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To Find the Effectiveness of EMG Findings in Upper Limb Plyometric Exercise Versus Upper Limb Kinetic Chain Exercise on Biceps and Triceps for Racket Sports Players-A Comparative Study

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Abstract: *Title: Comparative Analysis of Electromyographic Activity in Upper Limb Plyometric Versus Kinetic Chain Exercises Targeting Biceps and Triceps in Racket Sport Athletes*
Background: Electromyography (EMG) is a reliable technique for quantifying muscle activation and neuromuscular performance by recording the electrical potentials generated by muscle fibers during contraction. In the context of sports rehabilitation and performance enhancement, understanding muscle recruitment patterns during specific exercise modalities is critical for optimizing training strategies.
Objective: To compare the electromyographic (EMG) activity of the biceps brachii and triceps brachii during upper limb plyometric exercises versus upper limb kinetic chain exercises in athletes engaged in racket sports, and to determine which modality elicits greater neuromuscular activation.
Methodology: A comparative, experimental study was conducted on four competitive racket sport athletes over a 12-week intervention period. Surface EMG electrodes were used to record muscle activity of the biceps and triceps during standardized upper limb plyometric and kinetic chain exercise protocols. The study was carried out in the outpatient department of Shree Venkateshwara College of Paramedical Sciences, College of Physiotherapy. Data were analyzed to compare the amplitude and pattern of EMG signals between the two exercise modalities.
Results: EMG analysis demonstrated significantly greater muscle activation in both the biceps and triceps during plyometric exercises compared to kinetic chain exercises. The enhanced recruitment observed in plyometric training suggests superior neuromuscular engagement and potential benefits for explosive upper limb performance in racket sports.
Conclusion: Upper limb plyometric exercises elicit higher electromyographic activity in the biceps and triceps muscles than kinetic chain exercises in racket sport athletes. These findings support the incorporation of plyometric training into athletic conditioning programs aimed at enhancing upper limb power and performance..

Keywords: Electromyographic Activity

I. INTRODUCTION

EMG stands for electromyography it is the study of the muscle electrical signals. EMG is sometimes referred to as myoelectric activity. muscle tissue conducts electrical potentials similar to way nerves do and the name given to these electrical signals is the muscle action potential. Surface EMG is a method of recording the information present in these muscles action potentials. EMG signal is a biomedical signal that measures electrical currents generated in muscle during its contraction representing neuromuscular activities. The nervous system always controls the muscle activity (contraction/relaxation). Hence the EMG signal is a complicated signal, which is controlled by nervous system and is dependent on the anatomical and physiological properties of muscle. EMG signal acquires noise while traveling

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through different tissues. moreover, the EMG detector, particular if it is at the surface of skin, collects signals from different motor units at a time which may generate interaction of different signals[1] .

In EMG patients learn to control and to alleviate their muscle tension. Biofeedback is often called a "psychophysiological intervention," although its change mechanisms are more psychological than physiological: it has been repeatedly demonstrated that the effectiveness of EMG biofeedback is mediated by cognitive changes, such as increases in self- efficacy and coping strategies induced through biofeedback training, rather than primarily by learned physiological control [2] .

Electromyography is the subject which deals detection, analysis and utilization of electrical signals emanating from skeletal muscle. Electromyography is a very useful method in measuring muscle stimulation that has numerous application in the diagnosis and treatment of disease as well as the potential to enhance human abilities. Emg is widely used in medical area for assisting weak or elderly. For this ,non-invasive electrode was used to detect small signal from the muscles is more friendly user instead of needle type invasive electrode

. The electromyogram circuit was developed to acquire useful muscle to small range signal received from the muscle, high precision instrumentation amplifier are required to amplify the signal[3].

Racket sports include a variety of disciplines such as: badminton, racquetball, paddle, tennis, table tennis, squash, etc., which are competed individually or in pairs. Racket sports are characterized by being a cyclical disciplines, which combine very intense physical load cycles with short breaks, allowing incomplete recovery from the efforts performed. In the last decade, racket sports have become an important alternative to traditionally practiced sports, considerably increasing the number of people who practice them. One of the main factors that differentiates each of the racket sports is the court on which the game takes place. However, in relation to physiological responses we can find a diversity of results in studies of performance in rackets sports, considering all the elements of the game involved in sports performance and how they determine the response of the player's body during a match. According to the above and considering the growth that racket sports have had in recent years; the aim of this review is to analyse and compare the indicators of the internal load of each sport. In order to reset physiological references better adjust the training of the players and also use these references in order to propose the practice of these sports for healthy purposes to the general population[4] .

