Aksaray University
Journal of Sport and Health Researches
ASUJSHR
DOI: 10.54152/asujshr.1140907

Makale Türü	Başvuru Tarihi	Kabul Tarihi	Online Yayın Tarihi
Derleme Makalesi	06.07.2022	03.10.2022	29.12.2022

SPOR REHABİLİTASYONUNDA MOTOR ÖĞRENME

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Özet

Bir becerinin erken gelişimi sırasında hareketi oluşturmaya ilişkin bilişsel görüşler, bu becerinin işleyen bellekte bilinçli olarak erişilebilir durumda olduğunu varsaymaktadır. Bu da hareketin veya becerinin oluşumuna, geri alınmasına ve uygulanmasına büyük ölçüde bağlı olduğunu kabul eder. Beceri edinmenin bu erken bildirimsel aşaması sırasında hareket hazırlama ve kontrolün dikkat talepleri yüksektir, ancak öğrenen daha yetkin hale geldikçe, hareket uygulamasını destekleyen bildirimsel bilgi, aşamalı olarak zengin bir prosedürel temsile dönüşür. Bilinçli olarak yapılmasına gerek kalmaz ve çok daha az dikkat gerektirir. İnsanların çevreye tepki verme ve çevreye uyum sağlama şekillerinin çoğu, bu bilinçli farkındalık olmaksızın dolaylı olarak gerçekleşmektedir. Yine de, sporda motor beceriler ve günlük yaşam için gerekli olan herhangi bir sayıdaki öğrenilmiş beceriler, genellikle açık bir şekilde edinilir ve bu durum, bunların icrası sırasında bilinçten çok büyük katkılarla sonuçlanabilir. Mevcut yaklaşımlarda motor öğrenme önemli olsa da rehabilitasyon programlarında özellikle spor alanında göz ardı edilen konulardan biridir. Spor alanında karşımıza en çok çıkmakta olan yaralanmalardan biri de ön çapraz bağ (ÖÇB) yaralanmalarıdır. Bu yaralanmalar sonrasında motor beceri ve motor öğrenmedeki defisitler kişinin tekrar yaralanma öncesi durumuna dönmesini zorlaştırmaktadır. Bu çalışmanın amacı da spor rehabilitasyonunda ve özellikle ÖÇB yaralanmaları sonrası motor öğrenme, kortikal plastisite ve nöromüsküler eğitimin önemini incelemektir.

Anahtar Kelimeler: Motor öğrenme; spor; egzersiz; ÖÇB; rehabilitasyon

MOTOR LEARNING IN SPORT REHABILITATION

Abstract

Cognitive views on generating movement during the early development of a skill assume that the skill is consciously accessible in working memory. Acknowledging that this is highly dependent on the formation, retrieval, and application of the movement or skill. During this early declarative phase of skill acquisition, the attention demands of motion preparation and control are high, but as the learner becomes more proficient, the declarative information supporting motion practice gradually evolves into a rich procedural representation. It doesn't need to be done consciously and requires much less attention. Much of the way people respond to and adapt to the environment happens indirectly without this conscious awareness. Nevertheless, motor skills in sport and any number of learned skills necessary for daily life are often clearly acquired and this can result in enormous contributions from consciousness during their execution. Although motor learning is important in current approaches, it is one of the neglected subjects in rehabilitation programs, especially in the field of sports. One of the most common injuries in the field of sports is anterior cruciate ligament (ACL) injuries. After these injuries, deficits in motor skills and motor learning make it difficult for the person to return to their pre-injury state. The aim of this study is to examine the importance of motor learning, cortical plasticity and neuromuscular training in sports rehabilitation and especially after ACL injuries.

Key Words: Motor learning,; sport; exercise; ACL; rehabilitation

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INTRODUCTION

Motor learning is a comprehensive term that covers a wide range of phenomena, approaches, and disciplines. It is needed in any task-oriented movements with any effector and in movements made by almost every animal species. It has enormous practical importance for physiotherapists, musicians, dancers, athletes, pilots, sports coaches and animal trainers. Motor learning also has great theoretical and experimental interest for psychologists and neuroscientists (Krauker et al., 2019). The aim of this review is to examine the stages of motor learning, what affects motor learning, its importance in sports rehabilitation and especially in rehabilitation after anterior cruciate ligament injuries.

