The Effect of Therapeutic Exercises Using Aqua Noodles in Ankle Joint Rehabilitation for Female Athletes with Tibia Fracture in Various Team Sports Activities

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Abstract

The research problem revolves around the frequent occurrence of leg bone fractures in team sports. The researcher observed that many school team players involved in football, handball, basketball, track and field, and volleyball suffer from tibial fractures. This often leads to complications such as the inability to move the ankle joint or restricted movement. The research objectives were twofold: to develop therapeutic exercises using Aqua Noodle in a water environment for the rehabilitation of the ankle joint in women with tibial fractures, and to assess the effectiveness of these exercises. The hypothesis proposed that there would be statistically significant improvements in muscle strength and range of motion of the ankle joint between pre- and post-tests in women with tibial fractures. The research sample included female school team players aged 14-16 years. A total of 18 injured individuals were intentionally selected, with 3 excluded for the exploratory experiment, resulting in 15 participants for the main experiment. The collected raw data was processed, analyzed, and discussed. The researcher concluded that therapeutic exercises using Aqua Noodle had a positive effect on the sample. Several recommendations were made, including the importance of using therapeutic exercises and Aqua Noodle in a water environment for various injuries and across different age groups for both men and women.

Key words: Therapeutic exercises- The Aqua Noodles- ankle joint rehabilitation- tibia fracture

تأثير التمرينات العلاجية باستخدامThe Aqua Noodles في تأهيل مفصل الكاحل للاعبات المصابات بكسر عظم الساق في الفعاليات الرياضية الجماعية المختلفة

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الملخص

تتلخص مشكلة البحث باصابة كسر عظم الساق والتي تحدث كثيراً في الالعاب الفرقية. اذ لاحظت الباحثة ان الكثير من لاعبات الفرق المدرسية اللواتي يلعبن خماسي كرة القدم وكرة اليد وكرة السلة كرة الطائرة يصابن بكسر عظم الساق والتي تؤدي الى مضاعفات منها عدم قدرة المصابة على تحريك مفصل الكاحل أو ان الحركة تكون مقيدة. اما اهداف البحث فكانت : اعداد تمرينات علاجية بأستخدام the Aqua Noodle داخل الوسط المائي لتأهيل مفصل الكاحل للمصابات بكسر عظم الساق في الالعاب الفرقية. والتعرف على تأثير التمرينات المعدة في تأهيل مفصل الكاحل. اما فرضية البحث فكانت: وجد فروق ذات دلالة احصائية بين الاختبارات القبلية والبعدية في تحسين القوة العضلية والمدى الحركي لمفصل الكاحل

للمصابات بكسر عظم الساق. وتكونت عينة البحث من لاعبات الفرق المدرسية والتي تتراوح اعمارهن بين (14-16) سنة. وكان عددهن (18) مصابة تم اختيارهم بالطريقة العمدية، وتم استبعاد (3) للتجربة الاستطلاعية، فيما تكونت عينة التجربة الرئيسة من (15) مصابة، وتمت معالجة البيانات الخام التي تم الحصول عليها وتحليلها ومناقشتها، وقد توصلت الباحثة لعدة استنتاجات منها ان التمرينات العلاجية والاكو نودلز اثرت ايجابياً على العينة، كما تم التوصل الى عدة توصيات منها: ضرورة استخدام التمرينات العلاجية والاكوا نودلز داخل الوسط المائي لأصابات اخرى وعينات اخرى بأعمار مختلفة للرجال والنساء.
الكلمات المفتاحية : التمرينات العلاجية - The Aqua Noodles - تأهيل مفصل الكاحل – كسر عظم الساق

1. Introduction and the importance of the research.

Injuries are significant obstacles that prevent athletes from continuing to perform physical activities normally, with leg fractures being among the most common injuries. These fractures often result from player collisions, being struck by a competitor, or falling during performance.

Countries like the United States, Germany, Switzerland, France, and Spain have recognized the benefits of Aqua Noodle in recreational activities, therapeutic and rehabilitation programs, and training for various age groups. Aqua Noodle is also known by other names, including Noodle Aqua, Pool-Noodle, Aqualog, and AquaBall (Tomihiro, Noriko: 11, 2009).

Physiotherapy is a critical medical procedure used after diagnosing injuries and performing fracture surgeries. It helps prevent muscle atrophy, maintain joint flexibility, prevent stiffness, and avoid complications from injuries. Additionally, it aims to restore and maintain the normal movement and functions of the affected limbs, ultimately rehabilitating the injured to return to their normal condition. The types of physical therapy vary depending on the injury's nature, location, and medical treatment approach. Therefore, it is essential to select appropriate therapeutic exercises and assistive methods tailored to the specific type of injury.

