

# INTENSIVE TRAINING EFFECTS ON SHOULDER MUSCLE INJURY IN TABLE TENNIS PLAYERS



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EFEITOS DO TREINAMENTO INTENSIVO SOBRE A LESÃO MUSCULAR DE OMBRO EM TENISTAS DE MESA

EFFECTOS DEL ENTRENAMIENTO INTENSIVO EN LA LESIÓN MUSCULAR DEL HOMBRO EN JUGADORES DE TENIS DE MESA

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## ABSTRACT

**Introduction:** The glenohumeral joint has the greatest range of motion. Its stability is relatively poor. It depends on muscle strengthening and increased proprioception in the articular and adjacent joint tissues. Muscle-strengthening training for this joint is still an empirical subject related to table tennis players. **Objective:** Explore muscle strengthening training's effect on shoulder muscle injury in table tennis players. **Methods:** Eight table tennis players from a university were selected as a research subject, separated, and classified between injured and control group. Three weeks of strengthening training were adopted to rehabilitate the rotator cuff injury of the table tennis team athletes. The joint angle test and kinematics were collected with isokinetic force measurement employing Cybex-6000. The EMG and other relevant data were collected before and after the experiment. **Results:** The infraspinatus strength test results of 8 athletes before the experiment were  $1.88 \pm 2.10$  versus  $1.61 \pm 1.80$  after the experiment; there was no change in pain among 5 of the eight athletes, the shoulder pain of 1 athlete increased, and the shoulder pain of the other 2 table tennis players decreased. **Conclusion:** Strengthening exercise by intensive shoulder training proved effective in conjunction with traditional rehabilitation, positively influencing hypertrophy and proprioception of the joint complex. **Evidence Level II; Therapeutic Studies – Investigating the results.**

**Keywords:** Tennis; Shoulder Injuries; Muscle Strength.

## RESUMO

**Introdução:** A articulação glenoumeral é a que possui maior liberdade de movimento e sua estabilidade é relativamente precária, dependendo do fortalecimento muscular, da propriocepção da capsula articular e tecidos adjacentes. O treinamento de reforço muscular nessa articulação ainda é um tema empírico relacionado aos jogadores de tênis de mesa. **Objetivo:** Explorar o efeito do treinamento de reforço muscular na lesão muscular do ombro de jogadores de tênis de mesa. **Métodos:** Oito jogadores de tênis de mesa de uma universidade foram selecionados como objeto de pesquisa, separados e classificados entre lesionados e grupo controle. Três semanas de treinamento de reforço foram adotadas para reabilitar a lesão do manguito rotador dos atletas da equipe de tênis de mesa. Foram coletados dados no teste de ângulo articular e cinemática com medição de força isocinética empregando Cybex-6000, além de coleta de dados via EMG e outros dados relevantes antes e depois do experimento. **Resultados:** Os resultados do teste de força muscular do infra-espinal de 8 atletas antes da experiência foram de  $1,88 \pm 2,10$  contra  $1,61 \pm 1,80$  após o experimento; não houve alteração na dor entre 5 dos 8 atletas, a dor no ombro de 1 atleta aumentou e a dor no ombro dos outros 2 jogadores de tênis de mesa diminuiu. **Conclusão:** O exercício de reforço por treinamento intensivo sobre a lesão no ombro mostrou-se eficaz em conjunto com a reabilitação tradicional, influenciando positivamente na hipertrofia e na propriocepção do complexo articular. **Nível de evidência II; Estudos Terapêuticos - Investigação de Resultados.**

