The Effect of Rehabilitation Exercises Accompanied by the Dietary Supplement (ZMA) on Partial Tear in the Deltoid Muscle, indicated by the Electrical Activity of Throwing Athletes

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Ringing Magnetic X-ray, Sports Injury Rehabilitation, Deltoid Tearing Assessment

ABSTRACT

The first chapter consists of an introduction to the study in its importance in using ringing magnetic X-ray to find out the range of sports injury. It also refers to the role of the scientific rehabilitation programs which go in harmony with the continuing development of medical and treating sciences as well as the role of treating ways and its importance of applying the rehabilitation programs in the recovery of sports injuries. The researcher also indicates the research significance using the style of identifying the sports injuries using the new modern medical devices and the physical, biochemical and electric action (SMG) signs as ones of developing and improving the tearing deltoid.

This chapter also includes the problems emerged from the injured deltoid of partial tearing of young handbollers and the importance of identifying such problems by the modern medical devices. This helps in finding the proper.

1. Introduction

Sports injuries are a phenomenon that demands the attention of everyone working in the sports field. They are one of the key factors that can force an athlete to withdraw from sports competitions. No area of sports activity is free from the potential risk of injuries. Rehabilitation exercises and proper nutrition are among the most effective means of physical therapy when used systematically and precisely, in alignment with the functional state of the body. The aspects of sports rehabilitation depend on the neuromuscular coordination of all the body's systems. In recent years, there has been significant development and diversity in the methods and techniques used in physical therapy. Here, the positive role of rehabilitation exercises becomes apparent, as they are considered one of the most important means at this stage due to their positive impact.

Through her observations, the researcher noticed that the deltoid muscle in throwing athletes is highly susceptible to injury due to its extensive use and the lack of attention to its nutrition and strengthening. This could be through proper warm-up and full muscle stretching or through the inappropriate use of weights during training. The importance of this research lies in the attempt to prepare rehabilitation exercises accompanied by the dietary supplement (ZMA) for the partial tear injury of the deltoid muscle in throwing athletes, indicated by the muscle's electrical activity.

Research Problem:

Through the researcher’s experience in the field of injury rehabilitation and her direct interaction with athletes, she noticed the widespread occurrence of deltoid muscle tear injuries among throwing athletes, particularly at very early stages. These injuries are among the most common ones that athletes can unexpectedly experience.

Moreover, the deltoid muscle tear injury often recurs, leading to further complications and pushing the injury to another level of severity. Upon reviewing the studies and research related to this field, the

researcher observed a lack of studies addressing the rehabilitation of athletes with partial tears in the deltoid muscle. There is also a noticeable gap in the focus on the athlete's nutrition and the failure of previous rehabilitation programs to monitor the muscle's development using the electrical activity (EMG) as an indirect indicator of sports injuries and their progression.

Research Objectives:

The research aims to:

1. Prepare rehabilitation exercises accompanied by the dietary supplement (ZMA) for partial tears in the deltoid muscle of throwing athletes in track and field events.
2. Determine the effect of rehabilitation exercises and the dietary supplement (ZMA) on partial tears in the deltoid muscle, indicated by the electrical activity of throwing athletes.

Research Hypotheses:

The researcher hypothesizes:

Rehabilitation exercises and the dietary supplement (ZMA) have a positive effect on the deltoid muscle tear, indicated by the electrical activity of throwing athletes.

Research Fields:

Human Field:

Athletes from the Al-Nasiriya Club and Al-Shatra Club who suffer from partial tears in the deltoid muscle.

Temporal Field:

From March 1, 2024, to May 1, .2024

Spatial Field:

The Physiology Laboratory at the College of Physical Education and Sports Sciences, University of Thi-Qar.

The sports halls of the clubs in Thi-Qar Governorate, Nasiriyah, and Shatra.

2. Methodology

The researcher used the experimental method, designing a single experimental group with pre-measurement, mid-measurement, and post-measurement.

Research Population:

The researcher defined the research population purposively, including athletes with partial tears in the deltoid muscle from clubs in Thi-Qar Governorate (Nasiriyah, Shatra). This group represented %83.33 of the total population, with 12injured athletes. The researcher excluded 2athletes based on the opinion of a specialist doctor due to complications at the injury site. Therefore, the total research population consisted of 10injured athletes.

