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REHABILITATION EQUIPMENT FOR MOTOR FUNCTION RECOVERY AND RESTORATION AFTER INJURIES

Mustafina K.K.

master

Tanabai Z.

student

Taraz Regional University named after M.H. Dulati,
Kazakhstan, Taraz, st. Tolebi 60, 080000

Abstract. The article presents a review of modern simulators for restoring motor activity after injuries. As the number of injuries caused by accidents and sports damages increases, there is a growing interest in developing innovative rehabilitation methods. Simulators specially designed for this purpose provide unique opportunities for restoring motor functions. This article examines various simulators, covering their functionality and effectiveness in the context of medical rehabilitation.

Keywords: Traumatology, simulators, recovery of motor activity, rehabilitation, health.

Introduction.

According to research (Chekeres P.P., Budashkina M.V., Mukhanova V.V., and others), about 50% of all injuries to the musculoskeletal system among athletes occur in the knee joint. The second most common are injuries to the cruciate ligaments. Injuries to the anterior cruciate ligament and meniscus account for 70% of all such cases, according to the study (Sofu H., Yildirim T., Gu'rsu S., et al.). These injuries are considered some of the most severe because they affect the ability to support body weight and the walking process, leading to a decrease in physical activity and worsening the social adaptation of the victims.

Research shows that in athletes, biomechanical asymmetry and afferent conductivity disturbances in the limb become the cause of secondary tears of the anterior cruciate ligament and meniscus in 44% of cases (Hewett T.E., Di Stasi S.L., Myer G.D.). Typically, the rehabilitation process takes from five months to one year. However, even after limb functionality is restored, there is a significant risk of complications associated with the consequences of injuries and diseases caused by knee joint damage. Studies conducted by both foreign (Dejour H., 2014; Kessler M.A., 2008) and domestic scientists (Arkov V.V., Kalinkin L.A., Milenin O.N., and others, 2008) emphasize that the risk of developing (gonarthrosis) - deforming arthrosis of the knee joint, caused by a disturbance in body balance during movement, increases by 13–42%. Moreover, domestic scientific works note that after surgical intervention for anterior cruciate ligament reconstruction (ACL), there are disturbances in both static and dynamic balance. It is indicated that by 10 months after surgery, dynamic balance in the operated leg is not fully restored, maintaining functional instability.

Therefore, the return of an athlete to active participation in sports after restoring his motor functions does not exclude the risk of re-injury when performing extreme and maximum exercises. This underscores the importance of seeking new approaches, methodologies, and organizational forms of physical rehabilitation aimed at restoring the stability of the knee joint and sensorimotor control of the athlete's movements as fully as possible.



Main Part. Modern challenges in healthcare require the medical community to urgently create effective ways to restore motor functions after injuries. An important aspect in this field is the development of innovative training devices designed to improve the rehabilitation process.

Modern simulators offer a multitude of functions, including exercises to improve strength, coordination, and mobility. Innovative technologies of electrostimulation and virtual reality provide patients with unique experiences of visual and tactile stimuli, creating conditions for more effective workouts.

Modern fitness equipment integrates advanced technologies such as artificial intelligence, motion analysis, and biometric systems. These innovations not only make training more effective but also allow for a more nuanced approach to exercises, taking into account the unique physiological characteristics of each person.

To ensure the successful integration of modern training devices into the clinical rehabilitation process, several obstacles must be overcome, including financial costs and training requirements for medical personnel. Organizing effective training for doctors and physiotherapists to work with the latest technologies, along with support from management, helps overcome resistance to change and promotes the successful introduction of innovations.

The success of the rehabilitation process largely depends on attention to psychological factors. The use of simulators integrated with virtual reality provides a stimulating and supportive environment, contributing not only to the physical but also to the mental recovery of patients.

The collection and processing of information obtained with these devices provide medical workers with important data. This information can be used for instant modification of rehabilitation programs, allowing for the development of personally oriented therapeutic strategies.

Analyzing modern achievements, it is also necessary to look into the future. Future research will focus on developing new materials, virtual reality technologies, and methods for adapting simulators to the needs of a wide range of patients.

Let's consider modern simulators and technologies that contribute to progress in medicine. Simulators are training devices designed to improve physical abilities such as strength, speed, endurance, flexibility, and coordination, as well as to refine techniques in sports and enhance the functionality of the sensory organs. They are widely used in the field of physical culture and sports. Depending on the goals, simulators can be intended for individual or group training and can have a local impact on specific muscle groups or a global one, involving a large part of the muscle apparatus.