1.1.What is Motor Learning?

Motor learning is a process that requires skill in mobility and includes permanent changes that occur with experience or practice (Schmidt, 2005). Motor learning is also the result of input information processed by the human nervous system (central and peripheral) (Stuart et al., 2002). In other words, motor learning is the emergence of complex processes in the brain in response to the practice or experience of a particular skill that causes changes that allow the production of a new motor skill in the central nervous system (Bate et al., 2008).

1.2. Motor Learning Theories

Although there are different types of motor learning theories, this study focused on ecological theory, which is the most accepted theory. In this theory, Motor Learning is considered as the coordination between perception and action through the task and environmental constraints. Also, Newill (1991) is defined as the most appropriate matching of perception and action with the task. Clinically, Newill described the use of this theory as clinical implications: The patient learns to distinguish the relevant perceptual clues that are important for action (Newell et al., 1991).

1.3. Motor Learning Stages

In addition to “motor learning components” we can consider motor learning by dividing it into stages. The first stage is the cognitive phase in this stage movements are slow, inconsistent, inefficient, significant cognitive activity is required. The second stage is the associative phase in this stage movements are more fluid, reliable, effective, less cognitive activity is required. The last stage is called the autonomous phase in this stage movements are

accurate, consistent, efficient, little, or no cognitive activity is required (Keegan, 2016; Keegan 2016).

1.3.1. Factors Affecting Motor Learning

Age, race, culture, or genetic predisposition affect motor learning. Except those:

- Verbal instructions
- Practical features and versatility
- Fatigue
- Active participation and motivation
- Possibility of making mistakes
- Postural control
- Memory
- Feedback (Molina-Rueda et al., 2010; Greenwood et al., 2003; Cuerda et al., 2015).

1.4. Gender Differences and Motor Performance

The physical characteristics of boys and girls are similar before puberty. Therefore, biology seems to offer little explanation for pre-adolescent motor performance differences. However, girls enter puberty about 2 years before boys. Ultimately, this results in an earlier termination of long bone growth, causing girls to be shorter than boys on average. Also, during and after puberty, boys produce increased amounts of testosterone, which is closely related to increased muscle tissue. Thus, in any motor task where size and strength are an advantage, adolescent boys are thought to have a biological advantage in performance compared to adolescent girls (Thomas et al., 1985). However, Dalvand et al. stated in their study, no significant difference was found between fine and gross motor skills of both genders on male and female students (Dalvandm et al., 2008). In another study, besides providing a motor skills datasheet to children through the Bruininks-Oseretsky motor proficiency test, it was concluded that there is a direct relationship between age and motor skills, and that girls' performance is higher than boys in fine motor activities that require eye-hand coordination (Hassan., 2001).

1.5. Injuries In Sport

Considering the importance of early years for motor learning and performance development, it becomes clear that physical activity-related injuries are common in adolescents in leisure physical activity and school-based physical activity. Accordingly, participating in sports club

activities is becoming more and more popular among adolescents. Looking at the studies conducted in this area, the prevalence of injury is highest in sports clubs (28% for boys and 24% for girls), followed by leisure physical education (18% for boys and 13% for girls) and school sports (10% for boys). has been revealed. When physical activity and sports-related injuries in 0-12 year old children are examined, the highest injury incidence in sports (0.66 injuries/1000 hours participation), followed by physical education classes (0.50 injuries/1000 hours) and leisure time (0.39 injuries/1000 hours). has been reported. When we consider these injury prevalences, that deficits in motor learning and performance actually emerge from a young age. Also, knee region, which is important for biomechanics, performance and also one of the frequently seen injury areas in both adolescent and adult groups, is also frequently mentioned in injury and prevalence studies.