Therapeutic exercises are among the most effective means of rehabilitating injured individuals, as they accelerate bone healing. These exercises also help drain blood pools, prevent internal bleeding in the joint, and ultimately restore muscles and joints to their functional positions (Rushdie, 15, 1984).

For athletes with a simple leg bone fracture, rehabilitation is essential to expedite their recovery and enable them to return to normal activities and play as before the injury. One innovative method for achieving this is through therapeutic exercises using Aqua Noodle in a water environment. This approach represents a new scientific method for injury rehabilitation, utilized immediately after the fracture healing process is complete. Unlike traditional rehabilitation methods that rely on specific medical devices, this technique leverages the properties of water to enhance the recovery process.

The physical properties of water, such as density, viscosity, and hydrostatic pressure, significantly influence various factors during water exercise therapy. These factors include body position, the degree and level of difficulty, and the nature of movement resistance due to water's density and viscosity. Additionally, physiological changes occur as a result of immersion in water. In essence, the resistance encountered by a body moving in water necessitates a certain effort to overcome, which is roughly equivalent to the effort required to counteract Earth's gravity on land (Sardah, Abba Eid, 2013, 25-26).

The Aqua Noodle

Aqua Noodle pool toys are simple yet effective tools that can enhance your hydrotherapy sessions. By providing increased resistance and flexibility, these noodles allow users to perform a variety of water exercises aimed at building muscle strength and cardiovascular fitness. Made from flexible, buoyant polyethylene foam, pool noodles come cylindrical and are used by individuals of all ages for swimming activities (https://en.wikipedia.org).

Broken leg bone

A leg injury can occur due to various causes such as a direct impact, a fall, or sudden movements like turning quickly. This type of injury may also be accompanied by a dislocation of the heel joint. In team sports such as football, handball, and basketball, as well as in activities like jumping, gymnastics, and diving, fractures of the shin bone are relatively common. The leg consists of two main bones: the tibia and the fibula. The tibia, which is the larger and stronger of the two, is situated in the front and inner side of the leg, while the fibula is longer but more delicate, positioned on the outer side. These bones articulate with each other via a synovial joint at the upper end and a fibrous joint at the lower back. The upper end of the tibia connects to the thigh through the knee joint, while the lower end forms a concavity that supports the tarsal bones, forming the ankle joint. Injuries to the leg bone often cause pain during ankle joint movement. Following a fracture, the leg might be treated with surgery or a cast, and physical therapy is typically required for rehabilitation. Certain leg muscles are responsible for the extension and flexion of the ankle joint (Francis et al., 117, 2013).

Ankle joint:

The ankle joint is a robust synovial joint supported by strong fibrous ligaments and tendons that stabilize and protect it. The stability of the joint is further enhanced by the interlocking arrangement of the bones. The joint is formed by the articulation of the tibia and fibula with the talus bone at the ankle. The tibia's articular surface is concave, providing a secure fit for the talus bone, which increases the stability of the joint. The ankle joint operates around a single transverse axis and thus allows for two primary movements: dorsiflexion and plantarflexion (Watat, 2012, 20).

The importance of research is evident through therapeutic exercises and auxiliary means within the aquatic environment, to accelerate the injured person's return to his activity after his injury has completely and naturally healed and to get rid of collateral damage.

1.1 Research problem

The leg is particularly susceptible to injuries in sports, with fractures of the shin bone being a common issue in team sports. Observations reveal that many school athletes involved in football, handball, basketball, and even volleyball frequently suffer from such fractures, which can lead to complications such as restricted ankle joint movement or prolonged immobility following treatment. This issue is often exacerbated by the lack of consistent training sessions. Consequently, the researcher aims to explore this problem and identify effective solutions. The focus is on using Aqua Noodle therapeutic exercises in a water environment to enhance joint flexibility and muscle strength, which can help restore normal joint movement. This method was chosen because it is accessible to female athletes who may not be proficient swimmers, offering an effective and manageable approach to rehabilitation.

1.3 Research objectives:

1.3.1 Preparing therapeutic exercises using the Aqua Noodle in water to rehabilitate the ankle joint for women with a broken leg bone in various team events.

1.3.2 To assess the effectiveness of these Aqua Noodle therapeutic exercises in the aquatic environment on the rehabilitation of the ankle joint for women with a fractured tibia from various team sports.

1.4 Research hypotheses:

1.4.1 There are statistically significant differences between the pre-and post-tests of the research sample and in favor of the post-tests in the muscular strength of the ankle joint for women with a broken tibia in various group events.

1.4.2 There are statistically significant differences between the pre-and post-tests of the research sample, and in favor of the post-tests, in the range of motion of the ankle joint for women with a broken tibia in various group activities.

