CORE STABILITY TRAINING EFFECTS ON LOWER LIMB REHABILITATION OF JUDOKAS

EFEITOS DO TREINO DE ESTABILIDADE DO CORE NA REABILITAÇÃO EM MEMBROS INFERIORES DE JUDOCAS

EFECTOS DEL ENTRENAMIENTO DE LA ESTABILIDAD DEL CORE EN LA REHABILITACIÓN DE LOS MIEMBROS INFERIORES DE JUDOKAS

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ABSTRACT

Introduction: Judo is a sport that presents a high incidence of sports injuries. Judo athletes want to master their skills to the maximum. Good physical conditioning is necessary to decrease the incidence of surgeries and achieve better results. Core stability exercises can discretely reduce the likelihood of lower limb injuries in judo athletes. Objective: This paper examines the rehabilitation of core stability training effects on lower limb injuries in judokas by case studies. Methods: A Chinese judo team member with a lower limb injury underwent core stability training. Isokinetic strength tests, body composition tests, and functional checks explored the athlete's physical recovery after training. Results: The athletes' lower limbs progressed with good recovery (P<0.05). Additionally, a recovery in fitness level was also noted (P<0.05). Conclusion: Core stability training positively affects recovery from lower limb injuries in judokas. **Evidence level II; Therapeutic Studies - Investigating the results.**

Keywords: Judo; Lower Limbs; Athletic Injuries; Strength Training.

RESUMO

Introdução: O judô é um esporte com alta incidência de lesões esportivas. Atletas de judô querem dominar o máximo de suas habilidades. Para diminuir a incidência de cirurgias e alcançar melhores resultados é necessário um bom condicionamento físico. Os exercícios de estabilidade do core podem reduzir discretamente a probabilidade de lesões nos membros inferiores em judocas. Objetivo: Este artigo analisa o efeito da reabilitação com treino de estabilidade do core em lesões de membros inferiores de judocas por meio de estudos de caso. Métodos: Um membro da equipe chinesa de judô com lesão de membro inferior realizou treinamento de estabilidade do core. Foram utilizados testes de força isocinética, testes de composição corporal e verificações funcionais para explorar a recuperação física do atleta após o treino. Resultados: Os membros inferiores dos atletas evoluíram com boa recuperação (P<0,05). Adicionalmente, notou-se também uma recuperação no nível de aptidão física (P<0,05). Conclusão: O treinamento de estabilidade do core afeta positivamente a recuperação de lesões de membros inferiores em judocas. ***Nível de evidência II; Estudos terapêuticos - Investigação de resultados.***

Descritores: *Judô; Membros Inferiores; Traumatismos em Atletas; Treino de Força.*

RESUMEN

Introducción: El judo es un deporte con alta incidencia de lesiones deportivas. Los atletas de judo quieren dominar el máximo de sus capacidades. Para reducir la incidencia de las cirugías y lograr mejores resultados, es necesario un buen acondicionamiento físico. Los ejercicios de estabilidad del core pueden reducir discretamente la probabilidad de lesiones de las extremidades inferiores en los judokas. Objetivo: Este artículo examina el efecto de la rehabilitación con el entrenamiento de la estabilidad del core en las lesiones de las extremidades inferiores en los judokas mediante el estudio de casos. Métodos: Un miembro del equipo de judo chino con una lesión en las extremidades inferiores se sometió a un entrenamiento de estabilidad del core. Se utilizaron pruebas de fuerza isocinética, pruebas de composición corporal y controles funcionales para explorar la recuperación física del atleta después del entrenamiento. Resultados: Los miembros inferiores de los atletas evolucionaron con una buena recuperación (P<0,05). Además, también se observó una recuperación del nivel de aptitud física (P<0,05). Conclusión: El entrenamiento de la estabilidad del core afecta positivamente a la recuperación de las lesiones de las extremidades inferiores en los judokas. ***Nivel de evidencia II; Estudios terapéuticos - Investigación de resultados.***

Descriptores: *Judo; Miembros Inferiores; Traumatismos en Atletas; Entrenamiento de Fuerza.*

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INTRODUCTION

Judo events are sports events with a high incidence of sports injuries. Chronic injuries have plagued many athletes for a long time, limiting athletic ability and competition performance.[1] Training and competition were affected after the Chinese judo athlete AXX was diagnosed with lower limb injuries at the end of 2019. Under this situation, this research passed the phased assessment of the AXX system and developed targeted core stability training. This ensures that he will improve their physical ability while conducting special training.[2] At the same time, this method makes the injury of the lower limbs get a good recovery.

