BIOMECHANICAL ENERGY METABOLISM MODEL OF SPORTS MEDICINE

O MODELO DE METABOLISMO DE ENERGIA BIOMECÂNICA NA MEDICINA DO ESPORTE

EL MODELO DE METABOLISMO DE ENERGÍA BIOMECÁNICA EN LA MEDICINA DEL DEPORTE

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ABSTRACT

Introduction: This is a study on the reasonable organization and collocation of sports health elements in different sports forms, and how this is reflected through scientific exercise instructors. Objective: To improve the effect of sports medicine on the biomechanical energy metabolism of human health. Methods: The biomechanical model of knee joint stress was used to analyze the mechanical behavior of knee joint flexion, such as movement and contact; the variation law and peak value of stress on the contact surface of the tibiofemoral joint were obtained. Results: Based on the changes of stress on tibiofemoral joint contact surface and the peak value of the data obtained in this paper, the model and data basis were provided for guiding scientific sports training and sports medicine treatment, preventing knee joint sports injury, knee joint inflammation, and reasonably improving sports performance. Conclusions: Sports medicine is effective in improving human health. The objects of clinical exercise guidance include all people, from infancy to the old age. The function of exercise is recognized in the effect of the whole process of prevention, treatment and rehabilitation of a variety of clinical diseases. The effectiveness of exercise in the whole process of disease is also recognized. ***Level of evidence II; Therapeutic studies - investigation of treatment results.***

Keywords: Sports medicine; Health; Biomechanical phenomena.

RESUMO

Introdução: Este é um estudo sobre a organização e colocação racional de elementos da saúde do esporte em diferentes modalidades esportivas, e como isso se reflete nos instrutores de exercício científico. Objetivo: Melhorar o efeito da medicina do esporte no metabolismo energético biomecânico da saúde humana. Métodos: O modelo biomecânico de estresse na junta do joelho foi usado para analisar o comportamento mecânico da flexão da junta do joelho, tais como movimento e contato; a lei de variação e o valor máximo de estresse na superfície de contato da junta tíbio-femoral foram obtidos. Resultados: Com base nas mudanças de estresse na superfície de contato da junta tíbio-femoral e o valor máximo dos dados obtidos neste estudo, a base do modelo e dos dados foram fornecidos para guiar cientificamente o treino de esportes e o tratamento da medicina do esporte, prevenindo as lesões da junta do joelho no esporte, a inflamação da junta do joelho, e melhorando o desempenho esportivo de forma razoável. Conclusões: A medicina do esporte é eficaz na recuperação da saúde humana. Os objetos da orientação clínica de exercícios incluem todos, desde a infância até a velhice. A função do exercício é reconhecida através do efeito de todo o processo de prevenção, tratamento e reabilitação de uma série de doenças clínicas. A eficácia do exercício no processo total de doenças também é reconhecida. ***Nível de evidência II; Estudos terapêuticos – investigação de resultados de tratamento.***

Descritores: *Medicina esportiva; Saúde; Fenômenos biomecânicos.*

RESUMEN

Introducción: Este es un estudio sobre la organización y colocación racional de elementos de la salud del deporte en diferentes modalidades deportivas y como eso se refleja en los instructores de ejercicio científico. Objetivo: Mejorar el efecto de la medicina del deporte en el metabolismo energético biomecánico de la salud humana. Métodos: El modelo biomecánico de estrés en la articulación de la rodilla se usó para analizar el comportamiento mecánico de la flexión de la articulación de la rodilla, como movimiento y contacto. Se obtuvo la ley de variación y el valor máximo de estrés en la superficie de contacto de la articulación femorotibial. Resultados: Con base en los cambios de la articulación femorotibial y el valor máximo de los datos obtenidos en este estudio, la base del modelo y de los datos se fornecieron para guiar científicamente el entrenamiento de deportes y el tratamiento de la medicina del deporte, previniendo las lesiones de la articulación de la rodilla en el deporte, la inflamación de la articulación de la rodilla, y mejorando el rendimiento deportivo de forma razonable. Conclusiones: La medicina del deporte es eficaz en la recuperación de la salud humana. Los objetos de la orientación clínica de ejercicios incluyen todos, de la infancia hasta la vejez. Se reconoce la función del ejercicio a través del efecto de todo el proceso de prevención, tratamiento y rehabilitación de una serie de enfermedades clínicas. La eficacia del ejercicio en el proceso total de enfermedades también se reconoce. ***Nivel de evidencia II; Estudios terapéuticos – investigación de resultados de tratamiento.***

