MUSCLE INJURY AND SPORTS REHABILITATION MANAGEMENT IN ENDURANCE TRAINING ORIENTED TO WINTER SPORTS

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LESÃO MUSCULAR E GERENCIAMENTO DA REABILITAÇÃO ESPORTIVA NO TREINAMENTO DE RESISTÊNCIA DIRECIONADO AOS ESPORTES DE INVERNO

GESTIÓN DE LAS LESIONES MUSCULARES Y DE LA REHABILITACIÓN DEPORTIVA EN EL ENTRENAMIENTO DE RESISTENCIA DIRIGIDO A LOS DEPORTES DE INVIERNO

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ABSTRACT

Introduction: Muscle injury in ski sports training has gradually increased, greatly impairing performance in ice and snow sports competitions. Objective: To study muscle injury and muscle movement during ice and snow sports training and the rehabilitation of muscle injuries. Methods: Thirty skiers with knee muscle injuries were selected as subjects and underwent rehabilitation training for six weeks, and the indicators were statistically evaluated. Results: The ski injuries were mainly muscle strain, muscle or ligament strain, and ligament rupture. The indices after treatment were significantly different from those before treatment ($P < 0.05$); compared with the three rehabilitation programs, the improvement of each index in group C was significantly different from that in the other two groups ($P < 0.05$), while there was no significant difference in the improvement of each index between the multi-angle isometric training treatment in group A and the proprioceptive neuromuscular stimulation technique in group B ($P>0.05$). Conclusion: The influence of recovery training technology on knee muscle re-education was proposed, and a rehabilitation plan for skiing was presented. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: Skiing, Snow; Endurance Training; Athletic Injuries.

RESUMO

Introdução: O quadro de lesão muscular no treinamento esportivo de esqui tem aumentado gradualmente, prejudicando muito o desempenho das competições esportivas de gelo e neve. Objetivo: Estudar a lesão muscular e o movimento muscular durante o treinamento esportivo no gelo e na neve, bem como a reabilitação das lesões musculares. Métodos: Trinta esquiadores com lesão muscular no joelho foram selecionados como sujeitos e submetidos a treinamento de reabilitação por um total de 6 semanas, tendo os indicadores sido avaliados estatisticamente. Resultados: Os tipos de lesões no esqui foram principalmente tensão muscular, tensão muscular ou ligamentar e ruptura ligamentar. Os índices após o tratamento foram significativamente diferentes daqueles antes do tratamento ($P < 0,05$); comparado com os três programas de reabilitação, a melhora de cada índice no grupo C foi significativamente diferente da dos outros dois grupos ($P < 0,05$), enquanto não houve diferença significativa na melhora de cada índice entre o tratamento de treinamento isométrico multiangular no grupo A e a técnica de estimulação neuromuscular proprioceptiva no grupo B ($P>0,05$). Conclusão: A influência da tecnologia de treinamento de recuperação na reeducação muscular do joelho foi proposta, e foi apresentado um plano de reabilitação para a prática de esqui. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

Descritores: *Esqui na Neve; Treino de Resistência; Traumatismos em Atletas.*

RESUMEN

Introducción: El cuadro de lesiones musculares en el entrenamiento de los deportes de esquí ha ido aumentando progresivamente, lo que perjudica en gran medida el rendimiento en las competiciones de deportes de hielo y nieve. Objetivo: Estudiar las lesiones musculares y el movimiento muscular durante el entrenamiento de los deportes de hielo y nieve, así como la rehabilitación de las lesiones musculares. Métodos: Se seleccionaron como sujetos treinta esquiadores con lesiones musculares en la rodilla y se sometieron a un entrenamiento de rehabilitación durante un total de 6 semanas, y se evaluaron estadísticamente los indicadores. Resultados: Los tipos de lesiones de esquí fueron principalmente la distensión muscular, la distensión muscular o de ligamentos y la rotura de ligamentos. Los índices después del tratamiento fueron significativamente diferentes de los anteriores ($P < 0,05$); en comparación con los tres programas de rehabilitación, la mejora de cada índice en el grupo C fue significativamente diferente de la de los otros dos grupos ($P < 0,05$), mientras que no hubo diferencias significativas en la mejora de cada índice entre el tratamiento de entrenamiento isométrico multiángulo en el

grupo A y la técnica de estimulación neuromuscular propioceptiva en el grupo B (P>0,05). Conclusión: Se propuso la influencia de la tecnología de entrenamiento de recuperación en la reeducación muscular de la rodilla y se presentó un plan de rehabilitación para el esquí. ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

Descriptores: Esquí; Entrenamiento de Resistencia; Traumatismos en Atletas.