1.5 Research Fields.

1.5.1 Human domain: School team players with bone fractures.

1.5.2 Spatial domain: Educational swimming pool.

1.5.3 The time domain: - from (1/4/2023) until (1/9/2023).

2- Research methodology and field procedures:

2-1 Research methodology.

To address the research problem effectively, the researcher selected the most suitable method from a range of scientific research methodologies. Given the nature of the research problem, the experimental method was chosen as it allows

for controlled testing and precise measurement of outcomes to achieve accurate results.

2-2 Research Sample.

The research sample was intentionally selected from female players of school teams in the Rusafa district of Baghdad Governorate. The participants, aged between 14 and 16 years during the 2022-2023 season, had sustained a leg bone fracture. Initially, there were 18 participants; however, 3 were excluded because they had taken part in the preliminary experiments. Thus, the main experiment was conducted with a final sample of 15 participants.

2-3 Sample Homogeneity:

The researcher homogenized the research sample in terms of the variables weight, height, age, and training age. The results confirmed that the sample was homogeneous.

Table (1)

weight, height, age, and training age

Variables	measuring unit	Median	Mean	standard deviations	Skewness
Weight	Kg	62.000	62.133	2.416	0.592
Height	Cm	160.000	161.000	2.028	0.552
Age	Year	15	14.533	1.060	0.100
Training age	Year	4	3.600	0.632	0.547

2.4 Measurements and Tests for Research

• Ankle Joint Range of Motion Test: This test measures the angle of the ankle joint in various directions to assess its range of motion.

• Strength Test: This test evaluates the lateral and medial flexion strength of the foot to determine the muscle strength around the ankle joint.

2.5 The two exploratory experiments:

The researcher conducted two exploratory experiments at a private educational swimming pool located in the municipality area. These experiments are crucial for controlling variables and establishing conditions for the main experiment.

- First Exploratory Experiment: Conducted on May 21, 2023, to test the procedures and methods used in the research.

- Second Exploratory Experiment: Held on May 23, 2023, focusing on therapeutic exercises in the water using various methods.

2.6 Scientific Foundations of Tests

2.6.1 Reliability:

Reliability is a key scientific foundation for any test, ensuring that the test consistently measures what it is intended to measure. The researcher evaluated the reliability of the tests by assessing their consistency over time (Al-Daman, 113, 2006).

2.6.2 Validity:

Validity refers to the extent to which a test measures what it is supposed to measure. The researcher ensured the validity of the tests by examining their ability to accurately assess the intended outcomes (Al-Daman, 120, 2006).

2.6.3 Objectivity:

Objectivity in testing means conducting tests without bias or personal judgment. The researcher ensured that test results were free from personal beliefs and biases, focusing on factual data (Al-Daman, 120, 2006).

Table (2)

Explains the scientific foundations of research tests

Variables	Reliability	Validity	Objectivity
Dorsiflexion	0.93	0.96	0.96
Plantar flexion	0.94	0.97	0.93
Inversion	0.87	0.93	0.97
Turning inward	0.93	0.96	0.94
Lateral flexion force of the foot	0.91	0.95	0.97
Medial flexion strength of the foot	0.92	0.96	0.97

2.7 Field research procedures:

2.7.1 Pre-Tests:

The researcher conducted the pre-tests and measurements on May 28-29, 2023, which corresponded to Sunday and Monday, at the educational pool. All conditions were controlled, and the safety of the tools and equipment used was ensured. Additionally, the assisting team was made aware of their duties during the tests.

2.7.2 Main experiment:

The therapeutic exercises were applied in the swimming pool using Aqua Noodle on the research sample. The total number of therapeutic sessions was 24, spread over 8 weeks. Each session lasted between 30-45 minutes. The sessions began immediately after the fracture had healed, with three sessions per week. The first four weeks' sessions included relaxation exercises, flexibility exercises, and muscle stretching exercises, totaling 12 sessions. The second four weeks included

resistance exercises, strength exercises, and relaxation exercises. The main experiment started on Sunday, June 20, 2023, and ended on Thursday, July 27, 2023.

2.7.3 Post-tests:

The researcher conducted post-tests on the research sample after the therapeutic sessions on Tuesday and Wednesday, August 1-2, 2023, under the same conditions as the pre-tests.

Table (3)
Results of Lateral and Medial Ankle Flexion Strength Tests

Variables	Pre-test		Post-test		T-*test*	Sig
	Means	standard deviations	Means	standard deviations		
Lateral flexion force of the foot	31.933	4.463	60.000	7.801	12.920	0.00
Medial flexion strength of the foot	27.466	2.774	62.400	4.548	29.085	0.00

2.8 Statistical methods:

The researcher used SPSS to find the results, which were placed in tables and discussed.