The technical features of simulators depend on design solutions, which are determined by the need to predominantly develop one or several motor qualities simultaneously. For example, technical devices such as treadmills, cycling, rowing, and similar simulators allow for targeted development of overall speed and power endurance.

Different designs of pulling devices, expanders, rollers contribute to the development of dynamic strength and flexibility; exercises on a mini-trampoline improve agility and coordination of movements.



Simulators designed for various types of impacts on the body can be combined into a single multifunctional device. Thus, using the gymnastic complex "Health," it is possible to improve almost all aspects of motor abilities.

The goals of health-improving workouts on simulators include:

- Development of proper posture;
- Correction of various spine problems;
- Fat-burning workouts;
- Reduction of excess weight;
- Improvement of the body's functional capabilities;
- Exercises for various deviations in health conditions.
- The goals of rehabilitative workouts include:
 - Recovery after injuries;
 - Elimination of physical development imbalance;
 - Improvement of joint mobility.

The application of simulators in practice follows the main principles that represent the key regularities determining the main criteria for the development of the structure and management of the training process.

The principle of awareness and activity states that for the best results in exercises, one must approach with a conscious, interested participation. It is important to have a clear goal in the training process.

The principle of visibility. "The principle of visibility involves intensive use of visual stimuli, including images, perceptions, and other forms of visual perception, as well as active engagement of data obtained through sensory experience, providing direct interaction with the surrounding reality." To achieve this, educational videos and audiovisual feedback means, including sound and light indicators, are used during workouts on simulators.

The principle of accessibility. The principle of accessibility implies adapting training programs on simulators to the individual characteristics of participants, including their gender, physical fitness level, and development. This means choosing such a volume and intensity of exercises that will be sufficient to stimulate physical development but at the same time not overload and not harm health. At the same time, accessibility does not mean offering too simple or basic tasks.

The principle of systematicity. This principle in physical training and workouts is key to achieving sustainable progress and improving physical condition. This principle emphasizes the importance of regularity of workouts and the balance between loads and rest, allowing the body to adapt to increasing demands without the risk of overtraining or injury.

The principle of dynamism is based on the need for continuous but gradual increase in the requirements for the level of physical activity and the complexity of the performed exercises. This approach ensures progress in improving physical abilities. The body's reaction to repeated load changes over time: adaptation occurs, allowing the same actions to be performed with less effort. In this regard, many sports simulators are equipped with programs or offer interactive changes in the level of load according to the current physical condition of the user to maintain this principle in the training process.



Various types of simulators are actively used in the rehabilitation process for targeted development of motor abilities such as overall speed endurance and endurance when performing strength exercises, as well as speed, coordination, strength, and flexibility, which are important components of health. The introduction of these devices into the practice of medical centers significantly increases the arsenal of tools and methods of therapeutic physical culture, improving both the health-improving and therapeutic potential of the sessions.

Training devices can be used both on an individual and a group basis, offering both local and general effects on the body. They provide the opportunity to precisely regulate physical loads and target specific muscle groups. This makes them an effective tool for targeted improvement of the cardiovascular, respiratory, nervous systems, and maintaining the health of the musculoskeletal system. Thus, they are recommended for the treatment and prevention of various conditions, including hypertension, vegetative-vascular dystonia, chronic nonspecific lung diseases, arthritis, arthrosis, and others.

The technical features of simulators are determined by the need to predominantly develop a particular motor quality or several simultaneously. Technical devices such as treadmills, cycling and rowing simulators, and the like, allow for targeted development of overall speed and speed-strength endurance. Different designs of expanders and rollers contribute to the development of dynamic strength and flexibility. With the help of a mini-trampoline, coordination of movements is perfected. Various in direction of impact on the body, simulators can be combined into one device and be called universal (for example, the gymnastic complex "Health"). With their help, it is possible to develop practically all motor qualities.

The human musculoskeletal system includes bones, muscles, joints, ligaments, tendons, cartilage, and other connective tissue. These are any anatomical structures with which we stand, walk, run, jump, and perform any actions. Unfortunately, during any activity, one can get injured. It occurs as a result of falling, impact, twisting the leg, or other circumstances. People get injured in the gym, at work, and sometimes even at home in situations that do not predispose to injury at all.

To prevent muscle atrophy and "teach" them to work again, post-traumatic rehabilitation is required.