**Descritores:** Tênis; Lesões do Ombro; Força Muscular.

## RESUMEN

**Introducción:** La articulación glenohumeral tiene la mayor libertad de movimiento y su estabilidad es relativamente precaria, dependiendo del fortalecimiento muscular, la propiocepción de la cápsula articular y los tejidos adyacentes. El entrenamiento de fortalecimiento muscular de esta articulación sigue siendo un tema empírico relacionado con los jugadores de tenis de mesa. **Objetivo:** Explorar el efecto del entrenamiento de fortalecimiento muscular sobre el daño muscular del hombro en jugadores de tenis de mesa. **Métodos:** Se seleccionaron ocho jugadores de tenis de mesa de una universidad como objeto de la investigación, se separaron y clasificaron entre el grupo de lesionados y el de control. Se adoptaron tres semanas de entrenamiento de fortalecimiento para reabilitar la lesión del manguito rotador de los atletas del equipo de tenis de mesa. Se recogieron datos en la prueba de ángulo articular y en la cinemática con medición de fuerza isocinética empleando el Cybex-6000, además de la recogida de datos mediante EMG y otros datos relevantes antes y después del experimento. **Resultados:** Los resultados de la prueba de fuerza del músculo infraespinoso de 8 atletas antes del experimento fueron de  $1,88 \pm 2,10$  frente a  $1,61 \pm 1,80$  después del experimento; no



hubo cambios en el dolor entre 5 de los 8 atletas, el dolor de hombro de 1 atleta aumentó y el de los otros 2 jugadores de tenis de mesa disminuyó. Conclusión: El ejercicio de fortalecimiento mediante entrenamiento intensivo en la lesión de hombro demostró ser eficaz junto con la rehabilitación tradicional, influyendo positivamente en la hipertrofia y la propiocepción del complejo articular. **Nivel de evidencia II; Estudios terapéuticos - Investigación de resultados.**

**Descriptor:** Tenis; Lesiones del Hombro; Fuerza Muscular.

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## INTRODUCTION

In daily training or competition, the inherent competitive and antagonistic characteristics of competitive sports determine that sports injury is inevitable. Once sports injury occurs, it will inevitably bring negative physical and psychological effects to athletes, and often seriously affect daily training and competition results. However, sports injury can be prevented and treated. Therefore, the prevention and treatment of sports injury has been the focus and difficulty of competitive sports training for a long time.<sup>1</sup> Table tennis is a sport with high technical requirements. The characteristics of table tennis and the particularity of the force producing part can easily lead to the injury of athletes' shoulder joints. In table tennis, all swing movements need the shoulder joint to assist other joints to complete together. The characteristics of this project determine that the shoulder joint is the most frequently used joint, which is prone to injury, especially the rotator cuff injury. Rotator cuff injury has a great impact on Athletes' sports ability, which often leads to the premature retirement of elite athletes.<sup>2-3</sup>

Shoulder joint is the largest joint in human upper limbs and the most flexible joint in human body, but its stability is relatively poor, mainly due to the large area of joint fossa. In relevant studies, it can be found from the physiological anatomy of the shoulder joint that the shoulder joint is mainly composed of a large and round humeral head and a small and shallow scapular pelvis. The external joint capsule plays a role in fixation, but it is very thin.<sup>4</sup> In this case, the activity of the joint will be greatly increased, but the stability of the joint will be reduced. It is the surrounding muscles that help the stability of the joint.<sup>5</sup> There is a close relationship between shoulder injury and table tennis. Table tennis requires athletes' shoulders to contract and swing their arms very quickly, so as to complete the stroke. However, this repeated and rapid arm swing will squeeze and rub the surrounding tissues, and damage will occur when they bear a large force.<sup>6</sup>

## METHOD

### Research object

The athletes of a university table tennis team were selected as the research object. According to the infraspinatus muscle strength test, pain arc test and lift off test, the athletes with shoulder muscle injury were selected. Eight athletes diagnosed with sports rotator cuff injury were the research and analysis objects. The injured shoulder joints were dominant shoulders. The average age was  $21.2 \pm 2.2$  years old, engaged in table tennis for more than 6 years, and reached the level of national second-class athletes or above. (Table 1) All subjects voluntarily participated in the test and experiment, and signed informed consent.