To verify the location and severity of the injuries, an MRI scan was conducted at Al-Hussein Teaching Hospital. Through the MRI report and the specialist doctor's assessment, the location, extent, and severity of the injuries were determined.

Methods and Tools Used in the Research:

Data Collection Methods:

Personal interviews.

Tests and measurements.

Observation.

Data Collection Tools and Devices:

1. One handheld calculator.
2. One Chinese-made laptop.
3. One Sony video camera.
4. Medical supplies including Dettol, cotton, gauze, adhesive tapes to secure electrodes on the body, and razors for removing hair from the electrode placement area.
5. An EMG (Electromyography) device from a USA-based company.
6. A dynamometer to measure muscle strength, measured in kilograms.

Field Research Procedures:

Determining Research Variables:

The research variables and the electrical activity (EMG) of the deltoid muscle were determined through scientific sources and expert opinions from specialists in the field.

Selection of Tests and Research Measurements:

After reviewing many scientific sources and references to select the appropriate tests and measurements for the study variables, they were determined based on scientific sources and in agreement with a number of experts and specialists to ensure their validity. All experts and specialists agreed on the validity of the tests.

Description of Measurements and Tests Used in the Research:

The researcher used several tests that must meet various scientific conditions to measure the variables related to the study and align with the research objectives and the requirements for measurement. The tests and measurements were selected based on expert opinions in the fields of medicine, sports rehabilitation, and nutrition to ensure their validity. These included tests for maximum strength, strength endurance of the muscle, and EMG (electromyography) activity tests (peak and area). The tests are as follows:

Maximum Strength Tests: Evaluating the highest amount of force a muscle can exert in a single effort.

Strength Endurance Tests: Measuring the ability of the muscle to sustain repeated contractions or maintain a contraction over time.

EMG Activity Tests: Assessing the peak and area of electrical activity in the muscle to gauge its functionality and recovery progress.

First: Test Name: (Measurement of Maximum Strength of Shoulder Muscles)

Purpose of the Test:

To measure the maximum isometric strength of the injured arm, defined as "the maximum effort that can be produced to perform a single voluntary muscle contraction," as illustrated in Figure .(1)

Test Description:

The subject sits on a chair attached to a dynamometer device. The subject's trunk should be upright, looking forward, and the arm extended downward, holding the iron grip connected to the device via a metal chain. Upon receiving the agreed-upon signal, the subject is instructed to abduct the injured arm away from the trunk with maximum force.

Tools Used in the Test:

-Dynamometer device.

-Chair attached to the dynamometer device.

-Lightweight metal chain.

Recording Method:

The maximum isometric strength of the injured arm is recorded to the nearest kilogram as determined by the device. The resistance is measured by pulling the arm to a specified weight while it is extended to its maximum possible capacity.

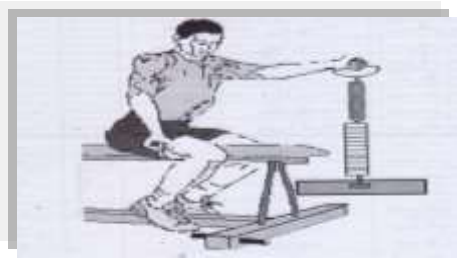

Figure 1: Illustration of the Method for Testing Strength with the Dynamometer Device

Second: Test for Arm Strength Endurance:

Test Name:

Arm Abduction and Lowering Test (30seconds) .

Purpose of the Test:

To measure the strength endurance of the deltoid muscle.

Devices and Tools:—:

– 1Bench with a height of 50cm.

— 2 Electronic stopwatch.

1.5 — 3kg dumbbell.

Performance Specifications:

Sit on a bench with the trunk straight and the injured arm hanging down beside the body, with the fingers pointing towards the body. Hold a 1.5kg dumbbell, raise the arm to the side of the body until the upper arm is in a horizontal position, forming a 90-degree angle with the body at the shoulder joint, then return the arm to the fully extended downward position. Repeat the movement as many times as possible.

Performance Recording Method:

Count the number of correct repetitions performed within 30seconds.

Recording:

Record the number of correct attempts completed by the subject within 30seconds.