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INTRODUCTION

With the continuous development of China's economy and the continuous improvement of the status of competitive sports, the country has realized that the development of winter sports is inseparable from the development of sports power, especially after the successful holding of the 2008 Beijing Summer Olympic Games. The state has formulated a series of measures to promote the development of ice and snow sports, such as the "North ice South Exhibition" and "balanced development of ice and snow" in the Olympic glory plan, so that China's ice and snow sports have made great progress. In recent years, cross-country skiing projects continue to narrow the gap with foreign high levels. With the success of the 2022 Beijing Winter Olympics, the state has increased investment in the development of ice and snow projects.[1]

Research shows that once sports injury occurs, athletes' whole-body training stops, which not only affects their physical health and reduces the training effect, but also greatly affects athletes' mental state. The training after recovery will have a great psychological shadow, especially for those athletes who have serious sports injuries and even affect their normal life, they will also face great life pressure.[2] Sports injury seriously limits the development of elite sports teams in Colleges and universities. At present, in the field of ice and snow sports training, the phenomenon of simply pursuing "three major and one obedience" still exists. The pursuit of achievement eager for quick success and instant benefit will only cause serious physical losses for high-level athletes, and the number of competitions at different levels and types will continue to increase. Under the condition of increasingly fierce competition, athletes are overwhelmed, and the mental and physical tension breaks the physical and mental defense line of athletes, Cause different degrees of sports injury. Effectively reduce the possibility of athletes' sports injury and muscle injury. Therefore, in order to ensure that athletes continuously improve their comprehensive competitive level in normal training and competition and effectively prevent sports injuries, it is necessary to explore and study the current situation, causes and rehabilitation schemes of ice and snow sports injuries.[3]

METHOD

Questionnaire survey

Questionnaire design: combined with literature research and expert advice, a questionnaire survey was conducted on skiers and coaches. In order to ensure the reliability of the research data, the effectiveness of the overall content, structure and design of the questionnaire for athletes and coaches was tested. The study and all the participants were reviewed and approved by Ethics Committee of Hexi University (NO. 2018HXU0057Z).

Questionnaire distribution and recovery: in this study, 150 questionnaires were distributed to athletes, and 110 were recovered, with a recovery rate of 73%. Except for 10 invalid questionnaires, there were 100 valid questionnaires, and the effective recovery rate was 91%. In the process of this study, 60 questionnaires were distributed to coaches, and 60 were recovered, with a recovery rate of 100%.

Experimental scheme

The three groups received rehabilitation treatment for 6 weeks, 3 times a week, a total of 18 times. Group a proprioceptive neuromuscular facilitation (PNF): according to the actual dysfunction of the subjects (weak muscle strength), the training was carried out by combining basic techniques with special techniques. The lower limbs were treated in four modes: d1f (flexion adduction external rotation), d1e (extension abduction internal rotation), D2f (flexion abduction internal rotation) and d2E (extension adduction external rotation). Among them, d1f and d1e were one group, D2f and d2E were one group. Each group completed a course of treatment, relaxed and rested for 8-10 seconds, and each treatment lasted 40 minutes.

Group B multi angle isometric training (MIE): according to the actual situation of the subjects, a group of isometric exercises is carried out every 20 ° within the range of motion of their joints, that is, a group of training is completed at the knee flexion position of 30 °, 50 °, 70 °, 90 ° and 110 °, a total of 5 groups. The "tens" principle is adopted (muscle contraction for 10 seconds each time, then rest for 10 seconds, repeat for 10 times as a group, rest for 1 minute between groups), Train quadriceps femoris and hamstrings respectively for 40 minutes.

Group C PNF combined with Mie: on the basis of completing all the procedures of the above two techniques, the time was halved, and the total treatment time was 40 minutes.

RESULTS

Injury status of skiers

The study found that among the 100 Chinese athletes surveyed, 82 were injured, accounting for 82% of the total number of athletes surveyed, while only 18 were uninjured, accounting for 18%. Among the 70 male athletes surveyed, 58 were injured, accounting for 82.9% of all male athletes, and only 12 were not injured, accounting for 17.1%; Among the 30 female athletes surveyed, 24 were injured, accounting for 80% of the total number of female athletes, and only 6 were not injured. See Table 1 for details.

Table 2 shows that Chinese skiers have seven types of injuries. Among the injuries, muscle strain ranked first, accounting for 80%, 52 male athletes and 28 female athletes, followed by muscle or ligament strain, accounting for 60%, 48 male athletes and 12 female athletes; 53 people with fractures ranked third, accounting for 53% of the injured.