### Research methods

According to the research needs, through the screening of athletes with shoulder muscle group injury, formulate targeted reinforcement training scheme and carry out training. Test the joint angle, kinematics, EMG and other relevant data before and after the experiment, and understand the impact of shoulder muscle reinforcement on Athletes' technical movements through the comparison of the data before and after the experiment.<sup>7</sup>

**Table 1.** basic information of research objects.

name	Age	Years of exercise	Sport level	Height (CM)	Weight (kg)
Dux	25	12	one-level	171	64
Lix	21	10	one-level	178	71
Liux	20	11	one-level	176	72
Zhangx	19	7	one-level	182	75
Cuix	20	10	two level	181	71
Fengx	19	10	two level	173	68
Max	21	11	two level	178	70

### Data acquisition

Measurement of range of motion of shoulder joint.

The subjects sit on the test bench, the upper arm is abducted at 90° and the forearm is flexed at 90° so that the whole upper limb is at the same level, and the "t" shaped ultrasonic sensor is placed at the elbow joint. The testers stabilize their shoulder and foot bones with one hand, hold the front arm of the tested limb with the other hand, rotate their shoulder joint, and record the internal and external rotation range and the whole rotation range.

Internal and external rotator muscle strength test of shoulder joint.

Before the test, the system shall be calibrated routinely, and the subjects shall make full preparations. In particular, the shoulder joint rotates in all directions to ensure that the muscles and ligaments around the shoulder joint are fully stretched and prevent test injury. During the test, the fixation method and joint alignment of the tested joint shall be operated in strict accordance with the requirements of the user manual of cybex-6000 isokinetic force measuring system. Set the test angular velocity to 180° / s and 300° / s, repeat the test for 3 times and rest for 30s.

## RESULTS

### test results of infraspinatus muscle strength (Table 2)

**Table 2.** Test results of infraspinatus muscle strength of table tennis players before and after the experiment.

	Before training	After training	P value
X±SD	1.88±2.10	1.61±1.80	0.186

Note: \* indicates significant difference (P < 0.05).

As shown in Table 2, the test results of infraspinatus muscle strength of shoulder joint injured athletes of table tennis team before and after the experiment show that the test results of infraspinatus muscle strength of 8 athletes before the experiment are  $1.88 \pm 2.10$ , and the test results of infraspinatus muscle strength after the experiment are  $1.61 \pm 1.80$ , indicating that the pain degree of infraspinatus muscle of the tested athletes is relieved after reinforcement training. However, the statistical test before and after the experiment showed that there was no significant difference in the test results of infraspinatus muscle strength (P < 0.05), indicating that although reinforcement exercise can alleviate the degree of shoulder pain of the tested athletes, the effect is not obvious.

## Improvement of active internal and external rotation angles of shoulder joint after reinforcement training (Table 3)

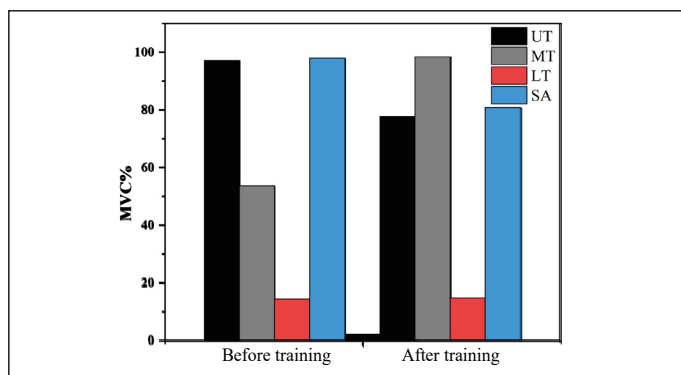
**Table 3.** active internal and external rotation angles of shoulder joints of table tennis players before and after the experiment.

