

It matters in order to:

1. Enhance the balance and stability:

So, like the athletes with the better center of gravity control can maintain stability in various movements reducing the likelihood of falls or imbalance.

2. Optimize the movement efficiency:

It matters to optimize the movement efficiency. So, the precise center of gravity control allows for smoother, more energy efficient movement, improving overall performances.

3. Improve agility and quick direction changes:

It matters to improve agility and the quick direction changes. So, it is basically essential for the sports like the court game and the field games like the basketball, soccer and the tennis where the rapid movement adjustments are required.

This kind of training basically helps having a good control on the center of gravity or keeping the center of gravity under the base of support. So, that the risk of fall down or the imbalance will be getting reduced and the movements like the agility movement and the change of direction will become smoother. So, the athlete will be getting motivation on that and on the other hand there will be an improvement in the performance can be seen. This kind of training that matters in order to reduces the injury risk like the strengthening the center of gravity control minimize the chances of sprain, strain and the other injuries related to the poor balance in the posture. Because in sports we have seen that many of the injuries occurs because of the poor balance and the disturbed posture.

4. Reduces injury risk:

In order to reduce the injury risk like the strengthening the center of gravity control minimize the chances of sprain, strain and the other injuries related to the poor balance in the posture, because in sports we have seen that many of the injuries occurs because of the poor balance and the disturbed posture.

If the athlete is having a center of gravity sense, it ultimately helps in improving the balance, so that doing the various movements there are less chances that the athlete is going off balance or having a fall and all so that there will be a reduced risk of injuries.

5. Boost the force generation and the absorption:

It matters to boost the force generation and the absorptions like it is crucial for sports that involve the movements like jumping, lifting kind of thing. So, where the controlled center of gravity shift enhances the power output.

Training strategies to improve the COG control:

There are various training strategies to improve the COG control. So, the athletes can improve their COG control through specific drills and exercises.

1. Balance drills

One of them is called the balance drills. So, the exercises such as stability, ball training, single leg stand and the bubble board activities improve COG awareness. So, in the initial part the exercises may be difficult for the athletes but as they go on training it will become much more comfortable for them.

2. Agility drills

The exercises like the agility drills, like the ladder drill, the cone drills and the plyometric jumps help athletes adjust their COG rapidly during the movements. So, they will be getting more sense of where their center of gravity is or whether it is coming under the base of support or not.

3. Strength training

The exercises like the strength training, the exercises like the planks, deadlifts and the resistant band workouts strengthen the core muscles for better COG stabilities.

4. Postural training

The postural training like the yoga, pilates and the functional movement training enhances the posture and the body control to the athletes.

5. Proprioceptive training

The training likes the proprioceptive training. So, using the unstable surface like the Bosu ball and the resistance band to challenge balance in the control. So, this kind of exercises may be used for the rehab purpose as well in order to improve the balance and the control over the center of gravity.

6. Dynamic trainings

The dynamic trainings like the practicing the sport specific drills where COG shifts frequently such as dribbling in basketball, tackling in rugby or the defensive movement in tennis. So, again these drills basically improve the sense of center of gravity and help in keeping the center of gravity under the best of support in order to improve the balance and posture during the particular movements.

There are biomechanical analysis which basically helps in improving the center of gravity control because it is giving you visual feedback, so the athlete basically can see himself or herself and can try to control or to get the center of gravity in the particular position. So, they help the athlete to refine their movements for the better performances.

The video analysis:

The coaches and the trainer use motion tracking and the force plate data to enhance the sports technique by adjusting the body positioning and the movement mechanics. And in particular, they are basically focusing on the movement of the center of gravity. So, how the athletics is swaying, in which direction they are swaying. So, this will be ultimately helping them in order to improve their control over the center of gravity.