Descriptores: *Medicina desportiva; Salud; Fenómenos biomecánicos.*

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INTRODUCTION

The generation and development of a new thing cannot be separated from the joint action of internal and external factors. As a new discipline, sports medicine has its own characteristics and advantages.[1] Facing the pursuit of health, some choose to swim, some choose to do Tai Chi, and some choose to run. Although the form of exercise is different, they all get healthy in the end, sports medicine is dedicated to the study of the reasonable organization and collocation of sports health elements in different forms of sports, which can be reflected by scientific exercise instructors to organize and guide different sports individuals and develop personalized exercise programs.[2] Different from traditional sports skills education, sports medicine carries out healthy sports skills education, advocating higher, faster, stronger, more beautiful, more excited to be healthier. The study on the effect of sports medicine on improving the biomechanical energy metabolism of human health was proposed.[3] Sports medicine addresses the issue of individualized instruction in exercise, the safety of exercise for each person, the health effects of exercise, and how exercise can become an integral part of a lifestyle.

METHOD

Biomechanical model of knee joint force

The knee joint is composed of femoral ankle, tibial plateau, fibula, patella, ligament, meniscus, articular cartilage, muscle, etc. , and its structure is shown in Figure 1.

The force on various parts of the human body is quite complex, which involves a lot of biomechanical knowledge and physical knowledge. In order to facilitate modeling, the complex physiological structure of the knee joint is reasonably simplified, around the knee joint, it was simplified into four parts, namely the upper limb, femur, patella and tibia. At the tibiofemoral joint, the complex structure was simplified into a joint ball and the four ligaments were simplified into one: The cruciate ligament. When the human body flexes the knee, if the "femur" is taken as the research object: the cruciate ligament (the position of patella) is taken as the fulcrum, its mechanical structure is shown in Figure 2.[4]

Under the condition of weight load, static and foot support, the knee support is related to the knee bend Angle and the inclination of various body parts. As can be seen from Figure 2, in order to obtain the pressure F of the knee joint, the femur can be taken as the rigid body for discussion. Assuming that the human body is in the stationary state of bent knee and the patellar ligament (position of patella) is taken as the fulcrum, the external tibial moment can be obtained as 0:

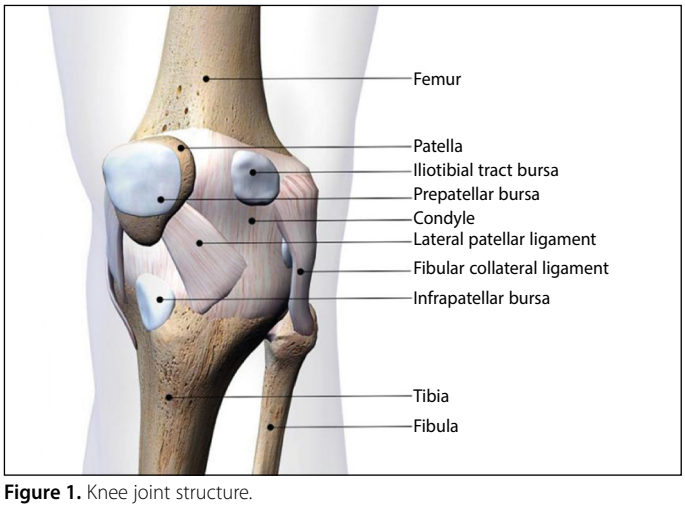
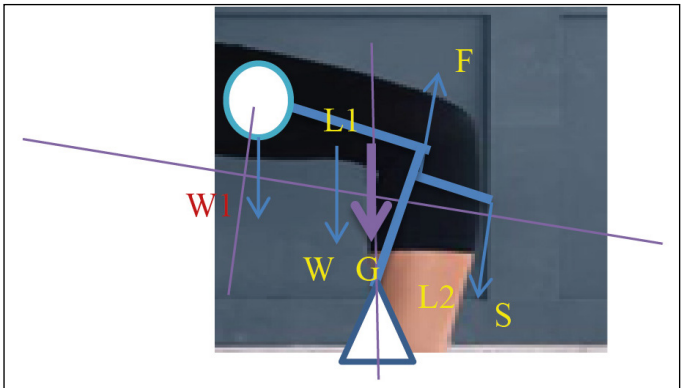