	Before training	After training	P value
Internal rotation angle of shoulder joint (°)	42.71±3.10	60.76±0.13	0.016*
External rotation angle of shoulder joint (°)	80.17±2.14	88.10±2.14	0.012*

Note: \* indicates significant difference (P < 0.05).

As shown in Table 3, after physical therapy and three weeks of shoulder joint reinforcement exercise, the active internal rotation and external rotation angles of the shoulder joint of the table tennis players of Jilin University have changed significantly. The statistical test shows that there is a significant difference in the read only memory (ROM) values of the shoulder joint of the players before and after the experiment (P < 0.05). Combined with the experimental results, it can be seen that the physical therapy and shoulder reinforcement exercise of athletes with shoulder injury can significantly increase the internal rotation ROM value and external rotation ROM value of their dominant arm.

## sEMG comparative analysis of muscle activities of each group during forehand stroke before and after training (Figure 1)



**Figure 1.** Proportion of average value of maximum amplitude of EMG of each muscle in MVC during forehand stroke.

It can be seen from Figure 1 that after training, the multiple variable counter (MVC%) values of muscles such as superior trapezius bundle (UT), middle trapezius bundle (MT) and anterior saw muscle (SA) are significantly different from those before the experiment (P < 0.05), that is, there are significant differences in the EMG activities of these four muscles when the tested athletes complete the forehand stroke before and after training. There was no significant difference in EMG activity between inferior trapezius bundle (LT) and infraspinatus muscle (P > 0.05).

## DISCUSSION

From the analysis results of surface electromyography (sEMG) of table tennis players with shoulder joint injury before and after reinforcement exercise, it can be seen that there are significant differences in the activities of superior trapezius bundle (UT) and anterior saw muscle (SA) before and after reinforcement exercise. After reinforcement exercise, the proportion of UT / SA and MT / PM increased significantly. There was significant difference compared with that before reinforcement exercise (P < 0.05). This shows that athletes with shoulder joint injury will lead to the imbalance of shoulder joint muscle strength. In order to complete the hitting action, athletes mostly lift the shoulder and foot bone and fix it on the chest wall, so as to make the hazy bone swing ideally relative to the trunk. At this time, the compensatory activities of superior bundle of posterior trapezius muscle and anterior saw muscle increase, A large number of repetitive swing movements for a long time can easily lead to excessive load on the above muscles, lead to muscle fatigue, reduce or reduce muscle strength, and even lead to injury. There are many reasons for the decrease of middle bundle activity of trapezius muscle, which may be muscle weakness or strain caused by long-term traction, or to reduce the antagonistic effect of pectoralis major muscle.<sup>8-9</sup> Generally, during the swing process of hitting the ball, the functions of shoulder joint such as up rotation, backward inclination, internal rotation and external rotation are the collaborative result of the joint movement of many muscles. The main muscles involved are the superior trapezius bundle, inferior trapezius bundle and anterior saw muscle. Any muscle injury or functional disorder may lead to the decline of shoulder joint function and change the force line of glenoid joint. Thus affecting the completion quality of hitting technical action.<sup>10</sup> Targeted shoulder joint reinforcement exercise can help the injured muscles gradually recover their functions and improve the coordination of different muscles when they complete the hitting action. Its performance is that the EMG activity has been improved after training.

## CONCLUSION

Most table tennis players have experienced shoulder joint injury. Because of the movement characteristics of table tennis, it is easy to cause shoulder joint injury. In this paper, the EMG signals of athletes completing forehand stroke after targeted reinforcement exercise were compared. The activities of superior trapezius, anterior serratus and anterior deltoid increased, while the activities of middle trapezius decreased. During backhand stroke, the sEMG activity of superior trapezius bundle and anterior saw muscle increased, while the sEMG activity of middle trapezius bundle decreased. Shoulder reinforcement exercise can improve the imbalance of shoulder muscles, so as to achieve the rehabilitation treatment of shoulder pain.

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