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Effect of Ankle Proprioceptive Training on Ankle Injury of Martial Arts Players

Sile Wang[1, 2*]

[1]*College of Physical Education, Anqing Normal University, Anqing 246000, China*
[2]*College of Graduate, Kyungnam University, Changwon 51767, Korea*
[*]*Corresponding Author*

Abstract: *The ankle joint is an important weighted joint of the human body, and it is very easy to sprain in daily sports and life. Furthermore, functional ankle instability can be easily caused by an acute sprain of the ankle, which increases the risk of re-spraining. In view of this, this article summarizes and analyzes the literature on rehabilitation treatment of functional ankle instability, and explores the effect of proprioceptive training of ankle joints on the prevention of ankle injury in martial arts. This article selects a university martial arts team as the research object, and randomly divides them into 5 male and female experimental groups and 5 control groups. The experimental group received ankle muscle strength training, and the control group received ankle muscle strength training and ankle proprioception training. The dynamic balance system was used to perform balance tests before and after training in all control groups and experimental groups. After training, it has a significant effect on the average direction control ability, forward and left direction control ability, the value after training significantly increases, and the P values are 0.017, 0.032, and 0.043, respectively. The experiments in this paper show that both ankle muscle strength training and ankle joint proprioceptive training combined with muscle strength training can improve the dynamic and static balance ability of martial arts players; moreover, the combination of the two training combined to improve the balance ability is more significant and can effectively prevent the ankle joint the appearance of damage.*

Keywords: *martial arts, proprioceptive training, ankle joint, injury prevention, ankle proprioceptive training*

1. Introduction

Ankle sprains are the most common injuries in daily life, military training, and sports. Relevant data shows that more than 50% of injuries in sports occur in the lower limbs, and ankle sprains are the most common injuries in all sports, accounting for 15% of all sports injuries. The acute symptoms of ankle sprains are pain and local swelling and subcutaneous ecchymosis, which can cause the affected lower limbs to lose weight for a short period of time; the sequelae of repeated ankle sprains include pain, weakness, instability, and loss of control. The players need to engage in a lot more exercise than ordinary people, and most of the skill movements rely on the strength of the lower limbs. Because of the pathological characteristics of functional ankle instability, it greatly affects the life, study and work status of physical life.

The antagonism of martial arts is very strong, especially the ankle joint. Among all sports injuries, ankle joint injuries account for 14% -17%, and 85% of ankle joint injuries are caused by ankle varus. Many studies at home and abroad have shown that ankle joint injuries are very common in sports that change direction, stop, and turn similar to martial arts. A 9-year audience of more than 400,000 people the follow-up investigation shows that the chance of injury to the ankle joint is about 3.495%, and it can be seen that even in ordinary people, the chance of injury is very large. When ankle joints are damaged by ligaments or other soft tissues, such as tendons, the proprioceptors located in the joints and in the ligaments and tendons will also be damaged, resulting in abnormal sensory input. This is likely to cause ankle injuries again, and after sprains There is a high possibility that the ankle joint will be damaged again within one year. A study abroad shows that in patients with only one ankle injury, about 73% will sprain again[1]. The main reason can be attributed to the decrease in proprioceptive input of the ankle ligament or muscle tendon after injury, which affects the proprioceptive control of the joint, leading to a greatly increased possibility of re-injury. And for amateur players, it also makes them unable to enjoy the fun brought by martial arts. This study uses ankle proprioceptive training to prevent

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ankle injury in martial arts players, observe its clinical effect, and further explore the possible mechanism of ankle proprioceptive training for functional ankle instability in sports students.

2.Proposed method

2.1 Proprioception

(1) Definition of proprioception

Proprioceptors exist only in muscles and tendons, and external receptors exist in the skin. This concept is still used today. There are three main ways for the body to propagate proprioception: the proprioceptive input of joints, the input of vestibular organs, and the visual input.

In order to maintain the balance of the body when the external environment changes, the proprioceptive fibers in the body transmit sensory information when receiving stimulation. As an incoming component in the sensory-motor system, it controls the static state of a part of the limb or the posture of the whole body during the movement of the body, and dynamic stability feedback. Proprioception is provided by tissues in the deep muscles, tendons, and joints of the body. Its function is to sense the spatial sensation of the limb, the direction of movement, and the posture of the body. The proprioceptive input information has a very important effect on the brain's control of the body.