METHOD

Object

The gender of AXX is male. He is an athlete of the Chinese National Judo Team. He is 21 years old, 183cm tall, and weighs 95.7kg. Discomfort in the legs occurred in October 2019. Pain after intense training was diagnosed as lower limb injury.[3] In addition, the lateral collateral ligament of the left ankle was injured. Athletes suffer from pain when the training intensity is high.

Research methods

Isokinetic muscle strength test method

We use the ISOMED2000 isokinetic test system to measure the strength of the antagonistic muscles of the athletes' trunks, shoulders, hips, knees, and ankles.[4] The test speed of the torso, shoulder, hip, knee, and ankle joints is 60°/s. Both the fixing method and the test procedure strictly comply with the requirements of the operation manual.[5] The research index is the peak torque (Nm), the ratio of the peak torque of the antagonistic muscle group, and the bilateral difference.

Body composition test method

We use a Korean InBody3.0 body composition analyzer. The experiment uses 8 contact electrodes, multiple regression analysis, and multiple frequency detection methods to analyze the body composition comprehensively.[6] The research indicators are body weight (kg), muscle weight (kg), lean body weight (kg), body fat (kg), body fat ratio (%).

Function inspection method

We use American advanced Physical Therapy functional inspection methods to conduct comprehensive and phased inspections and assess athletes' physical functions.[7] This provides a reference and basis for core stability training.

Model design of lower limb injury response

The mass and moment of inertia of the femur and tibia are m_1, l_1 and m_2, l_2 respectively. And the femur and tibia are subjected to external forces F_h, F_b and F_s from the car.[8] The displacement of the knee is x_0. The displacement of the center of gravity of the femur and tibia is x_1, x_2. The rotation angle is θ_1, θ_2. So we get the equation of motion as:

$$\begin{pmatrix} m_1+m_2 & -m_1(L_1-L_0) & m_2(L_0-L_2) \\ -m_1(L_1-L_0) & I_1+m_1(L_1-L_0)^2 & 0 \\ m_1(L_0-L_2) & 0 & I_2+m_2(L_0-L_2)^2 \end{pmatrix} \begin{pmatrix} x_0 \\ \theta_1 \\ \theta_2 \end{pmatrix} + \begin{pmatrix} 0 & 0 & 0 \\ 0 & k & -k \\ k & -k & k \end{pmatrix} \begin{pmatrix} x_0 \\ \theta_1 \\ \theta_2 \end{pmatrix} = \begin{pmatrix} 1 & 1 & 1 \\ L_1-z_h & 0 & 0 \\ 0 & L_0-z_b & L_0-z_s \end{pmatrix} \begin{pmatrix} F_h \\ F_b \\ F_s \end{pmatrix} \quad (1)$$

From the equation of motion (1), the knee bending angle formula can be obtained:

$$\theta=\theta_1-\theta_2 \quad (2)$$

The tibial acceleration calculated from the position where the sensor is installed is as follows:

$$\alpha_A = x_0 + 0.066\theta_2 = x_x - (L_0 - L_2 - 0.066)\theta_2 \quad (3)$$

The acceleration from the upward position z from the lower end of the calf is as follows:

$$\alpha(z) = x_0 + (L_0 - z)\theta_2 \quad (4)$$

Calculate the bending moment $M(z)$ from the lower end to the upward position z according to the external forces F_b and F_s on the tibia.