1.6. ACL Injury, ACL Reconstruction and Motor Learning

The best rehabilitation should not be undertaken solely to quickly reveal performance effects. One of the most important aspects is to achieve long-term learning by trying to ensure that skills are retained and transferred. It is important to use task-specific and task-oriented applications for the patient or athlete after an ACL injury. Besides, exercises should be stimulating and arduous for the patient. For example, rehabilitation should be included in the exercises on which he/she perform multiple activities with eyes open and eyes closed on the balance board or swisball (Hansel et al., 2002; Durham et al., 2009). Apart from ACL injuries that do not need surgery, reconstruction operations are also frequently encountered after ACL injuries. ACL reconstruction does not mean that the athlete has reached his/her knee proper function or reduced the risk of other injuries. Recent studies in this area showed that only half of patients expected to return to pre-injury level after ACLR (Ardern et al., 2014). Although strengthening and intensive training activities at many levels of sports, injuries occur and the re-injury of the athlete who returns to the field after the rehabilitation process brings up the inadequacy of the training and exercise programs and the need for re-evaluation of the programs (Lephart et al., 2015). The conventional rehabilitation process following any injury focuses on pain control, providing range of motion and flexibility, and restoration of muscle strength and endurance (Andrews et al., 2011). However, when these programs are shaped regardless of the role of neuromuscular mechanism and motor learning, they cause a great deficiency and error, return to safe function, and risk of re-injury (Sugimoto et al., 2015).

1.7. Attentional Focus and Neuromuscular Education

While most physiotherapists give instructions to the patient, they only make discourses about the region of body but instead, it has been observed that the instructions given by taking into consideration the presence of the outer environment that give us much significant result for effective and creative movements (Lohse et al., 2010; Gokeler et al., 2013). The main goal of neuromuscular training is to re-train the spinal, subcortical and cortical levels where motor control is achieved. It will be possible to get the best results in rehabilitation by knowing the basic mechanisms of neuromuscular control and motor learning including different exercises in the neuromuscular training program with different equipment and technological innovations will provide safe and effective returning after injury (Kaya, 2017). The bigger improvements of external instructions group about some parameters gives us clearer information about the role of motor learning in its interaction with the environment and its importance in rehabilitation (Table 1).

Table 1. Comparison of instructions with internal focus and external focus (Gokeler et al., 2013)

Aim: improve postural stability	Internal Focus	External Focus
Instructions	Try to keep your knee aligned over your second toe	Try to keep the bar horizontal
	Try to minimize of your feet	Try to minimize movement of the bars on the balance board
	Try to keep your balance by stabilizing your body	Try to keep your balance by stabilizing the platform

1.8. Clinical Motor Learning Practices and Exercise Examples

There is substantial evidence that the usefulness of the various explicit and implied instructions that should be followed in the various exercises will be great (Table 2).

Table 2. External and Internal Instructions For Exercises (Gokeler et al., 2013)

Task	Explicit Instructions	Implicit Instructions
Squat	Stand with your feet shoulder- width apart	Stance: Think about keeping a big ball between your knees
Running	Bend your knees while landing	Imagine you run like a feather Land softly Try to make as little noise as possible
Vertical Jump	Bend your knees before you jump Exposively extend hips, knees and ankles, and propel off balls of feet to jump straight up	Imagine you're landing on eggs and you don't want to crack them Push yoursel off the floor as hard as possible Pretend you are a rocket that launches

1.9. Motor Learning in ACL Injury and Clinical Implications

During rehabilitation, a program should be prepared that takes into account reaction time, visual inputs, challenging tasks and environmental interaction (Dingene et al., 2017). These elements are should considered while planning a rehabilitation program in returning phase of sport (Risberg et al., 2009). Rehabilitation programs mainly focus on pre-planned motor skills in a predictable environment (Nyland et al., 2016). Apart from these components, in the later phases of rehabilitation, it is important to create a program that prepares the athlete for physical, psychological and environmental stresses that she/he will face when returns (Neuhaus et al., 2019; Johansson et al., 2003).