Incidence of injury in racket sports varies in tennis, the incidence rate is about 0.05–2.9 injuries per player per year. The occurrence rate of injury in badminton that has been reported in every 1000 h of badminton playing is 2.9 injuries per player. In squash, the rate of injuries reported as 18 injuries per 1000 h of participation. Most of the injuries in racket sports that occurred in the upper extremity are chronic and most likely fragments to injuries are the shoulder girdle (17.2%), wrist (12.23%), and elbow. It was Hypothesized that core stability and upper extremity play a cardinal role in athletic performance[5] .

The biceps, also biceps brachii is a large muscle that lies on the front of the upper arm between the shoulder and the elbow. Both heads of the muscle arise on the scapula and join to form a single muscle belly, which is attached to the upper forearm. While the biceps crosses both the shoulder and elbow joints, its main function is at the elbow where it flexes the forearm and supinates the forearm. With a focus to improve the body form and build stabilized strength, the biceps program involves 5 workouts per week, with at least 2 rest days between workouts for a duration of 3 to 4 months. To build the strength and muscle, both a repetition of 10–12 repetitions per set is suggested, depending on the subject's exercise stamina. Triceps, also known as triceps brachii, is often referred to as a 'three-headed muscle'. The three muscle bundles, namely, the lateral head, the long head, and the medial head, make up the triceps and are the only muscles that lie along the posterior humerus.

Triceps function as extensors and help increase the angle between the forearm and the upper arm. Triceps are the muscles exerted for the pushing action. To develop the triceps, one needs to focus on exercises that push weights away from the body[6] . The biceps and its antagonist, the triceps, are the main flexors and extensors of the elbow joint. In the athlete they are responsible for accelerating the forearm during throwing or pitching and then decelerating the arm to prevent injury to the elbow joint. Rupture of the biceps or triceps is regarded as a rare injury, but in the authors' opinion the incidence appears to be increasing. Historically, operative repair of the biceps brachii was fraught with difficulty, but in recent times surgical techniques have improved and the results of biceps and triceps repair have

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improved[7] . It is logical that for athletes to seek to increase the rate of force development, because most sports involve fast movements for which forces must be generated quickly. In order to assist the athlete in training for power event the concept of plyometrics was introduced in Russia in 1969. Plyometrics is a type of exercise training designed to produce fast, powerful movements, and improve the functions of the nervous system, generally for the purpose of Improving performance in sports. Plyometric movements, in which a muscle is loaded and then contracted in rapid sequence, use the strength, elasticity and innervations of muscle and surrounding tissues to jump higher, run faster, throw farther, or hit harder, depending on the desired training goal. Plyometrics is used to increase the speed or force of muscular contractions, often with the goal of increasing the height of a jump. Plyometrics are exercises that enable a muscle to reach maximum strength in as short a time as possible. This speed and strength ability is known as power. Plyometric exercises are a quick, powerful movement using a pre-stretch or counter movement, which involves the stretch shortening cycle. The purpose of plyometric exercises is to increase the power of subsequent movements by using both the natural and elastic components of muscle, and tendon and the stretch reflex[8] .

Plyometric is a compound word formed from the Greek word “pleion” meaning “more” and “metric” meaning measure. Plyometric training is generally seen as one of the most successful technique to provide speed and strength in order to increase the muscle strength and to improve the development of muscle by increasing the bounce feature, to make the athlete higher jumps during the game and to react instant when needed in the game. If the space between speed and strength can be filled with plyometric studies , weight training performed in plyometric training is seen as one of the most useful techniques for the development of this feature.

Training programmes made with plyometric exercise make positive contributions to motor features such as speed and power. Plyometric training is a training method that positively affect the explosive power , maximal force and speed performance of the athlete. In other words, the plyometric training methods is a resistance training involving rapid stretching of the muscle in a short period of time, from the eccentric contraction to concentric contraction to produce strong movement. Plyometric training is preferred by athletes to develop strength and explosive strength in all sport branches[9].