Rehabilitation after injury accelerates the recovery process, prevents the development of complications, and contributes to a faster return to normal life. Exercise bikes specially designed for training the upper and lower limbs after injuries are one of the effective methods of rehabilitation.

However, before talking about rehabilitation equipment and its varieties, it is important to understand what rehabilitation is and who may need such support.

Rehabilitation is the restoration or compensation of impaired body functions, and the following categories of people may need it:

- Athletes after injuries
- Elderly or weakened people
- People with weak muscle tone
- Those in need of improving joint mobility
- Those who have suffered a heart attack or stroke
- Those in need of improving the cardiovascular and respiratory systems



- People with limited mobility or partial paralysis (wheelchair users or bedridden)
- People with musculoskeletal system diseases.

Then, rehabilitation equipment (rehabilitation simulators) can be considered devices or devices that, through passive or active training, help fully or partially restore lost functions.

The first prototype of the modern exercise bike - "Gymnasticon" - was invented in 1796 by Francis Lowndes. However, at that time, the invention was not popular; its star hour only came in the next century.

A rehabilitation simulator is a special mechanical or electrical device for restoring the musculoskeletal system after injuries or surgeries.

Exercise bikes are singled out into a separate group because patients with different severity of injuries of the lower and upper limbs can exercise on them. The possibility of training in a sitting position allows people with limited abilities to perform exercises.

In addition, the use of an exercise bike improves the condition of the cardiovascular system, reduces the risk of thrombosis, the occurrence of heart attack, stroke, serves as a prevention of venous blood stasis, and improves microcirculation in tissues.

There are simulators with active or passive development of legs or arms. In the first case, the patient independently engages according to the set mode parameters, moving hands or legs on the pedals. In the case of passive muscle development of the limbs, the device itself moves the hands or legs.

With the correctly selected methodology of classes and dosed load, recovery after injury with such simulators occurs much faster. For maximum therapeutic effect, training can be supplemented with therapeutic physical culture - LFK, massage, and physiotherapy.

It is important to approach training rationally and increase the load gradually.

Thus, the use of therapeutic physical culture using simulators plays a significant role in the rehabilitation of sports injuries.

Modern active rehabilitation of athletes invariably includes specially designed workouts in the gym, exercises for joints, and myofascial correction with qualified specialists using advanced methods. The treatment focuses on the careful selection of personalized exercises and the development of corrective programs after a visual examination, aiming to correct pathological movement patterns. It is directed towards strengthening the muscular corset, which is a key element of the musculoskeletal system's support, improving the flexibility and elasticity of the spine, increasing the range of motion in the joints, and stimulating the cardiovascular system during gymnastic exercises.

Of course, not every piece of gym equipment is suitable for therapeutic and rehabilitation purposes. It is important that the movements performed on the machine precisely match the joint's range of motion. Some machines should be equipped with special limiting devices that help to start and finish the exercise, providing additional safety during training.

The technique used in rehabilitation machines is based on an integrated method of treating musculoskeletal injuries in athletes. One example of rehabilitation



equipment is a multifunctional trainer with a microcontroller, which allows for performing 500 diverse corrective exercises with variable vibration. This vibration helps to lower the threshold of muscle relaxation and eases the load on the spine, affecting most key points.

An anatomical backrest, following the contour of the spine's curvature, significantly reduces the load on the spine. Seat height adjustment provides comfortable placement for athletes of various heights, allowing them to technically correctly perform exercises for targeted training of the necessary muscle groups. A safety belt prevents back injuries and excessive tension in the lumbar region. The limitation mechanism sets the maximum movement amplitude and allows for exercises to be conducted for patients with injuries or diseases of the musculoskeletal system, suffering from reduced mobility. The locking mechanism allows patients in the rehabilitation phase to set the machine to an "easy start" mode, which enables starting the exercise from an intermediate phase of movement, bypassing the initial stage. A device for isometric strength testing provides accurate measurement of muscle strength, as well as analysis and, if necessary, correction of the rehabilitation plan.

A system based on the use of Smart Cards and software allows for monitoring rehabilitation and training processes, as well as analysis and, if necessary, correction of the training plan.

During the training process for athletes with injuries, a unique device - a movement limiter - is used. It allows setting the required range of motion and prevents movements that could be dangerous.

Thus, the use of gym equipment in therapeutic physical education plays a key role in the rehabilitation process after sports injuries.

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