Third: Test: Measurement of Electrical Signal (Peak – Area) for the Injured Deltoid Muscle

Device Operation Method:

The modern EMG device is a compact unit weighing no more than 390grams, worn around the player's waist with a belt. This device transmits Bluetooth signals regarding muscle activity, which are received by another device known as the Bluetooth signal receiver, connected to a personal laptop. The modern EMG device allows the athlete to perform all types of movements, including jumping, rotating, and sprinting up to 40meters from the signal receiver. The EMG signal, which represents the start and end time of muscle activity, the muscle's electrical amplitude, and the working area of the muscles involved in the movement, is recorded and stored.

5-2Description of the Rehabilitation Program:

The researcher developed rehabilitation exercises for the partial tear of the deltoid muscle, accompanied by the daily intake of three ZMA supplement pills (see Appendix 1and 2). The program lasted for 8 weeks, with three rehabilitation sessions per week, totaling 24rehabilitation sessions. The various and suitable rehabilitation exercises included movements of the shoulder joint such as abduction, adduction, flexion, extension forward and backward, and raising and lowering the arm.

The researcher ensured the use of repetition and variation in performing the rehabilitation exercises during the mentioned weeks, with variations in performance regarding the increase and progression in the range of motion, as well as in the gradual increase in strength, starting from body weight resistance to dynamic strength. The purpose was to develop the joint's range of motion and the flexibility of the deltoid muscle, to increase the muscle's strength and endurance.

Furthermore, the researcher emphasized the use of stretching exercises to stimulate the largest number of motor units to participate in the work and to return the injured muscle to its normal state before the injury. The researcher also considered appropriate rest times for the injured athlete, according to the athlete's ability to return to activity.

Pilot Studies:

The researcher conducted several pilot studies on March 20, 2024. The first pilot study was carried out at 9:00AM on a sample of 3athletes in the Physiology Laboratory of the College of Physical Education and Sports Sciences at the University of Thi-Qar. A second pilot study was conducted after 7days. During the pilot studies, the researcher ensured that the same conditions and circumstances as the main experiment were maintained as much as possible to ensure the reliability of the results.

Preliminary Experiments One and Two:

Purpose:

1. Verify the suitability of the equipment and tools used in the tests and prepare them.
2. Ensure the appropriateness of the tests prepared in the methodology developed by the researcher.
3. Familiarize with the operation of the electrical activity device in all its details.
4. Get to know the assisting staff and their number.
5. Determine the time required to conduct the tests.
6. Train on the recording method.
7. Identify the difficulties faced by the researcher.

Pre-Tests for the Research Community:

The pre-test is a method that allows us to understand the current state and actual level of injury within the community, serving as the starting point for the researcher. The researcher used a set of tests to serve as indicators to control variables and ensure the accuracy of the results on one hand and the effect of rehabilitation exercises on the other. The researcher used tests that included maximum strength and strength endurance for the sample on March 28, 2024, at 9:30AM on Thursday in the halls of the College of Physical Education and Sports Sciences at the University of Thi-Qar. These tests coincided with the electrical activity tests of the muscle. All sample members attended the test, along with the assisting team.

Main Experiment (Part One):

The first part of the main experiment consisted of four weeks, with three rehabilitation units per week. The first week included isometric strength exercises along with static passive stretching exercises without equipment (as detailed later in the program description).

Interim Tests:

The researcher conducted physical tests four weeks after implementing the rehabilitation program on 2024/4/1. This was done according to the details mentioned in the description of the rehabilitation exercises provided later to ensure the improvement and response of the participants to the exercises in the partially torn deltoid muscle.

Main Experiment (Section Two):

The second section of the main experiment included four weeks, with three different rehabilitation units applied each week. These units featured rehabilitation exercises of varying intensities, focusing on using dynamic strength and positive dynamic stretching with body weight. These exercises aimed to increase muscle strength and joint range of motion. Additionally, they sought to enhance muscle function through neuromuscular adaptation, which leads to increased muscle strength by organizing the work of muscle fibers and the regulation of neural signals.