Dynamic upper extremity dominant tasks such as throwing, hitting, and serving occur as the result of the integrated, multisegmented, sequential joint motion, and muscle activation system known as the kinetic chain. Proper utilization of the kinetic chain allows maximal force to be developed in the core which can then be efficiently transferred to the arm during these actions. In order for the tasks to be effective and efficient, the kinetic chain links must have optimal amounts of muscle flexibility, strength, proprioception, and endurance as well as the ability to perform the task consistently on a repetitive basis. Proper kinetic chain sequences referred to as biomechanical “nodes” have been previously described for baseball pitchers and tennis players [10].

Closed kinetic chain exercises are being widely used in rehabilitation treatments. Research has indicated that the development of closed kinetic chain exercise for the low limb would be beneficial for the upper limb. Closed kinetic chain exercises have positive effects on muscle activity, stability of the joint, closed kinetic chain exercise with weight bearing is a good test method for isometric weight bearing and movement [11]. Here as the lower extremities function primarily in a closed chain environment, the upper extremities function predominantly in an open chain environment. Most activities of daily living (ADLs) and athletic events require open chain function of the upper extremities. However, the upper extremity must be able to function in a closed chain just as the lower extremities must be able to function in an open chain. During athletic events and ADLs, a person will fall, push, or swing from objects. This requires the shoulder to move around a fixed distal hand[12].

Need for the Study

Optimal biceps and triceps activation is critical for performance in racket sports. Electromyography (EMG) provides precise data on muscle activation, yet comparative evidence on upper limb plyometric versus kinetic chain exercises is limited. This study investigates which modality more effectively enhances neuromuscular activation in racket sport athletes.

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Aim

To compare EMG-based muscle activation of the biceps and triceps during upper limb plyometric and kinetic chain exercises in racket sport athletes.

Objectives

• To analyze EMG activity of biceps and triceps during plyometric and kinetic chain exercises.
• To compare the effectiveness of both modalities in activating these muscles.

Hypotheses

H_0: No significant difference in EMG activity between the two exercise types.
H_1: Significant difference in EMG activity between the two exercise types.
This version is concise and publication-ready for journal formatting. Let me know if you'd like it aligned with specific journal style guides (e.g., APA, Vancouver, ICMJE).

Methodology

Study Design and Setting

A comparative experimental study was conducted over two months at Shree Venkateshwara College of Paramedical Sciences, College of Physiotherapy.

Participants

Four male racket sport players aged 20–25 years were recruited based on the following criteria:
Inclusion Criteria:
• Male, aged 18–30 years

Exclusion Criteria:

• Recent upper limb injury or fracture
• Presence of skin lesions
• Uncooperative behavior

Grouping and Intervention

Participants were divided into two groups (n=2 each):
• Group A: Received upper limb plyometric exercises
• Group B: Received kinetic chain exercises
Each group followed a progressive 4-week protocol (3 sessions/week, 12 reps per exercise):
• Week 1: 2 sets
• Week 2: 3 sets
• Weeks 3–4: 4 sets
Plyometric Exercises: Wall chest pass, overhead forward throw, and clap push-ups.
Kinetic Chain Exercises: Dumbbell chest fly and push-ups.

Outcome Measure

Surface Electromyography (EMG) was used to assess muscle activation pre- and post-intervention. EMG amplitude was interpreted as a marker of muscle effort and strength.
Statistical Analysis
• Paired t-test: To assess within-group pre–post differences
• Unpaired t-test: To compare post-intervention results between groups
A p-value < 0.05 was considered statistically significant.

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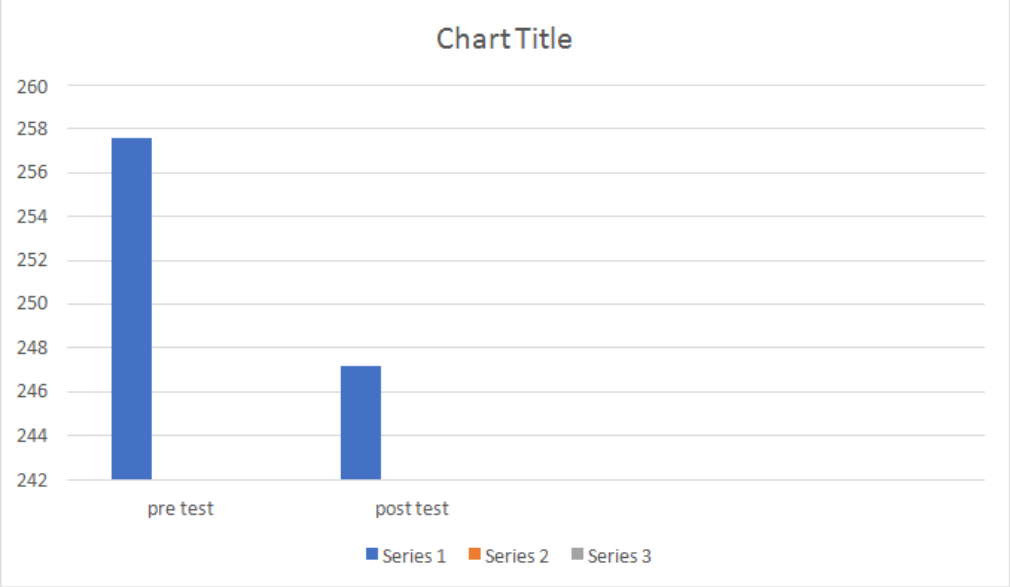
TABLE 4.4: PRE AND POST VALUES OF GROUP B TRICEPS