(2) Proprioceptive receptors

Important components of the sensorimotor system include proprioception and neuromuscular control. Proprioceptive input mainly relies on the muscles (muscle spindles and Golgi apparatus) and the mechanoreceptors of the joints to collect and provide proprioception to the joints. Muscle shuttles are very sensitive to stretch (reflex reflex). Most muscle shuttles are located in the limbs. In the muscle; the Golgi is located in the tendon and is sensitive to muscle strength responses. The mechanoreceptors of the joint include the Pansini body, the Rouffini body (also known as the ring body), and the free nerve ends scattered in the joint [2]. The Rouffini body is present in the joint capsule and ligaments. The main sense is the pressure of the joints. Pansini bodies are present in the joint capsule, mainly the joint pressure and vibration sense, and the free unmyelinated nerve endings are present in the ligaments and related muscles, mainly the pain[3]. Neuromuscular control is an unconscious outgoing response to incoming information about dynamic joint stabilization.

(3) The effect of proprioception on the ankle joint

The ankle joint is an important proprioceptive organ in the body. It provides the brain with a large amount of input of proprioceptive information. When a person walks on uneven ground, the proprioceptive input information will be adjusted by the central nervous system so that the human body will adapt to the ground environment, such as changing the pace of the person. The introduction of vision is also a more important aspect, but the proprioception of the joint is more indispensable because its transmission is fast and accurate.

The ankle joint participates in the integration of feedback information through proprioceptive input. The ankle joint, as a proprioceptive organ, can provide the necessary proprioceptive information to the high-level center. At the same time, the ankle joint will receive the information of the high-level center and respond to the corresponding environment and situation. Studies have shown that if the ligament of the joint is torn, it will not only affect the input of the proprioception of the joint, but more importantly, it will affect the signal that is passed to the central nervous system. These factors may lead to the early occurrence of joint degeneration and cause dynamic instability, balance and coordination of the joint. Clinical studies have found that the ability to stand on one leg will be affected after ankle injury. If ankle injury and ligament tear are not considered, the lack of proprioception of the ankle joint will also lead to joint instability and joint degradation [4]. Even if no direct injury occurs, the lack of proprioception will lead to joint damage. In real life, often the damage directly leads to the loss of proprioception, which accelerates the risk of joint degradation. To maintain normal training and competition, athletes must maintain the normal proprioception of the joints, otherwise it will lead to a decline in competition, training level and shortened career.

(4) Injury of proprioception and ankle

Ankle injuries and proprioception of the ankle joint affect each other: proprioception decreases, the risk of joint injury increases, and joint injury can also lead to proprioceptive obstacles. Ankle instability can be expressed in many types. Postural sway, reduced joint position, reduced joint strength and range

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of motion, decreased nerve reflex rate, and delayed the response time of the fibula muscle group (PRT) in people with ankle injuries). The prolonged response time to the fibula muscle group may be caused by a decrease in proprioception due to injury and a blockade of the afferent joint nerve. The reason may be that the afferent nerve disorder of the joint will change the reflex process in some sudden movements. This may be an important cause of joint instability. Initially, nerve block was just a hypothesis, but after a lot of research, it turned out that ankle joint sprains do lead to joint block. Some people have studied the peroneal nerve block in ankle instability and confirmed this hypothesis experimentally. The electromyogram (EMG) was used to test the reaction time of the fibula muscle group of those with ankle instability, and it was found that the reaction time of the fibula muscle group of people with ankle instability was significantly delayed compared to healthy people. However, the results of some studies have denied this view. Some people tested the reaction time of the fibula muscle in patients with unilateral ankle instability, and compared the ankle joint on the healthy side, and found that there is no significant difference between the two. Some people tested the response time of the fibula muscle of the ankle injured by different planes and compared it with the response time of the fibula muscle of the non-ankle injured. The conclusions do not support this view.

Some people compared the ankle joints of patients with unstable ankle joints with normal ankle joints. As a result, no gap was found within one year of tracking. Because the testing methods and experimental procedures are different, and lack the same type of standards, it is normal to have different conclusions. Some researchers have focused on the ankle joint during walking. They have designed a device that can suddenly apply a varus force to the ankle joint during walking to simulate a twisted foot in normal walking.

During the process, the fibula muscle group will respond quickly. The more severe the ankle sprain, the lower the ankle joint proprioceptive function. Some people use one-leg standing experiments to check athletes who have suffered ankle injuries and found that subjects who have suffered ankle injuries have weaker motor and proprioceptive abilities. It can be seen that the loss of ankle proprioception and the degree of injury are closely related.