Post-Tests for the Research Sample:

The researcher conducted the post-tests for the research sample after completing the application of the rehabilitation exercise protocols developed by the researcher on the experimental group on May 1, .2024

Statistical Methods:

The researcher used the Statistical Package for the Social Sciences (SPSS) to analyze the results of the pre, mid, and post-tests using non-parametric statistics due to the small size of the research population and the heterogeneity of its members in the mentioned variables. The statistical methods included:

1. Arithmetic mean
2. Standard deviation
3. Skewness coefficient
4. Percentage
5. Friedman test

Presentation, Analysis, and Discussion of Results:

To achieve the objectives of her research and test its hypotheses regarding the impact of the prepared rehabilitation exercises on the partial tear of the deltoid muscle and its electrical activity (EMG), the researcher presented the results of the pre, mid, and post-tests for the experimental group affected by the partial tear of the deltoid muscle in the form of tables as follows:

Presentation, Analysis, and Discussion of EMG Test Results in Pre, Mid, and Post Measurements for Maximum Strength and Strength Endurance

Presentation and Analysis of EMG Test Results in Pre, Mid, and Post Measurements for Maximum Strength and Strength Endurance

Discussion of EMG Test Results in Pre, Mid, and Post Measurements and Friedman Value

Table 1shows the arithmetic means, standard deviations, and the minimum and maximum values for the EMG in the pre, mid, and post measurements.

Maximum Value	Minimum Value	Standard Deviation	Arithmetic Mean	Unit of Measurement	Measurements	Variables
173.00	135.00	12.31	155.55	Axial	EMG Peak of	Treatments

134.00	105.00	6.41	123.14	Medial	Electrical Activity for Maximum Strength	
140.00	120.00	7.17	131.14	Medial		
91.00	72.00	6.16	82.82	Axial	EMG Peak of Electrical Activity for Endurance Strength	
82.00	51.00	8.02	70.13	Medial		
79.00	58.00	5.88	70.13	Medial		
1158.00	718.00	108.88	941.76	Axial	EMG Area of Electrical Activity for Maximum Strength	
680.00	440.00	75.09	550.76	Medial		
784.00	494.00	85.62	631.00	Medial		
102.00	87.00	4.33	94.27	Axial	EMG Area of Electrical Activity for Endurance Strength	
64.00	50.00	4.33	58.13	Medial		
76.00	63.00	4.31	70.13	Medial		

Observations from Table (1) indicate the following:

In the EMG Peak Activity Test for Maximum Strength:

The mean in the pre-test measurement was (855.55) with a standard deviation of (.(153.31

In the intermediate test, the mean was (531.05) with a standard deviation of (.(104.91

The post-test mean was (218.86) with a standard deviation of .(40.87)

The minimum value in the pre-test was (650.00), intermediate test (318.00), and post-test (165.00) .

The maximum value in the pre-test was (1200.00), intermediate test (677.00), and post-test (282.00) .

In the EMG Area Activity Test for Maximum Strength:

The mean in the pre-test measurement was (82.82) with a standard deviation of .(17.516)

In the intermediate test, the mean was (65.13) with a standard deviation of .(8.202)

The post-test mean was (42.53) with a standard deviation of (.(8.161

The minimum value in the pre-test was (62.00), intermediate test (51.00), and post-test .(30.20)

The maximum value in the pre-test was (128.00), intermediate test (80.00), and post-test .(58.30)

In the EMG Peak Activity Test for Strength Endurance:

The mean in the pre-test measurement was (941.60) with a standard deviation of .(131.88)

In the intermediate test, the mean was (651.50) with a standard deviation of .(94.09)

The post-test mean was (232.70) with a standard deviation of .(81.10)

The minimum value in the pre-test was (760.00), intermediate test (580.00), and post-test .(119.00)

The maximum value in the pre-test was (1200.00), intermediate test (880.00), and post-test .(340.00)

In the EMG Area Activity Test for Strength Endurance:

The mean in the pre-test measurement was (96.76) with a standard deviation of .(21.924)

In the intermediate test, the mean was (77.11) with a standard deviation of .(14.734)

The post-test mean was (52.76) with a standard deviation of .(8.058)

The minimum value in the pre-test was (73.10), intermediate test (60.20), and post-test .(42.10)

The maximum value in the pre-test was (130.50), intermediate test (95.80), and post-test .(63.30)

Table (2) shows:The mean ranks and the Friedman value for the results of the EMG activity tests in the pre-test, intermediate, and post-test measurements for maximum strength and strength endurance.