GROUP B	MEAN	STANDARD DEVIATION	PAIRED 't' TEST	P VALUE
Pre-test	247.2	17.7		
Post-test	257.6		1.02	<0.05

- Comparing the pre-test and post-test value of Group B showed the 't' test value is 2.067
- Which is significantly greater than t value <0.05 The result showed that there is significant increase in amplitude
- Graphical representation of pre and post test value of group B triceps

GRAPH 4.4



GROUP A TRICEPS AND BICEPS POST

GROUP A and B	MEAN	STANDARD DEVIATION	PAIRED 'T' TEST
Post-test (Triceps)	433.80	78.73	2.176
Post-test (Biceps)	751.00	702.10	3.657

- *0.05 level of significant
- Comparing the post test value of group A triceps and biceps shows the 't' value is Which is significantly greater than table value of 0.05
- The level of significant is p <0.05 (2.085)
- The result showed that there is significant
- Graphical representation of post test of group A and biceps and triceps

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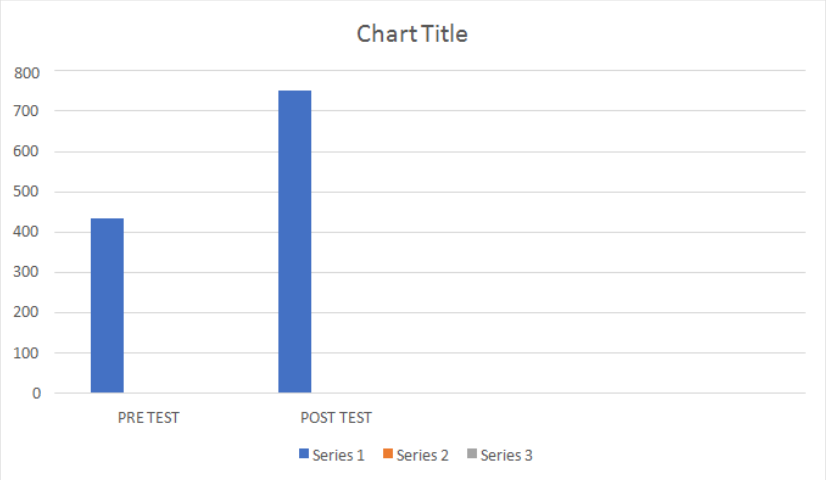
GRAPH 4.5

