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REHABILITATION OF BIOMECHANICS IN MIDDLE AND LONG DISTANCE RUNNERS

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ABSTRACT

This article describes the general characteristics of the biomechanics process in middle- and long-distance runners. In particular, running-related injuries in middle- and long-distance runners arise due to a number of internal and external factors. Therefore, it is necessary to develop a treatment program through the study of running biomechanics and kinematic movements. This is because studying physical exercises and sports movements helps organize the training system on a scientific basis, and studying the endurance of bones, tendons, and other tissues helps understand the mechanism of the effect of injurious factors on the body and enables their prevention. Improperly adopted running technique can significantly increase the load volume, which may result in damage to tissues and joints. For this reason, identifying the main error in runners' biomechanics and developing a management plan to comprehensively address their symptoms helps prevent all of the above.

Keywords: Running biomechanics, middle-distance running technique, rehabilitation, training program, individual approach, principles of sports training.

INTRODUCTION

Understanding running biomechanics is invaluable and effective for a coach in describing an athlete's technique, explaining how and why they accelerate or decelerate, and in understanding the internal and external forces that drive their movements. As an external expression of movement, an athlete's biomechanics converts their basic physiological, nutritional, and psychological processes into running motion. Those who are biomechanically "better" are often those who can manage this transformation more efficiently and economically, while also reducing the risk of injury.

This article discusses the key aspects of the running stride and its various components, different foot strike techniques, and how the rehabilitation of incorrect running technique can help prevent many injuries that may occur during training sessions. Of course, running has numerous health benefits. However, many injuries are not caused by training itself, but rather by improperly adjusted biomechanics. Broadly speaking, running-related injuries can arise from biomechanical factors, anatomical factors, or poorly structured training programs.

Solving Running Biomechanics through Developing a Treatment Plan

Stage 1 – Identifying and Understanding Training and Injury History

For a coach, it is very important to have an individual and detailed initial conversation with runners who have sustained injuries. This is because a complete injury history allows the coach to fully understand the scope of the problem and exclude any serious pathology.

When discussing running injuries, there are many risk factors that must be examined. Questions should be asked about modifiable factors such as running distance, frequency, speed, intervals, diet, hormonal issues or changes, use of orthopedic aids, running surfaces, warm-up, stretching, and physiological aspects.

Unmodifiable factors such as age, gender, height, experience, previous injuries, and overall health are equally important for research purposes.

Many scientific systematic reviews have shown that the biggest risk factor for the development of running injuries is a history of previous injuries. Incomplete rehabilitation of a previous injury can lead to disrupted biomechanics.

Asking runners about their short-term and long-term goals ensures that your treatment plan aligns with their needs and development.

Stage 2 – Deficits in Mobility and Motor Control (Physical Examination)

A physical examination is important in any symptomatic patient to make a correct diagnosis and to provide treatment through a comprehensive assessment of the whole body.

Key aspects that need to be assessed include range of motion, mechanical sensitivity of the nerves, and muscle strength.

Evaluating the runner's mobility and motor control is crucial because these factors can lead to biomechanical changes in their running style.

Movement screening includes analyzing a series of fundamental movements to detect any motor control defects or movement deficiencies.

Functional movement dynamics are tools developed to identify deficits in movement patterns and to test and predict potential future injuries.

Although these are reliable tools, their actual effectiveness in predicting future injuries has not been fully confirmed.

Instead of using screening tools to test and predict future injuries, you can use them to assess a patient's mobility and any existing motor control deficits that may contribute to injury.

Before observing their running, you can perform a movement screen. This allows you to regularly check for any issues in mobility or motor control, which helps with addressing symptoms.

Basic movements like touching the toes, bending backwards, rotating, single-leg balance, and squatting can be evaluated, and then the structural components of each movement can be analyzed in more detail.

Stage 3 – Analyzing Running Form

The next stage in identifying the source of symptoms and contributing factors is to evaluate the runner's form.

Analyzing biomechanics through treadmill use and video review is a reliable method for assessing the kinematic indicators of running.

After you have already assessed their mobility and motor control deficiencies, this step helps you determine why the runner has adopted a certain running style or, alternatively, whether their running style is compensating for mobility or motor control issues.

Some commonly observed running styles include:

- Running with large strides
- Knees turned outward

- Knees turned inward
- Landing the feet heavily on the ground
- Running with the body leaning backward

Stage 4 – Developing a Comprehensive Treatment Plan (Rehabilitation)

In order to understand the history, conduct a complete interview, perform a broad physical examination to identify all mobility and motor control deficiencies, and analyze running form, the coach must develop a comprehensive treatment plan.

This plan should address every aspect of the runner's problems so that full rehabilitation and long-term recovery can be ensured.