These are some of the examples for adjustment of center of gravity in the sports like in sprint. So, they optimize their starting stance to lower COG for explosive acceleration. The high jumpers it is very famous like it utilized the fosbury flop techniques to manipulate their COG allowing them to clear greater heights. In gymnasts and the divers, it is like they adjust their body alignment mid-air to control their rotation and maintain balance during the flips and the twists. In the weightlifters, they keep the barbell close to the body ensuring that their COG remains aligned with their base of support for maximum lift efficiencies. And in the cyclist and the skiers, they shift their center of gravity forward and backward depending on the terrain and speed to maintain the optimal control.

Injury prevention strategies:

Center of gravity training basically helps in injury prevention strategies as well.

1. Strengthening of the core muscles

The strengthening of the core muscles helps maintain Center of gravity control during dynamic movements reducing the risk of fall and misaligned injuries.

2. Landing mechanism technique

The landing mechanism technique in various sports and the drills, it also helps in reducing the injuries like the technique, the teaching proper landing techniques in the high impact sports like the gymnastic, the basketball, volleyball which requires a frequent jumping. It reduces the stress on joint and prevent injuries. Encouraging athletes to land with bent knees and a wider base of support to absorb shock more effectively. For example, gymnasts practicing controlled landing to minimize the force impact on the ankle and the knee.

3. Center of gravity awareness

There are some center of gravity awareness drills which basically helps in injury prevention like the training athletes to recognize and control their COG positions during dynamic movement decreases the risk of fall and misalignment injuries. Exercises such as single leg balance and the proprioceptive training improves body awareness. Some of the examples are soccer player perform drills to maintain balance while dribbling and changing the directions.

4. Rehabilitation exercises

Few more injury prevention strategies like the rehabilitation exercises. So, the physical therapist use center of gravity based training programs to add recovery from injuries particularly for knee, ankle and the hip stabilites. The balance board, stability, cushions and the controlled movement pattern help athletes regain strength and coordination. Some of the examples are like an injured basketball player recovering from an ACL tear performed controlled weight shift to restore balance and the shift.

5. The sport-specific conditioning

The sport-specific conditioning, which helps in controlling the COG and therefore controlling injuries, like developing muscle memory and proper body mechanics through center-of-gravity-focused training, reduces overuse injuries and enhances movement efficiency. Strengthening stabilizing muscles like the core muscles and the gluteal muscles helps the athlete maintain proper alignment and prevent strength-related injuries. For example, runners engage in core stabilization workouts to maintain optimal posture and prevent lower back injuries. So, it is like now they are focusing on improving the stabilizer muscles so that they can stabilize the center of gravity movement and keep it as far as possible under the base of support in order to have improved balance as well as better posture for a particular action.

6. Protective equipment and surface considerations

For injury prevention strategies, one more part I will discuss here is protective equipment and surface considerations, which play a very important role. All these equipment are designed to maintain the center of gravity in the correct position. Using proper footwear and supportive gear can enhance center-of-gravity control and reduce injury risk.

Training on appropriate surfaces like grass mats or shock-absorbing floors minimizes the impact force on the joints. For example, tennis players wear shoes with lateral support to prevent ankle rolling during rapid movements. So, all these things are designed in such a way that they will become an assistive tool for athletes to keep their center of gravity in a place where they want or in a place that gives them an advantage to improve performance and reduce injuries.

The method of measuring center of gravity:

We all know that the center of gravity is the point where the entire mass of an object or body is considered to be concentrated. It is the theoretical balance point where the gravitational force acts equally in all directions. COG plays a crucial role in determining an athlete's balance, stability, and movement efficiency. Understanding how to measure

and analyze the center of gravity is essential for optimizing sports performance and preventing injuries.

Knowledge regarding the center of gravity helps improve balance and stability for athletes in various sports. It assists in injury prevention by identifying movement insufficiencies and reducing stress on the joints. It supports performance enhancement by optimizing movement mechanics and efficiency. It provides scientific insight into how the center of gravity shifts during different activities, aiding in technique refinement. There are several techniques used to measure the center of gravity in both static and dynamic conditions, including estimation of segmental mass, the mass center, the center of segmental mass, moment of inertia.