Type of significance	Significance level	Average rank	متوسط الرتب	Measurement	measruing unit	Processors the exams
moral	0,000	17.00	3.00	Tribal	microvolt	Peak electrical activity EMG of maximum force
			2.00	Middle finger		
			1.00	after me		
moral	0,000	20.00	3.00	Tribal	microvolt/ second	Area of maximum force EMG electrical activity
			2.00	Middle finger		
			1.00	after me		
moral	0,000	15.00	3.00	Tribal	microvolt	Peak EMG electrical activity for force endurance
			2.00	Middle finger		
			1.00	after me		
moral	0,000	19.00	3.00	Tribal	microvolt/ second	The area of EMG electrical activity to bear forces
			2.00	Middle finger		
			1.00	after me		

Sample Size: 10

Significance Level: 0.05

Upon reviewing Table (2), it is evident that there was a positive effect of the rehabilitation exercises in the pre, mid, and post-tests, with significant differences between the three tests for all variables, favoring the post-test measurements in the EMG variables as indicated by the following observations:

In the EMG (Peak-Area) test for maximum strength:

The mean rank value in the pre-test was (3), in the mid-test (2.00), and in the post-test (1) with a degree of freedom (2). To confirm the significance of the differences, the researcher calculated the Friedman value, which was (17.00) at a significance level of (0.000), smaller than the significance level (0.05). This indicates significant differences between the pre, mid, and post-tests, favoring the post-test.

For the area variable, the mean rank value in the pre-test was (3), in the mid-test (2.00), and in the post-test (1) with a degree of freedom (2). The calculated Friedman value was (20.00) at a significance level of (0.000), smaller than the significance level (0.05), indicating significant differences between the pre, mid, and post-tests, favoring the post-test.

In the EMG (Peak-Area) test for endurance strength:

The mean rank value for the EMG peak signal of the deltoid muscle in the pre-test was (3), in the mid-test (2.00), and in the post-test (1) with a degree of freedom (2). To confirm the significance of the differences between the test results in the pre, mid, and post-tests, the researcher calculated the Friedman value, which was (15.00) at a significance level of (0.000), smaller than the significance level (0.05), indicating significant differences between the pre, mid, and post-tests, favoring the post-test.

For the area variable, the mean rank value in the pre-test was (3.00), in the mid-test (2.00), and in the post-test (1.00) with a degree of freedom (2). To confirm the significance of the differences between the test results in the pre, mid, and post-tests, the researcher calculated the Friedman value, which was (19.00) at a significance level of (0.000), smaller than the significance level (0.05), indicating significant differences between the pre, mid, and post-tests, favoring the post-test.

3. Results and discussion

Discussion of EMG Electrical Activity Test Results in Pre, Mid, and Post Measurements and Friedman Value

From our observation of the average ranks and the calculated Friedman value results shown in Table (2) for the EMG electrical activity test (peak-area) for maximum strength, we note a significant decrease in the electrical signal percentage of the deltoid muscle between the pre, mid, and post-tests, favoring the post-test in both the peak EMG variable and the electrical activity area of the muscle. The researcher attributes this improvement in the peak EMG electrical signal variable of the deltoid muscle to:

The rehabilitation program accompanied by the dietary supplement (ZMA) and the type of exercises applied, which are based on scientific principles, have led to significant differences between the three measurements. The training of the deltoid muscle was based on sound scientific principles, by organizing and programming the training process, using optimal intensities and repetitions through rehabilitation exercises that match the capability of the injured athlete, as determined by the tests conducted at the beginning of each rehabilitation unit, with regulated rest periods between each exercise. This had a positive effect on developing the strength of the deltoid muscle and the associated muscles through the repetitions and intensities used in the rehabilitation process.

Scientific sources indicate that "organized training results in an increase in an individual's capacity due to performing physical exercises over several days, weeks, or months by adapting the body's systems to the optimal performance of those exercises. In other words, the impact of physical exercises stimulates muscle cells to adapt and become more economical in performing the exercise intensity" .(1)

Here, the researcher believes that the muscle has become more effective in stimulating motor units through improved muscle functional performance and economic effort. This was observed by the researcher through the noticeable improvement in the required electrical muscle activity to reach a certain level of muscle contraction. Therefore, the primary goal of the rehabilitation exercises was to induce physiological adaptations in the muscle, which resulted in improved recruitment and synchronization of the motor units involved. As Risan Khuraibet and Ali Turki pointed out, "the execution of any movement is related to the extent of motor unit participation in the muscle work in terms of the number of motor units. The greater the number of motor units participating in muscle contraction, the higher the muscle strength. The athlete's ability to recruit muscle fibers for participation in muscle contraction is related to the training factor, thus facilitating high coordination in performance."