The goal of creating a careful plan is to individualize the program according to the specific test results of the runner.

Each plan will look slightly different and should take into account the runner's unique history and every aspect of their biomechanics.

We propose a rehabilitation plan that consists of five components, covering the following aspects in running training:

1. Mobility
2. Stability
3. Form drills
4. Re-training running mechanics
5. Adaptability

Each runner will need different attention in each area.

The goal is to evaluate the technique of the runner and to use treatment tailored to the specific issues that the runner is facing.

Mobility

Dynamic warm-up is not only a foundational component of training programs for track and field athletes, but also for several other endurance-based sports disciplines.

Including dynamic stretching before any physical activity is more preferable than static stretching, although its physiological mechanisms are still not entirely understood.

Manual release of soft tissues can also be included as part of the warm-up, since it has been shown to improve mobility without disrupting muscle activity.

Static stretching and PNF (Proprioceptive Neuromuscular Facilitation) techniques — research has shown that PNF stretching before workouts such as running can increase effectiveness.

However, if performed before weightlifting or high-intensity exercises, it has been found to reduce performance.

Dynamic stretching, on the other hand, has been shown to positively affect joint range of motion.

Static stretching and PNF may affect immediate performance and therefore should not constitute the entire warm-up.

Instead, they are recommended either before the workout or at the end of the training session.

There is no universal "standard" mobility routine for runners — your assessment results will dictate the appropriate approach.

Stability

Using physical exercises to improve motor control and correct muscle strength imbalances has been consistently shown to be effective in enhancing running efficiency and work performance in middle- and long-distance runners.

During evaluation, the coach can identify any motor control or strength deficiencies and develop a personalized program based on the needs of each runner.

In the rehabilitation of runners, mobility and stability are two crucial aspects that must be addressed.

To resolve a specific movement dysfunction, the sample program must be tailored to eliminate such deficiencies.

Form Drills

The purpose of form drills in rehabilitating runners is to improve motor learning and assist in retraining proper running technique.

Form drills help isolate specific components of the running stride and make it easier to modify the runner's movement pattern.

There are many different drills that can be included in the training plan, and they must be tailored to the individual needs of each runner.

Below are some examples of running drills:

- A – Skipping drill
- B – Bounding drill
- High-knee running drill
- Butt kick drill (two variations: kicking backward and upward)
- Straight-leg running without bending the knees
- Lateral drill involving alternating opposite arm and leg movements while running sideways

Running Retraining

Retraining running technique has been shown to be effective in addressing key biomechanical factors associated with running injuries, such as ground reaction forces, energy exchange in the knees and feet, and the center of mass excursion.

Even after one month of follow-up, runners have demonstrated the ability to maintain improvements, indicating that the running retraining program can be successful.

The main component of running retraining is cadence or step frequency.

Running speed = step frequency × stride length

Many studies have been conducted on cadence and its effect on biomechanics.

There is no universally "ideal" cadence, but research has shown that even a small increase in cadence—while maintaining the same running speed—can significantly improve running biomechanics.

A 10% change is sufficient to alter the forces passing through the knee and does not negatively affect running performance.
When step frequency increases while maintaining constant speed, it reduces stride length, vertical oscillation, ground reaction forces, and impact shock.
It also decreases the amount of energy absorbed in the hip, knee, and ankle joints.
All of these factors are major biomechanical contributors to lower limb injuries in runners, such as tibial stress fractures and anterior knee pain.
Thus, retraining cadence can help prevent such injuries.

Note: Running Retraining Corrections for Testing Purposes
Important Reminder:
Caution must be exercised when modifying the biomechanics of runners, especially when working with high-performance athletes.
If you do not have sufficient experience in this area, it is advised to proceed carefully.
Overstriding Corrections:

- Increase cadence
- Encourage landing the foot under the center of mass
- Promote softer landings
- Encourage shorter steps

Pelvic Alignment:

- Use verbal or visual feedback to help maintain level pelvis positioning

Propulsion Phase:

- Encourage driving the knees further apart
- Promote greater push-off force

Hard Impact:

- Increase cadence
- Encourage softer landings

Crossover Gait:

- Promote a slightly wider base of support
- Ensure the runner stays in a straight line and verify that their feet are landing on either side of the line

Adaptability
Post-run adaptability may address mobility deficits that were observed during the initial dynamic warm-up.
Static stretching, PNF (Proprioceptive Neuromuscular Facilitation), and dynamic stretching have all been shown to positively affect joint range of motion.

In your post-workout routine, you may include more static stretching or PNF-based approaches.

CONCLUSION

Rehabilitation of running biomechanics is a complex process that requires a comprehensive assessment and, based on the results of the evaluation, the development of a detailed and individualized treatment plan.