2. Cortical Plasticity and Its importance for Rehabilitation

There is a direct relationship between cortical connections and functional performance. For cortical plasticity to occur, functional performance should be utilized and new connections and networks should be created (Risedal et al., 2002). In addition to this, it is known that environmental stimuli cause significant changes in neuronal structure and function depending on the genetic structure in the development of the brain (Classen et al., 1998). An enriched environment has been shown to provide more stimulation than normal in achieving neuroplastic changes and functional outcomes. Along with functional performance training, it

develops environmental re-education meaningful changes in cortical plasticity and motor learning (Kleim et al., 2008). However, these changes are not seen during the repetition of simple moves. Instead, the use of functional activities requiring motor skills, motor learning, changes the cortical map. Motor learning is defined as a process that requires skill in mobility and includes permanent changes that occur with experience or practice. According to motor learning theories, active participation of the person constitutes the basis of meaningful objectives in practice and abundant re-learning. Therefore, it is advantageous for us to consider this definition of motor learning in the exercises and practices we do after an injury (Classen et al., 1998).

2.1. Importance of Neuroplasticity Following ACL Injury

In a study conducted by Grooms et al. In 2015, The effect of visual input on ACL rehabilitation was examined. In addition, in this study, the contribution of the patient to the instructions that will activate the vestibular, visual and somatosensory system instead of internal commands was also examined. Exercises after anterior cruciate ligament are insufficient as they do not include the complex situations encountered by athletes in the field. This situation shows us that there is a need for increased visual stimulation rehabilitation after ACL ruptures. Therefore, including neuromuscular training and visual-motor stimuli and other technological gains in rehabilitation facilitates the athlete's return to sports by stimulating higher cortical levels and helps us reduce the rate of injury after returning to sports (Grooms et al., 2015) (Figure 2).