Preventive training helps to improve the ankle joint's ability to prevent sprains. Some people conducted a season-long investigation on the correlation between proprioception of ankle joints and ankle injuries in volleyball players, and found that proprioception can be used as one of the criteria for predicting ankle injuries. Some studies have also shown that proprioceptive training as a protective measure can effectively reduce the risk of ankle injury by improving the proprioceptive level of the joint [5]. Some people tracked all the matches of a college basketball league season, and found that professional basketball players with poor ankle joint stability have a 7 times greater probability of ankle injury than normal basketball players with good ankle joint stability. Ankle proprioceptive training has a significant effect on reducing multiple repeated ankle injuries. The stability of the ankle joint is needed by the body. Both orthopaedic experts and sports medicine experts have emphasized the importance of proprioceptive input and neuromuscular control in the rehabilitation of ankle joints. They also believe that they can help improve dynamics. Joint stability. The key to successful ankle rehabilitation is to choose the correct rehabilitation training method for the patient to achieve normal proprioceptive input.

2.2 Ankle joint

Ankle joint: also known as the talar joint, also known as the talar joint. It is one of the very important joints of the body. The main role of the joint is to bear the weight of the body. It is also a key part of the body and the ground contacting each other. It participates in the important actions of the human body such as standing, walking, jumping, and running [6]. The ankle joint is a very complex joint consisting of the tibia, the distal end of the fibula, and the talus. The saddle-shaped articular surface above the talus has cartilage, which can maintain the normal movement of the joint. Among injuries due to exercise, ankle injuries are the most common. The lateral malleolus is slightly narrower than the medial malleolus, but the lateral malleolus is slightly longer than the medial malleolus by about 1 cm and about 1 cm later relative to the medial malleolus. The body completes standing, walking, running, jumping and even more complex movements. This has a very important relationship with the bone, ligament, muscle strength of the ankle joint and the proprioceptive function of the ankle joint. Subtalar joint: It is composed of the calcaneus and the talus, also known as the calcaneus. It is the interface of the calcaneus to bear weight and plays an important role in the stability of the entire ankle joint. The definition of the ankle joint does not include the subtalar joint, but it has a great role in the movement of the ankle. The subtalar joint is mainly responsible for the movement of the ankle varus, and injuries such as twisted feet often hurt the subtalar joint. After restricting the movement of the

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subtalar joint, the flexibility of the entire ankle will be greatly restricted.

The ankle and subtalar joints are important hubs for calf and foot movements. Common twisted feet and injuries can affect these two joints. After the first ankle sprain, patients often do not get the correct rehabilitation advice and training guidance, so that sprains occur again, leading to severe joint instability, even chronic arthritis, and even surgical treatment.

The distal tibia, distal fibula, and talus are bony structures that make up the ankle joint. The joint is surrounded by joint capsules, the medial and lateral ligaments are attached and reinforced, and the medial ligament is also known as the triangular ligament. The triangular ligament starts at the tip of the distal tibia and is fan-shaped downward [7]. It stops at the sacrum of the foot. The triangular ligament is relatively tough. There are three ligaments on the outside of the ankle joint, anterior to the peroneal ligament in the front, a heel and peroneal ligament in the middle, and a posterior peroneal ligament in the rear. All three ligaments are more likely to be damaged than the triangular ligaments. Ankle sprains are mostly caused by the joints turning inward, which can cause damage to the lateral ligaments. The medial malleolus is composed of the distal tibia and talus. The fibula body has a triangular prism shape. The distal fibula forms the lateral malleolus with the talus and the calcaneus. The tip of the medial malleolus is about 1 cm higher than the lateral malleolus and about 1 cm forward.

The front end of the joint is closer to the inside. The subtalar joint is supported by numerous ligaments, which are mainly divided into deep ligaments, peripheral ligaments, and supporting ligaments. Deep ligaments include cervical ligaments and interosseous ligaments. There are mainly three bundles of internal, external and internal ligaments. Peripheral ligaments mainly include the calcaneal ligament, the subtalar ligament, and the anterior talar ligament. The main function of these ligaments is to limit the movement of the joint beyond the normal range to ensure the stability of the subtalar joint. Injuries with the fibular ligament when the foot is twisted in the foot are also common.