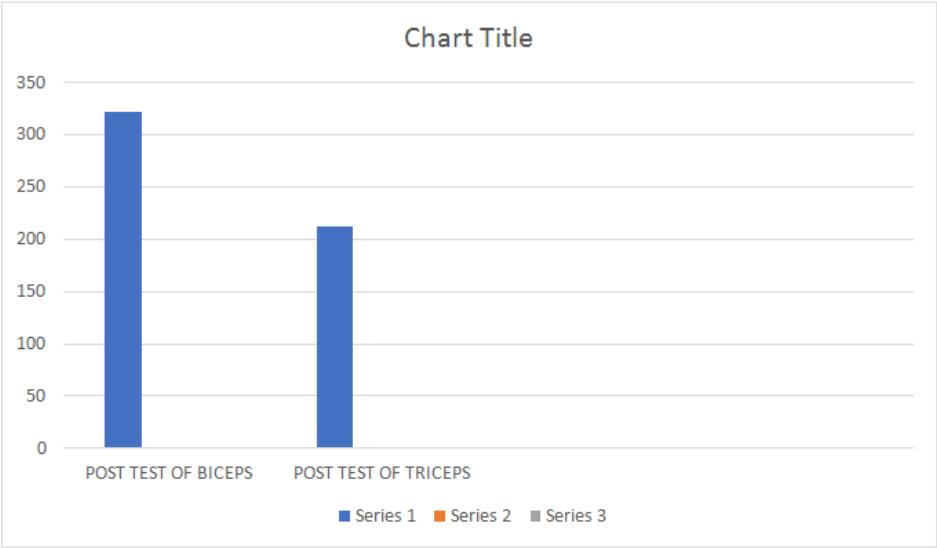


GROUP B BICEPS AND TRICEPS POST

GROUP B	MEAN	STANDARD DEVIATION	PAIRED 'T' TEST
Post-test (Biceps)	321.40	148.65	3.012
		103.49	2.067
Post-test (Triceps)	211.60		

- *0.05 level of significant
- Comparing the post test value of group A triceps and biceps shows the 't' value is Which is significantly greater than table value of 0.05
- The level of significant is p <0.05 (2.085)
- The result showed that there is significant
- Graphical representation of post test value of group B biceps and triceps

GRAPH 4.6



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II. RESULT

The statistical report state that there is significant improvement in plyometrics of group A when compared to kinetic chain exercise of group B and the level of significance is. 0.05

In group A the calculated paired 't' value is 1.09 than the group B calculated paired 't' value is 1.02,both the group A and group B the calculated unpaired 't' value is 2.2 more than the

0.05 the level of significance. So the alternate hypothesis is accepted in both tool

Hence, we reject the null hypothesis and accept the alternate hypothesis, which state that there is significant improvement group A treated with plyometric exercise than group B treated with kinetic chain exercise.

III. DISCUSSION

Precision is the most significant thing when generating a research report formulated with the statistics. This theory about precision doesn't require future evaluation except interrater and intraratar reliability check, after serious of trials we conclude ourselves into what is called as precision.

This study was conducted for racket sport players, who require balance as well as power as a main fitness parameter for an efficient performance. There are countless studies nowadays prevailing in the research field about the effectiveness of plyometric exercise, high intensity exercise strength training, as well as eccentric types of training for the main muscles which are involved in the racket sport. Based on these studies we found that biceps and triceps play a major role in this kind of sports.

So, we took biceps and triceps into our consideration and to make this study more precise and novel we discovered EMG. Electromyography is an important parameter. We selected kinetic chain exercises and plyometric exercises as two exercises to be compared with selection of two groups. Group A were given plyometric exercise and Group B were given kinetic chain exercises.

These two groups underwent EMG biofeedback analysis on the day of the study and both the group were given the exercises and post EMG findings were noticed, following the series of EMG findings we took amplitude of the wave in to consideration and formulated the pre-test and post -test.

In this event of study both the groups were found to have alterations in the EMG findings followed by the exercise. The compared post-test values of both the groups to find efficiency of these plyometrics and kinetic chain exercise. We at last found that there is marked alteration in the EMG readings for the athletes who underwent plyometric type of training rather than who underwent kinetic chain exercise.

The purpose of the study is to compare the effectiveness of EMG findings in plyometric exercise vs kinetic chain exercise on biceps and triceps for rachet sports players. The total study duration was 3 months which includes sampling, treatment, data collection and data analysis. Four (4) racket sports athletes were selected for the study and were randomly assigned in to two groups according to selection criteria. The treatment duration was 4 weeks for each groups. EMG recordings were measured before and after giving the interventions. Data were analysed and the results were interpreted using paired and unpaired 't' tests.

Plyometrics are exercises that enable a muscle to reach maximum strength in as short a time as possible. This speed and strength ability is known as power. Plyometric exercises are a quick, powerful movement using a pre-stretch or counter movement, which involves the stretch shortening cycle. The purpose of plyometric exercises is to increase the power of subsequent movements by using both the natural and elastic components of muscle, and tendon and the stretch reflex. Plyometric training is emphasized when the goal is to increase power. However, it is important to select plyometric drills that are movement specific; i.e. plyometric drills should be selected based on their similarity to movements that occur within the sport. Plyometrics consists of hopping, skipping, jumping and throwing activities designed to make the athlete faster. During the complex training method plyometrics must be done at maximum speeds; sub-maximal efforts will produce sub-maximal results. This is an application of the law of specificity. Going from slow muscles to fast muscles requires performing quick, "explosive" movements. These activities must allow for minimal contact with the ground (lower body) or the hand contact surface (upper body). Plyometrics are the best answer for these types of exercise needs. Lower body plyometric exercise emphasizes quick foot movements and the ability to get off the ground

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quickly. Upper body plyometric exercises emphasize using medicine balls to teach the muscle to respond more quickly to external forces.