The Area Under the EMG Curve:

The researcher attributes the observed developments in this variable to the fact that as resistance increases with the involvement of a larger number of motor fibers, the physical, physiological, and biochemical burdens decrease due to this development. This results in a reduction in the peak electrical activity index (EMG) due to the efficiency in the effort required for muscular work. Since power is

defined as producing the required force in the least amount of time, this led to increased stimulation strength of muscle fibers with a decrease in contraction time due to refinement and focus in the work. This resulted in a clear reduction in the area of electrical activity due to the proper functional work of the muscle and its responsiveness to effective rehabilitation exercises. Saad Saadon indicated that it is the result of the product of contraction force (stimulation) and contraction time. Omar (2012), citing Ali Jalal (2007), points out that there is neural activity resulting from the effect of muscle training (both isometric and dynamic strength training). This, in turn, works to engage a large number of muscle fibers in performing a particular movement, leading to an increase in strength level without a significant increase in muscle mass.

In the Test of the EMG Variable (Peak-Area) for Strength Endurance:

From our observation of the results shown in Table (2), we notice a significant improvement in the percentage of the electrical signal of the deltoid muscle between the pre-test, mid-test, and post-test measurements, with the post-test showing the most favorable results. This improvement in the peak EMG variable and the electrical activity area of the muscle is attributed by the researcher to:

The reason for this development is the use of the dietary supplement and the required resistance for the muscle work being higher in the post-test compared to the pre-test and mid-test. Initially, the muscle is not capable of working for extended periods, and muscle fatigue becomes evident when the work is prolonged. This prevents the recruitment of a larger number of motor units required for the task. The use of endurance exercises had a positive impact on developing the strength endurance of the deltoid muscle by applying appropriate intensity and volume to develop this physical capability. The primary goal of this method was to improve endurance. When the muscle is exposed to continuous and regular training, its activity increases, and its resistance to muscle fatigue, which results from sports injuries and improper muscle use, also increases. The rehabilitation program led to an increase in the recruitment of a larger number of motor units for muscle work, demonstrating suitable resistance for performing the required motor task. Consequently, there was a noticeable decrease in the peak of the electrical signal, making it more regular and less random. A healthy muscle exhibits a lower peak with regular and appropriate resistance produced by the trained muscle. This was confirmed by Adama and DeLuca (2005) and Janet L.) Janet L 2008 ,(2008) (who stated that when the working muscle fibers become fatigued, the person increases the voluntary effort by recruiting more motor units.) With the adaptation resulting from the rehabilitation exercises targeting the deltoid muscle, the muscle's ability to work improved.

Regarding the electrical wave under the curve (area):

The researcher believes that the area under the curve varies with the duration of performance, whether the work is maximal or extends for a longer period. It is directly proportional to the peak of the electrical signal in the muscle involved in the task and according to the type of work. As Mohamed Majid noted, the longer the duration, the larger the area under the curve, as it results from two main variables: the height of the electrical activity peak and the duration of this peak.

4. Conclusion and future scope

According to the research objectives and hypotheses, within the limits of the research community, field procedures, and statistical analysis of the data collected in the pre-, mid-, and post-tests of the variables under study, the following conclusions were reached:

Rehabilitation exercises accompanied by the dietary supplement (ZMA) have a positive effect on the rehabilitation of partial tears in the deltoid muscle.

Rehabilitation exercises have a positive impact on developing the strength and endurance of the muscle, which is reflected in the improvement of the electrical signal (EMG) for the variables (peak and area) of the injured deltoid muscle.

Recommendations:

1. Use the rehabilitation exercises prepared by the researcher and take three capsules daily of the dietary supplement to rehabilitate partial tears of the deltoid muscle.
2. Adopt the EMG muscle electrical activity variable to diagnose muscle injury cases, as it is an important and accurate diagnostic tool.
3. Pay attention to periodic tests of muscle electrical activity

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