Ankle proprioceptive afferent disorders are often caused by ankle joint sports injuries, etc., and the control of nerves and muscles is weakened, leading to poor stability of the ankle joint. The premise of returning to the playing field is to restore the neuromuscular control of the ankle joint to the greatest extent, and to rebuild the good stability of the ankle joint. So far, the research on ankle joint injuries at home and abroad has mainly focused on how to increase the non-static stability of the ankle joint.

This can not only prevent joint problems from occurring again, but can also be used as a main reference index for rehabilitation effects. Modern research shows that the ankle joint proprioceptiveness directly affects whether the ankle joint is easily damaged[8]. Therefore, the research on proprioception in rehabilitation has developed into a hot topic at home and abroad. There are many muscles related to the ankle that basically start from the calf and stop at the foot. Each muscle has its own function. The muscles on the front side of the calf are mainly responsible for ankle dorsiflexion, and the muscles on the back side of the calf make the foot. Plantar flexion, the muscles on the outside of the calf make the ankle valgus. The main muscles and their functions are as follows:

Tibia anterior muscle: It starts on 1/2 of the external side of the tibia, and ends at the medial side of the medial wedge and the base of the first metatarsal bone. Its main function is to make the foot do dorsiflexion and varus.

Toe long extensor: It starts at the upper end of the tibia and fibula on the outside of the tibialis anterior muscle and ends at the base of the mid and far phalanges of the second to fifth toes. Some people have a third fibula. Main function is to stretch two to four toes and dorsiflexed ankle.

Metatarsal extensor: The fibula and interosseous membrane, which starts between the tibialis anterior muscle and the toe long extensor, ends at the base of the metatarsophalangeal distal phalanx. The main function is to extend the metatarsophalangeal and dorsiflexed ankle joint.

Calf triceps: The sole is the soleus muscle, and the superficial layer is the gastrocnemius muscle. The soleus muscle starts at the upper back of the tibia and fibula, the medial head of the gastrocnemius starts behind the medial condyle of the femur, and the lateral head starts at the back of the lateral femoral condyle. The two muscles merge into the Achilles tendon and stop at the calcaneal tubercle. The main function is to make the ankle joint plantar flexion.

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3. Experiments

3.1 Research object

A total of 10 2019 martial arts players from a certain sports college were randomly selected, all of whom were men for experimental test explanation and training. Stability tests were performed on the left and right sides of 10 subjects, and the test results were recorded and analyzed for differences. Subjects must meet the following two conditions to perform their stability test: (1) no strenuous exercise in the past 24 hours; (2) physical health during the experiment, no neurological and muscular disorders, and no visual and vestibular dysfunction. The general information of 10 healthy subjects is shown in Table 1.

Table 1. General information of the subjects

	Age	Height(cm)	Weight(kg)
Subject	21.29±1.67	175.61±5.24	72.09±6.75

3.2 Experimental design

(1) Experiment time and place

October 15, 2019, a sports medical laboratory.

(2) Limb stability test and data collection

The lower limb stability test is performed by using the center-of-gravity trajectory tester. The test steps and methods are as follows:

1) Before the test, arrange the subject to be familiar with the lower limb stability test system and test environment, and to be proficient in the test method.

2) The subject stands barefoot on the center of the center of gravity movement trajectory tester, with both hands naturally placed on both sides of the body, maintaining the body balance for 30 seconds.

3) Record the data of the test system.

4) Repeat the measurement three times with a time interval of 5 min.

Collect the test data of the center-of-gravity trajectory tester, including the swing frequency, the coordination coefficient, and the stability coefficient, and take the best results of three tests. The smaller the swing frequency and the coordination coefficient value are within a certain range, the better the stability; the larger the stability coefficient value is within a certain range, the better the stability.

3.3 Data statistics and processing

The test data were expressed as mean ± standard deviation, and statistical analysis was performed on the test data using PASW Statistics 24.0 software and paired sample T test. $P < 0.05$ was used as the standard with significant difference.

4. Discussion

4.1 Stability differences between left and right sides of martial arts players

Test the stability of the left and right sides of the center of gravity of 10 healthy players, and compare and analyze the test results. As shown in Table 2 and Figure 1, the left swing frequency is lower than the right, the coordination coefficient is lower than the coefficient of stability is greater than the right side, and the data of each index are significantly different ($P < 0.05$).