When $0 \le z \le z_s$, the bending moment $M(z)$ from the lower end of the tibia to the upward position z is as follows:

$$M(z) = \frac{m_2}{L_0}\int_0^z \{x_0 + (L_0 - z')\theta_2\}(z - z')dz' \quad (5)$$

When $z_s \le z \le z_b$, the bending moment $M(z)$ from the lower end of the tibia to the upward position z is as follows:

$$M(z) = \frac{m_2}{L_0}\int_0^z \{x_0 + (L_0 - z')\theta_2\}(z - z')dz' - F_s(z - z_s) \quad (6)$$

When $z_b \le z \le L_0$, the bending moment $M(z)$ from the lower end of the tibia to the upward position z is as follows:

$$M(z) = \frac{m_2}{L_0}\int_0^z \{x_0 + (L_0 - z')\theta_2\}(z - z')dz' - F_s(z - z_s) - F_b(z - z_b) \quad (7)$$

RESULTS

Results and analysis of isokinetic muscle strength test before AXX core stability training

It can be seen from Table 1 and Table 2 that the strength of the AXX abdominal and back muscles was weak before the rehabilitation training. In particular, the weak abdominal muscles result in a low ratio of abdominal, back muscles. The horizontal abduction strength of the shoulder joint is weaker than the adduction strength. It shows that the strength of the back of the trapezius and deltoid muscles of the shoulder joint is poor.[9] The strength of shoulder joint flexors is weaker than that of extensors. It indicates that the strength of the pectoralis major, the front deltoid muscle, and the biceps are poor. The strength of hip flexors is weaker than that of extensors. It shows that the strength of the iliopsoas muscle is poor. The strength of knee joint flexors is weaker than that of extensors. It shows that the biceps femoris, semitendinosus, and semimembranosus muscles are weak.[10] However, from the test results, the left and right limbs of AXX are more coordinated, and the bilateral difference is less than 15%.

AXX core stability training three-stage training program

AXX rehabilitation training is carried out in 3 stages. Before each stage, they have undergone an isokinetic muscle strength test, a body composition test, and a physical function check.[11] Then, different training content

Table 1. Test results of isokinetic (60°/s) of trunk and shoulder joints before AXX rehabilitation training (2020.2.1).

Test index		Peak torque (Nm)		
		Left	Right	Bilateral difference
Trunk flexion and extension	Bend	202	/	/
	stretch	348	/	/
	Flexion/extension	58%	/	/
Shoulder joint horizontal abduction and adduction	Outreach	88	83	5.70%
	Adduction	101	99	2.00%
	Outreach/Adduction	87%	84%	/
Shoulder joint flexion and extension	Bend	67	72	-7.00%
	stretch	121	128	-5.50%
	Flexion/extension	55%	56%	/

was formulated at each stage according to specific training requirements, isokinetic muscle strength, body composition test results, and athletes' injury response. Optimize the training program by evaluating the training effect of each stage. This ensures the quality of athletes' rehabilitation training.

Analysis of isokinetic muscle strength test results during the intervention phase of AXX core stability training

From Table 3 and Table 4, it can be seen that the strength of the muscle groups in each part of the AXX body has been significantly improved after the 3 stages of rehabilitation training.[12] The strength gains of the shoulder, hip, and knee flexors are all-around 40%. In the National Games, the strength ratio of the front and rear muscle groups near each joint is more coordinated. Moreover, the left and right limbs are more coordinated, and the bilateral difference is less than 10%.

Analysis of body composition test results during the intervention phase of AXX core stability training

It can be seen from Table 5 that the body composition of AXX has undergone significant changes after three stages of core stability training, special training, and pre-match weight control.[13] Mainly manifested in reducing body weight, muscle weight, lean body mass, body fat, and body fat percentage. This makes AXX's body more in line with the special requirements. At the same time, the pre-match weight goal set by the coach was reached.

Table 2. The results were before AXX rehabilitation training (2020.2.1), hip joint, knee joint, and ankle joint isokinetic (60°/s).

Test index		Peak torque (Nm)		
		Left	Right	Bilateral difference
Hip flexion and extension	Succumbing	177	196	-9.90%
	Shin	325	322	0.90%
	Bending / stretching	54%	61%	/
Knee flexion and extension	Succumbing	124	142	-12.70%
	Shin	291	306	-4.90%
	Bending / stretching	43%	46%	/
Ankle flexion and extension	Succumbing	40	42	-4.70%
	Shin	132	148	-10.80%
	Bending / stretching	30%	28%	/

Table 3. Isokinetic (60°/s) test results of trunk and shoulder joints during the AXX core stability training intervention phase.