Rehabilitation of racket sports players shoulder should follow a kinetic chain based regimen that addresses specific deficits within individual links which can aid in restoring the natural proximal to distal muscle activation sequencing. The deficits can be addressed through a logical progression of therapeutic interventions focussing on flexibility, strength, proprioception and endurance with integrated kinetic chain components [13]. Closed kinetic chain exercises are being widely used in rehabilitation treatments in clinics. Research has indicated that the development of closed kinetic chain exercises for lower limb would be beneficial for the upper limb. Closed kinetic chain exercises have positive effects on muscle activity, stability of the joint, proprioceptive sense etc [14].

Electromyography (EMG) emerged as a diagnostic procedure to assess the health of Muscles and the nerve cells that control them (motor neurons). The electrodes receive the electrical signals transmitted by the motor neurons that cause muscle contraction. However, these EMG signals acquired from muscles require advanced methods for their detection, decomposition, processing, and classification that a specialist interprets. There are two basic types of electrodes to acquire these signals: surface and intramuscular electrodes. Surface electrodes are placed on the skin directly over the muscles, recording the signal from all the fibers under the two electrodes. Intramuscular electrodes can be indwelling (also known as needle) or fine wire electrodes (Fw-EMG), and they are inserted through the skin directly into the muscle , thus recording the signals from only few fibers. The general advantage of surface electrodes is that they are non-invasive and easy to apply. Their use, however, is limited to superficial muscles that are large enough to support electrode mounting on the skin surface, and crosstalk is particularly problematic for smaller muscles within a complex mechanical arrangement, such as the forearm . Indwelling electrodes need significantly more training for their proficient use in comparison to surface electrodes. Although they are ideal for recording the activity of deep muscles, correct placement requires a detailed knowledge of musculoskeletal anatomy. Furthermore, the invasiveness of inserting a needle into the muscles, as well as the associated pain, is the major disadvantage of intramuscular electrodes [15].

The growth of sports science and the commercialization of racket sports in recent years have focused attention on improved performance and this has led to a more detailed study and understanding of all aspects of racket sports. Scientists worldwide say the findings show that as physical activity is increasingly promoted as a critical part of a healthy lifestyle, sports injuries are becoming an important public health issue for both children and adults. As a result, injury prevention efforts need to go beyond targeting children and start addressing the risks faced by physically active adults as well. Fortunately, most sports injuries can be treated effectively, and most people who suffer injuries can return to a satisfying level of physical activity after an injury. Even better, many sports injuries can be prevented if people take proper precautions. The potential risk of injuries in sports seems to in- crease for all levels of athletes with increasing participation, intensity and demands, as well as longer training periods. As with any other sport, there are some injuries that are typical for racket sports. When comparing data injury from the racket sports from different studies we have to be very careful, because differences in injury definition, study design methods of data collection, population under study and observation period may leads to substantial variations.

Sports medicine findings, along with medicine and science findings, inevitably contribute to injury prevention and injury treatment programs for all racket sports players. For effective prevention, it is important to understand the functional anatomy and pathophysiology of injuries of different tissues. For in- jury prevention it is also necessary to understand the im- portance of excessive load and how these loads are dis- tributed, sports-injury mechanisms,

III. SUMMARY

The main objective of the study is to find out effectiveness of EMG findings in plyometric exercise versus kinetic chain exercise on biceps and triceps for racket sport players. Total of 4 racket sport athletes were selected for the study according to the selection criteria and equally divided two athletes in each group. Group A consist of 2 racket sport athletes who underwent plyometric exercises and group B consist of 2 racket sport athletes who under went kinetic chain athletes. The treatment duration was four weeks and the total study duration was three months. EMG findings on

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biceps and triceps were measured before and after giving the interventions by using EMG. The pre-test and post-test values of biceps and triceps were obtained and analysed for the results

IV. CONCLUSION

In this study the statistical results shows that there is improvements in both groups. When comparing both groups, it found that plyometric exercise is more effective than kinetic chain exercise for racket sport players.