The center of gravity of the whole body requires special procedure, which can be grouped as **experimental procedure** and **analytical procedure**. In the experimental procedure, there are two techniques, like the one with the **technique using cadavers**. The cadavers are dead bodies which are used for medical testing, teaching purposes, and more. So, they identify the segmental mass and the segmental moment of inertia at the center, and by summation of all the factors, they determine the center of gravity of the particular object.

The second **technique involves living objects**, and in that, we will first discuss the following points:

The reaction board method:

The reaction board method is used to estimate the position of the center of gravity of the whole body and determine the mass of the body segments. So, in this method, it is an experimental approach and is also called the board and scale method. This is based on the principle of equilibrium, which states that when a body is in equilibrium, the sum of moments acting on it is zero.

In this procedure, a large board is used, with one edge supported on a knife edge and the second edge on a scale. That can be a weighing machine or a force plate. The scale reading is noted as the initial reading. You can see this is a board I am referring to—one end is supported on a knife edge, and the second end is on a scale, which could be a weighing machine or a force plate. The reading will appear here on the meter. When the board is unloaded, the reading will appear here, and the initial reading will be recorded.

To determine the position of the center of gravity in the vertical direction, the subject lies supine on the board with the heels pressing against a footrest. This one from the scale and the second or the final scale reading is noted again here. So, when the board is offload, the first reading will be coming and when the person is on the board and the person is supposed to press this particular scale of the board, the meter will basically move on and the second reading will be noted down here. After that, the movements acting on the board about the footrest will be due to the body's weight and due to the reaction force acting at the opposite end.

So, as the system is in the equilibrium state, the sum of clockwise moments will be equal to the sum of anticlockwise moments. Thus, we can have a formula like this, W_s equals to

Rf minus Ri multiplied by L. So, as a simple mathematics if we put this W here we will be getting the value of S. So, S will be Rf minus Ri multiplied by L divided by W.

$$W \times S = (R_f - R_i) L$$

$$S = \frac{(R_f - R_i)L}{W}$$

Where W is nothing but the weight of subject. Ri is the initial reading. Rf is the final reading, L is the length of the board, and S is basically the distance of the center of gravity from the scale from here from here. Right, so we are basically getting the distance of center of gravity in the vertical direction when the person is supine. So, the advantage of this procedure is it is very simple inexpensive and accurate for static position and the limitation is it cannot be used for dynamic movements. So, using the same procedure when the subject acquires the upright position the location of center of gravity can be determined in the frontal that is front and back and in the lateral that is right to left axis as well.

This assumption is that the change from supine to the upright position will not shift the position of center of gravity. However, due to the shift of body fluids in the downward direction, the position of center of gravity is little lower in the upright position than in the supine position. So, in the previous methods, here we are basically getting finding out the position center of gravity something like here in the vertical direction like this. So, from here we will be in the position to find out in the front back or in the right left position as well. In another approach that involves the use of large boat, the location of center of gravity can be determined simultaneously in two axis and in different body postures.

In the previous one, we were finding out one axis only at once. Here, we are finding out the location of the center of gravity in two axes simultaneously. So, in this adaptation, a triangular board is used, which is supported on one end on a knife edge as before, and its other two ends are supported by a scale. The initial scale readings are noted on both scales when the board is not loaded, and again, the final scale readings are noted when the person lies on the board. And the moments along the two axes are computed as given, like the moment of x will be computed like this, $X = \frac{(R_{af} - R_{ai})}{W} S_1$

and the moment of y will be computed something like this, $Y = \frac{(R_{bf} - R_{bi})}{W} S_2$

[So, this will be one moment, and this will be another moment].

The intersection of these two will be the point where the center of gravity is located. So, this can be used for various body positions as well.

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