3. Presentation, Analysis, and Discussion of the Results

3-1 Presentation, Analysis, and Discussion of the Results of the Pre- and Post-Measurements of the Research Sample Regarding Muscular Strength

The table clearly shows an improvement in the strength tests for lateral and medial flexion of the ankle. The researcher attributes this improvement to the therapeutic exercises using Aqua Noodle, which had a positive impact on developing muscle strength. Regular therapeutic exercises, particularly those tailored to the players' abilities gradually increased as their capabilities improved, leading to enhanced strength. The researcher believes that these water-based therapeutic exercises stimulated the necessary muscle fibers, leading to increased strength. Farraj (2018, p. 48) notes that "strength is one of the means of treatment and can be defined as the ability of a muscle to overcome various forces".

Furthermore, the effectiveness of in-water therapeutic exercises, which focused on developing leg muscle strength, was evident from the test results. Stronger leg muscles enhance the performance of football, handball, basketball, and track and field players by improving their control over leg movements. This includes kicking the ball further, jumping higher, and running faster, all of which require significant muscle strength.

2-3 Presentation, analysis, and discussion of the results of the pre-and post-measurements of the research sample regarding the motor range variable.

Table (4)

results of ankle joint range of motion tests

Variables	Pre-test		Post-test		T-*test*	Sig
	Means	standard deviations	Means	standard deviations		
Dorsiflexion	6.533	0.833	17.200	1.264	26.004	0.000
Plantar flexion	11.866	0.915	35.600	2.797	27.811	0.00
Inversion	6.466	0.516	29.933	3.150	28.976	0.00
Turning inward	4.966	0.743	12.166	0.838	24.324	0.00

The researcher attributes the observed improvement in the range of motion for various movements of the ankle joint to therapeutic exercises and the use of Aqua Noodle in the aquatic environment. Each aspect of the improvement is discussed as follows:

1. Dorsiflexion Improvement:

The enhancement in dorsiflexion range of motion is primarily due to the therapeutic exercises and Aqua Noodle techniques employed in the water environment. These exercises effectively stimulate the body's defense mechanisms, accelerate compensation processes, and improve overall bodily functions. This is achieved by reducing the lack of motor activity caused by the injury, as water-based therapy provides a supportive environment that facilitates movement and recovery (Khalil, 2004, p. 12).

2. Plantarflexion Improvement:

The increase in the range of motion for plantarflexion is attributed to the activation of the muscles, tendons, and ligaments through the therapeutic exercises conducted in the aquatic environment. The combination of static and dynamic flexibility exercises performed at a controlled pace significantly contributes to expanding the range of motion. Effective therapeutic interventions involve exercises that ensure adequate flexibility in the muscles and tendons surrounding the joint, which is essential for achieving better plantarflexion outcomes (Hussein, 1985, p. 216).

3. External Inversion Improvement:

The improvement in the range of motion for external inversion of the ankle joint is linked to the therapeutic exercises and aquatic techniques used. These exercises enhance flexibility and increase the resistance faced by the affected limb,

thereby improving external inversion. The therapeutic approach employed, including appropriate rest intervals and effective use of Aqua Noodle aids, contributes to the observed gains in joint flexibility and motion (Prentice, 1986, p.81).

4. Internal Inversion Improvement:

The increase in the range of motion for internal inversion is attributed to the therapeutic exercises and the force exerted against the water's resistance during these exercises. The results from the internal inversion tests demonstrate that the Aqua Noodle therapeutic exercises positively impacted the range of motion. This improvement is a result of both the direct resistance provided by the water and the comprehensive approach to joint rehabilitation that includes strengthening muscles, tendons, and ligaments around the ankle joint (Al-Hasso,1987, p.23).

The researcher believes that the regular performance of therapeutic exercises and the use of Aqua Noodle in the aquatic environment have significantly contributed to increasing joint flexibility and strength. This comprehensive approach enhances the efficiency of muscle, ligament, and tendon functions, leading to improved joint strength and an increased range of motion.

4. Conclusions and Recommendations

4.1 Conclusions

1. The Aqua Noodle therapeutic exercises in a water environment were effective in improving the flexibility of the ankle joint, as indicated by an increased range of motion (extension-flexion).
2. These exercises also positively impacted muscle strength, enhancing both lateral and medial bending strength of the ankle joint.

4.2 Recommendations

1. It is essential to utilize therapeutic exercises and Aqua Noodles in a water environment for treating other injuries.
2. Similar studies should be conducted across various sports and different age groups for both women and men.
3. Develop therapeutic exercises using alternative methods for the same injury and other injuries.

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