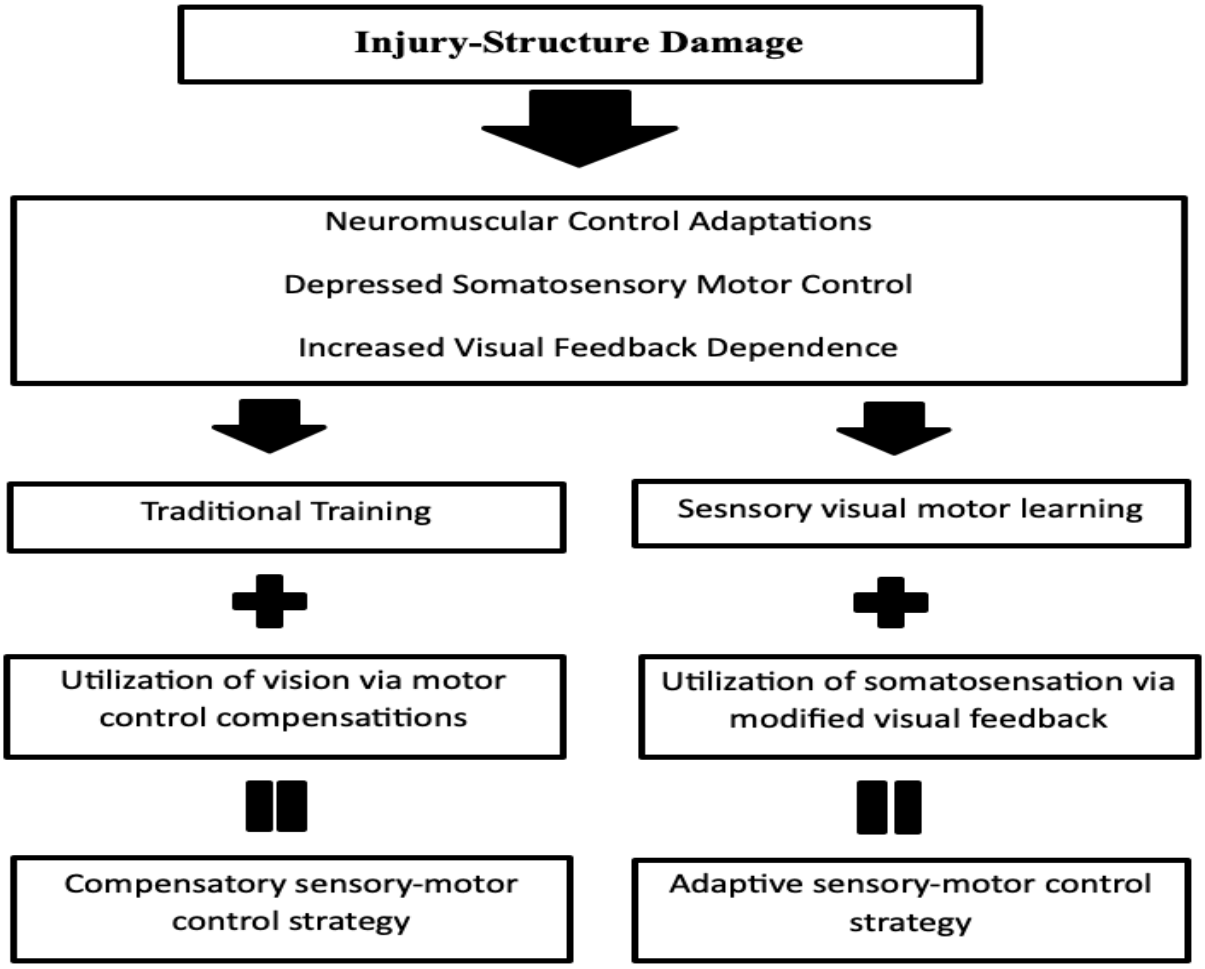

Figure 2. Conceptual Training Model (Grooms et al., 2015)

DISCUSSION and CONCLUSION

After ACL injuries, which is one of the most common injuries in the field of sports, motor learning, cortical plasticity and neuromuscular training and many other methods have been described in the literature. Our most important aim in this study is that developing motor skills and motor learning deficiencies should not be ignored and focused on is one of the most important issues. In addition, it will be the most special result of this review to draw attention to this issue by revealing how important even a small part of a comprehensive and deep subject is.

In a study by Effenberg et al., During the rowing movement, the effect of the audible stimulus according to the motion was examined besides the visual stimulus. As a result of this experimental study, the authors discussed that these auditory stimuli can be used in sports

rehabilitation to improve motor learning and adaptating patients for returning to sport besides walking exercises and Parkinson's Disease (Effenberg et al., 2016).

In a 2012 study by Di Tore P et al., They looked at the effect of exercising with video games for children on motor learning and motor control. As a result, preparing an exercise program based on DDR or Wii-based scientific guidelines has been described as a study that can contribute to children's motor learning and motor control development (Di Tore et al., 2012).

In a study conducted by Wulf G et al. On children in 2012, the commands given by the children considering the environment and the commands given only by considering the position of the hand were compared while throwing at a target. As a result, it was stated that the instructions given by external and considering enviromental effects have bigger improve for children motor learning while planning rehabilitation programs (Wulf et al., 2013).

In a study conducted by Sawers A et al. In 2012, the variables such as loss of limb, affected limb, time after injury should be taken into consideration before a program could be prepared in order to make motor learning more effective in rehabilitation (Sawers et al., 2012).

Meray J. Et al concluded that exercise provides the formation of silent synaptic revivals, making the information permanent by means of repeated motor and sensorial stimuli. Exercise and proper nutrition are required in order to save neurorestoration in favor of neurodegeneration, strong memory and new information in healthy brains as well as traumatic brain injury (Meray, 2018).

Currently, there is no consensus on which theory or model defines the way motor control is regulated. Motor learning theories should form the basis for motor rehabilitation. Well-designed studies have shown that transferring the basic gains of the individual in therapy after sports injuries to the contexts relevant to that individual, in addition to the incentives for variability, active participation, possibility of making mistakes, feedback and motivation, is very important to reduce functional deficiencies.Motor learning is a stage that must be included both in acquiring a new ability permanently and in rehabilitation phases after an injury. Therefore encouraging models such as external stimuli and visual stimuli that will stimulate the cortical levels of patients both sport rehabilitation and neurological rehabilitation. When this is the case, the use of new treatment methods and technologies that include these scopes in detail and the increase in research on these issues will yield better results.

Conflict of Interest: There is no conflict of interest in this study with any institution or person.

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