From this, we can see that muscle injury, muscle or ligament strain and ligament tear account for a large proportion of skiers' injury types. Therefore, this paper takes muscle injury as the focus of analysis.

Table 1. Incidence of sports injuries of skiers.

Group	Total	Injuries	Not injured	Total
Male athlete	70	58	12	70
Percentage (%)	100	82.9	17.1	100
Female athlete	30	24	6	30
Percentage (%)	100	80	20	100
Total	100	82	18	100
Percentage (%)	100	82	18	100

According to the degree of injury, muscle injury can be divided into minor injury, moderate injury and serious injury. Mild muscle injury refers to normal training according to the training plan within 24-48 hours after injury, and normal training can be carried out after routine treatment; Moderate muscle injury refers to the need to stop or reduce activity in the affected area after injury, but you can still continue training. It can be recovered through routine treatment and appropriate rehabilitation training; Severe muscle injury refers to the loss of physical ability after injury, which needs treatment and can not be trained at all; Muscle recovery requires at least half a month of rehabilitation and special treatment. From the previous section, we can see that there are 170 cases of muscle fatigue, muscle or ligament fatigue and ligament rupture. Table 3 analyzes 170 examples of muscle injury during exercise:

According to the survey results in Table 3, there are 38 skiers with mild muscle injury, including 38 male athletes, accounting for 34.6% and 22.4% of the total number of male athletes; There were 83 moderate muscle injuries, including 62 male athletes, accounting for 56.4% of the total number of male athletes, 21 female athletes, accounting for 35% of the total number of female athletes and 48.8% of the total number of athletes; There were 49 people with severe muscle injuries, including 10 male athletes, accounting for 9% of the total number of male athletes, and 39 female athletes, accounting for 65% of the total number of female athletes, accounting for 28.8% of the total.

Ski muscle movement - knee joint as an example

As can be seen from the previous section, as long as the skier has muscle injury, the probability is moderate and severe, leaving more or less hidden dangers to the skier's ski career. Therefore, this section analyzes the movement of knee muscles based on the situation of ski muscles - Taking knee joints as an example.

The peak torque of knee flexor and extensor group and the peak torque per unit weight can not well estimate the explosive force and coordination ability of knee muscle in cross-country skiing and technology, which not only affects the sports performance, but also is of great significance to maintain the stability of knee joint and prevent the strain of weak muscle group in sports. At the same time, the muscle distribution can also be found through research. Therefore, in this work, the strength of skiers' knee extensor and flexor muscles was tested and analyzed. The test results of maximum flexion and extension torque, torque angle, peak torque per unit weight and work done per unit weight of knee joint are shown in Table 4.

It can be seen from the test results in Table 4 that under the same speed on the same side, the peak torque, peak torque angle, peak torque per unit weight and work per unit weight of the left and right extensors of the ski athletes' knee joint are greater than those of the left and right flexors, and there are significant differences ($P < 0.05$).

The average performance index of knee joint can well reflect the work ability and output of muscle strength of knee joint. The range of motion is used to analyze the degree of flexion and extension of knee joint. See Table 5 for the test results of average knee flexion and extension power and range of motion of skiers.

From the analysis of test data in Table 5, it can be seen that under the two test speeds of 60 ° / s and 180 ° / s, the range of motion of athletes' left knee joint is 74.99 ± 0.50 (60 ° / s) and 74.99 ± 1.25 (180 ° / s). The range of motion of the right side is 74.00 ± 1.89 (60 ° / s) and 74.79 ± 1.00 (180 ° / s) respectively. After the comparison of the same speed and the same side, there is no difference in the range of motion of the athlete's knee joint. The range of motion of the left side is slightly larger than that of the right side, and the flexion and extension ability of the athlete's right muscle group is slightly weaker than that of the left side.

DISCUSSION

The preparation and warm-up activities of skiing should be systemic, which is very useful for preventing injury, "warming up" the body, lubricating joints and activating the central nervous system, and should be treated seriously and correctly.[4] At present, alpine ski coaches and

Table 2. Types and number of sports injuries of skiers.

	Male	Female	Total	Percentage
Fracture	32	21	53	53%
Joint dislocation	28	19	47	47%
Muscle or ligament strap	48	12	60	60%
Articulation	29	12	41	41%
Ligament break	16	14	30	30%
Muscle strain	52	28	80	80%
Brain trauma	11	14	25	25%
Other	10	0	10	10%

Table 3. Number of skiers with muscle injury degree n = 170.