Table 2. Comparison of test results of left and right center-of-gravity trajectories

	Swing frequency(HZ)	Coordination factor(%)	Coefficient of Stability(%)
Left	2.18±0.10	42.50±10.93	78.70±5.93
Right	2.25±0.13	48.90±9.43	74.90±6.15
T	-4.583	-3.807	4.835
P	0.001	0.004	0.001

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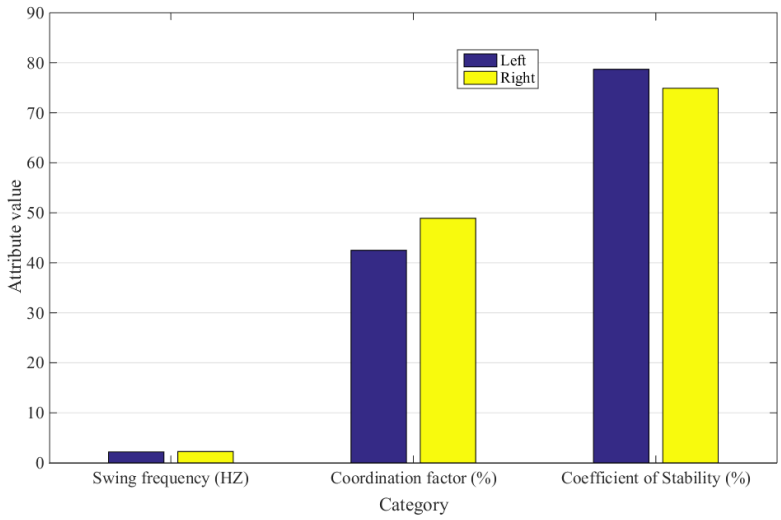

Figure 1. Comparison of test results of left and right center-of-gravity trajectories

There is a significant difference in the stability of the left and right sides of martial arts players, suggesting that the left side of martial arts players is more stable than the right side. The dominant hemisphere of most human brains is the left brain. The dominance of the left brain over the right limbs is dominant. The lower limbs are characterized by right feet and the right foot is the active foot when walking. Especially in sports, there is a distinction between dominant and non-dominant feet. Most players take the right foot as the dominant foot, so the muscle strength of the right foot is greater than that of the left foot. When the human body stands on one foot, the other foot controls the body's center of gravity. In the process of sports, the left foot is the supporting foot and the right foot controls the direction, so the stability on the left is greater than the stability on the right, but the specific mechanism has yet to be verified. As far as martial arts players are concerned, the instrument measures the relevant data of the stability of the left and right lower limbs through instruments to observe whether there is a difference and make a preliminary judgment.

4.2 Comparison of the stability between the affected side and the healthy side of functional ankle instability of martial arts players

As shown in Table 3 and Figure 2, the swing frequency of the affected side is greater than the healthy side, the coordination coefficient is greater than the healthy side, and the stability coefficient is less than the healthy side. There is a significant difference in each index data ($P < 0.05$). There is a significant difference in the balance and stability of the functional ankle joint between the players and the healthy side, suggesting that the stability of the sports student's healthy side is better than that of the affected side. Stability refers to the body's ability to control the center of gravity of the body, and is also a manifestation of the ability to balance. The balance is derived from the vestibule, proprioception, and vision. The vestibule is responsible for sensing the head and external information, and transmitting this information to the nerve center. The nerve center sends instructions to the relevant motor organs to control the body balance. The typical symptom of functional ankle instability is that the patient feels instability, especially when running on uneven ground, and when feeling ankle instability when going up and down stairs, indicating that the ankle on the affected side has poor stability. Proprioceptive dysfunction and lack of muscle strength are important factors that cause functional ankle instability. Proprioceptive sensation and muscle strength are important conditions for the body to maintain body balance. Therefore, this article considers that players have functional ankle instability with proprioceptive disorder decreased strength and muscle strength are the possible mechanisms leading to the difference in stability between the affected side and the healthy foot.

Table 3. Comparison of test results of unstable center and healthy center of gravity trajectory

	Swing frequency(HZ)	Coordination factor(%)	Coefficient of Stability(%)
Affected side	2.81±0.03	217.37±24.06	18.77±6.11
Healthy side	2.65±0.11	100.87±33.34	48.20±10.41
T	8.251	42.564	-30.292
P	0.000	0.000	0.000