Test index-peak torque (Nm)		Left side			
		2019.2.1	2020.5.3	2020.8.15	Increase
Trunk flexion and extension	Bend	202	242	255	26%
	stretch	348	390	401	15%
	Flexion/extension	58%	62%	64%	/
Horizontal abduction and adduction of shoulder joint	Outreach	88	94	98	11%
	Adduction	101	118	121	20%
	Outreach/ Adduction	87%	80%	81%	/
Shoulder joint flexion and extension	Bend	67	69	98	46%
	stretch	121	126	140	16%
	Flexion/extension	55%	55%	70%	/
Test index-peak torque (Nm)		**Right**			
		2019.2.1	2020.5.3	2020.8.15	Increase
Trunk flexion and extension	Bend	/	/	/	/
	stretch	/	/	/	/
	Flexion/extension	/	/	/	/
Horizontal abduction and adduction of shoulder joint	Outreach	83	90	97	17%
	Adduction	99	114	119	20%
	Outreach/ Adduction	84%	79%	82%	/
Shoulder joint flexion and extension	Bend	72	97	103	43%
	stretch	128	141	152	19%
	Flexion/extension	56%	69%	68%	/

Table 4. AXX core stability training intervention stage hip, knee, ankle joint isokinetic (60°/s) test results.

Test index-peak torque (Nm)		Left side			
		2019.2.1	2020.5.3	2020.8.15	Increase
Trunk flexion and extension	Bend	177	256	273	54%
	stretch	325	340	361	11%
	Flexion/extension	54%	75%	76%	/
Horizontal abduction and adduction of shoulder joint	Outreach	124	160	211	70%
	Adduction	291	340	352	21%
	Outreach/ Adduction	43%	47%	60%	/
Shoulder joint flexion and extension	Bend	40	39	47	18%
	stretch	132	166	171	30%
	Flexion/extension	30%	23%	27%	/
Test index-peak torque (Nm)		**Right**			
		2019.2.1	2020.5.3	2020.8.15	Increase
Trunk flexion and extension	Bend	196	226	266	36%
	stretch	322	349	359	11%
	Flexion/extension	61%	65%	74%	/
Horizontal abduction and adduction of shoulder joint	Outreach	142	149	198	39%
	Adduction	306	340	347	13%
	Outreach/ Adduction	46%	44%	57%	/
Shoulder joint flexion and extension	Bend	42	48	49	17%
	stretch	148	177	173	17%
	Flexion/extension	28%	27%	28%	/

Table 5. Body composition test results during the intervention phase of AXX core stability training.

Date	2020.1.20	2020.6.4	2020.8.15	Increase
Weight (kg)	97.6	95.1	93.6	-4
Muscle weight (kg)	80.7	80.8	78.3	-2.4
Lean body weight (kg)	85.9	85.9	83.4	-2.5
Body fat (kg)	11.7	10.8	10.2	-1.5
Body fat (%)	11.9	11.3	10.9	-1

DISCUSSION

Because judo athletes repeat special technical exercises many times during training and competition, local muscles will continue to contract and passively elongate actively. In this way, the local muscles will bear a greater load. Acute injury and chronic strain will develop over time. This results from local muscle atrophy of athletes and imbalance of muscle strength around joints. Core stability training requires periodic testing and stage evaluation. This provides a reference and basis for each stage of training to modify and improve the training plan. We need to analyze the athletes' injuries. At the same time, perform systematic muscle strength diagnosis, body composition test, and physical function check on athletes. In this way, targeted core stability training is developed. Only in this way can the athletes' injuries and performance levels be effectively improved.

CONCLUSION

The concept of core stability training in the practical test in AXX is in line with the needs of actual sports teams. The training achieved the expected purpose. In practice, we need to enhance our understanding of the importance of core stability training in preventing and treating sports injuries. Change the mindset of rehabilitation of sports injuries centered on treatment. We need to establish a modern core stability training concept of prevention first, treatment second, and prevention and treatment.

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