Group	light	moderate	Severe	Undamaged
Male athlete	38	62	10	0
Percentage (%)	34.6%	56.4%	9%	0%
Female athlete	0	21	39	0
Percentage (%)	0%	35%	65%	0%
Total	38	83	49	0
Percentage (%)	22.4%	48.8%	28.8%	0%

Table 5. Comparison of average power and range of motion of knee flexor and extensor.

Angular velocity	Index	Bend average power	Extended average power	Range of motion
60°/s	Left side	75.98±6.34	132.90±17.17	74.99±0.50
	Right	78.70±12.68	134.64±21.40	74.00±1.89
	P value	P>0.05	P>0.05	P>0.05
180°/s	Left side	127.95±16.44	237.10±55.01	74.99±1.25
	Right	145.77±26.61	134.64±21.40	74.79±1.00
	P value	P>0.05	P>0.05	P>0.05

Table 4. Comparison of four indexes of knee flexor and extensor at the same speed, on the same side and at the same speed.

Angular velocity		Index	Peak torque	Peak torque angle	Peak torque per unit weight	Peak work per unit weight
60°/s	Muscle	Left side	115. 08±14.22	29.7 ±5. 59	1. 76 ±0. 23	1. 97±0. 34
		Right	120. 78±14.32	32. 42±4. 57	1. 85 ±0. 22	1. 97±0. 27
		P value	P>0. 05	P>0. 05	P>0. 05	P>0. 05
	Extensive muscle	Left side	219. 78 ±26.26	63. 60 ±11. 67	3. 35 ±0. 29	2. 81±0. 47
		Right	225. 72±34. 72	65.09±1. 89	3. 44±0. 41	3. 13±0. 25
		P value	P>0. 05	P>0. 05	P>0. 05	P>0. 05
180°/s	Muscle	Left side	88. 85 ±23. 52	28. 46±4. 34	1. 35 ±0. 34	1. 17±0. 33
		Right	112. 36 ±15. 26	28. 21 ±7. 05	1. 71 ±0. 17	1. 37 ±0. 28
		P value	P>0. 05	P>0. 05	P>0. 05	P>0. 05
	Extensive muscle	Left side	163. 59 ±20. 88	61. 13±1. 89	2. 50 ±0. 28	2. 13 ±0. 40
		Right	158. 89±19. 00	63.11 ±7. 45	2. 42 ±0. 25	2. 15±0. 36
		P value	P<0. 05	P>0. 05	P<0. 05	P>0. 05

athletes pay less attention to preparatory activities, and this trend should be reversed. It is very important for skiers to make full preparations before training or competition. Some athletes do not pay attention to preparation activities before training, resulting in various sports injuries to their knee joints, which not only affects the training effect, but also affects the training interest, and is easy to be afraid of training. Therefore, every athlete should be required to make full preparations before each training to avoid injury accidents. Proper preparation can prevent sports injury and reduce muscle viscosity; It can improve the speed of muscle contraction and relaxation; It can increase muscle strength, elasticity and ligament stretch; It can help improve the function of internal organs. Therefore, it can reduce the discomfort caused by visceral discomfort at the beginning of exercise. In addition, preparatory activities can also regulate the psychological state, improve the neural connection between various centers, and keep the cerebral cortex in the highest arousal state for high-intensity exercise or competition.[5]

The experiment of this study shows that multi angle isometric training, proprioceptive neuromuscular stimulation, proprioceptive neuromuscular stimulation combined with multi angle isometric training can effectively improve the knee joint of 30 skiers with knee joint injury. Skiers have a positive impact. When measuring the thigh circumference of 10cm and the strength of quadriceps femoris and hamstring muscle before and after treatment, it is found that each group has different degrees of performance in these aspects after treatment. However, according to the analysis data, the rehabilitation effect of group C using proprioceptive neuromuscular stimulation technology combined with multi angle isometric training is the most significant. At the same time, it can improve the muscle strength around the knee and proprioception around the knee. Combined with multi angle isometric exercise therapy or proprioceptive neuromuscular stimulation therapy, the effect is better.[6]

CONCLUSION

The muscle injury of athletes in ice and snow sports directly determines the athletes' sports performance and sports life. This study investigated and analyzed 100 ice and snow athletes through questionnaire survey, expert interview and the training results of front-line coaches with rich training experience, combined with sports training theory, in order to understand the current situation, causes and types of muscle injury in ice and snow sports. 30 ice and snow athletes with muscle injury were selected to discuss the rehabilitation plan of sports injury. It is hoped to provide a useful reference for injury sports and athletes' rehabilitation in ice and snow events.

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