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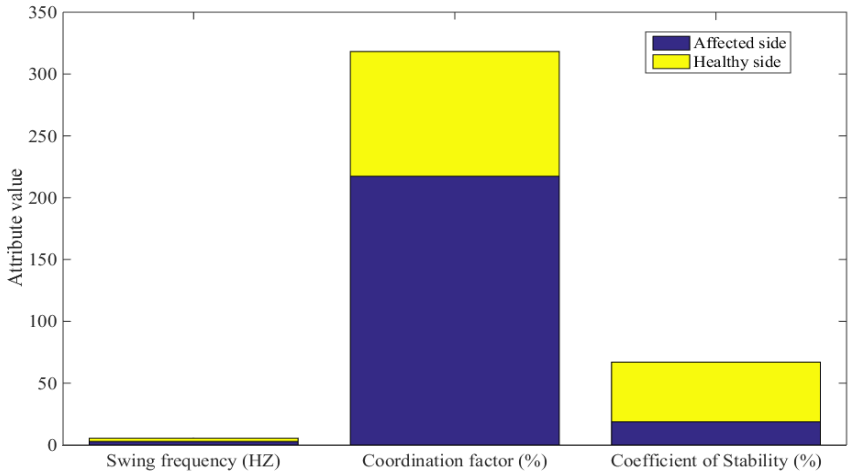

Figure 2. Analysis of the test results of the trajectory of the center of gravity of the unstable and healthy sides

5. Conclusion

There is no significant difference in the balancing ability of male and female martial arts players. Ankle proprioception training exercises have a significant effect on improving the proprioception of injured ankle joints, and they do not require the use of task equipment. They are simple, easy to implement, and easy to promote and use incidence can also be promoted in the general population to prevent lateral ligament injury of the ankle joint.

The stability of martial arts players from front to back is not as good as left and right. The control ability in the forward direction is worse than in the backward direction. The left and right ankles are surrounded by ligaments. The stability in the left and right directions is better. There are many actions to stop and turn sharply, so there is still a lot of damage. The poor stability of the anterior and posterior joints is likely to cause strain on the ankle joint and talus, and injuries such as martial arts ankles are limited. The research in this article is limited. How to prevent other injuries can be studied in the future.

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References

[1] Matthew G. Huddle, Jennifer A. Deal, Bonnielin Swenor, Dane J. Genther, & Frank R. Lin. (2016). "Association Between Dual Sensory Impairment, Hospitalization, and Burden of Disease", Journal of the American Geriatrics Society, 64(8), pp.1735.

[2] Amy Freeman-Sanderson, Leanne Togher, Mark Elkins, & Paul Phipps. (2016). "An Intervention to Allow Early Speech in Ventilated Tracheostomy Patients in an Australian Intensive Care Unit (Icu): a Randomised Controlled Trial", Australian Critical Care, 29(2), pp.114.

[3] Jakob Kostenbauer, & Hannah Kempton. (2016). "Pseudoathetosis and Ataxia - a Rare Presentation of Multibacillary Leprosy in a Non-Endemic Area", Leprosy Review, 87(2), pp.243-245.

[4] Cho, NMY, Giorgi, HP, Liu, KPY, Bae, YH, Chung, LMY, & Kaewkaen, K. (2017). "Proprioception and Flexibility Profiles of Elite Synchronized Swimmers", Percept Mot Skills, 96(7), pp.31512517724965.

[5] Erdal Hanci, Ufuk Sekir, Hakan Gur, & Bedrettin Akova. (2016). "Eccentric Training Improves Ankle Evertor and Dorsiflexor Strength and Proprioception in Functionally Unstable Ankles", American Journal of Physical Medicine & Rehabilitation, 95(6), pp.1.

[6] Ha, S. Y., Han, J. H., & Sung, Y. H. (2018). "Effects of Ankle Strengthening Exercise Program on an Unstable Supporting Surface on Proprioception and Balance in Adults With Functional Ankle

ISSN 2618-1576 Vol. 3, Issue 2: 48-55, DOI: 10.25236/FSR.2021.030211

Instability", Journal of Exercise Rehabilitation, 14(2), pp.301-305.
[7] Zhi Long, Renwei Wang, Jia Han, Gordon Waddington, & Judith Anson. (2016). "Optimizing Ankle Performance When Taped: Effects of Kinesiology and Athletic Taping on Proprioception in Full Weight-Bearing Stance", Journal of Science & Medicine in Sport, 20(3), pp.236-240.
[8] Lucette Toussaint, Aurore Meugnot, Arnaud Badets, David Chesnet, & Luc Proteau. (2016). "The Specificity of Practice Hypothesis in Goal-Directed Movements: Visual Dominance or Proprioception Neglect?", Psychological Research, 81(2), pp.407-414.