Figure 1. Knee joint structure.



Note: F is the knee support force (tibia and femur contact force), W1 is the gravity of the upper limb, W2 is the gravity of the thigh, S is the tension of the patellar ligament, W is the gravity of the body, L1 is the length of the femur, L2 is the length of the tibia, R is the distance from the patellar ligament to the center of the knee fulcrum.[5]

Figure 2. Force analysis diagram of human lower limbs.

F×r=(w2×(r+0.5L1sin(α))+W1×(r+L1sin(a))cos(β)

So there are knee joints under pressure:

$$F = (W2 \times (1 + 0.5\frac{L1}{r}\sin(\alpha)) + W1 \times (1 + \frac{L1}{r}\sin(\alpha))\cos(\beta) \quad (1)$$

Satisfy the sine law:

$$\frac{kL1}{\sin(\beta)} = \frac{L2}{\sin(\alpha - \beta)} \quad (2)$$

Among them: K(0≤K(t)≤1) is the proportion of the length of femur truncated from the center of gravity line to the length of femur L1, K is usually $\frac{1}{3}$ ~1.

Parameters The relationship between length of femur, length of tibia, gravity of upper limb, gravity of thigh and height and weight is L1=0.32h, L2=0.247h, W1=0.8168w, W2=0.1406w distance from the patellar ligament to the center of the knee fulcrum was measured several times, and the results were as follows: r=3.258±0.484, L1:r=12.379±1.839.[6]

Model Solving

Knee support force F, the target variable of the model, is controlled by two independent variables, the knee bend Angle α and the leg inclination Angle β, which can be calculated by using the triangular relation of the proportionality coefficient K . The variation rule of knee support force F can be investigated by the MA ×F and MINF obtained from the double changes of α and β.

The relationship between femoral inclination Angle α and the maximum and minimum knee support forces Ma ×F and minF is shown in Figure 3.

RESULTS

Knee support varies with the bend Angle of the knee and the inclination Angle of the leg. When the body is upright, each knee supports half of its body weight. When the knee flexion Angle changes, both the maximum and minimum support forces of the knee increase rapidly with the increase of the knee flexion Angle, and then decrease after reaching the peak value, and the difference between the maximum and minimum support forces expands locally. The maximum support force reaches the peak value when the knee bend Angle is 90, and the minimum support force reaches the peak value when the knee bend Angle is 72.4. When the knee bending Angle is fixed, the knee support force F decreases with the increase of the inclination Angle of the leg,

that is, the smaller the inclination Angle of the leg, the greater the knee support force F. Considering the feasibility of actual movements, set the ratio K of the length of femur of the center of gravity line to the length of femur between ~1. Thus, when the knee is bent 90°, that is, when the femur is perpendicular to the tibia, the knee support force F reaches the maximum, and the bearing capacity of each knee is 4~6 times of the body weight. At the same time, the smaller the leg inclination Angle, the greater the knee support force F. For a person with a weight of W=70KG, the calf is tilted 17.4° when the knee is bent 90°, and each knee is subjected to 390KG of gravity. That is: =90°, =17.4°, maxF=5.58W. The knee bending Angle and the force on the knee joint are shown in Table 1.

α β units are degrees, k is multiples, max×F, minF is a multiple of body weight.

Based on the static motion, a biomechanical model of the knee joint was established. Based on this, the kinematic and contact behaviors of the knee joint were analyzed, and the variation law and peak value of the stress on the contact surface of the tibiofemoral joint were obtained. It provides models and data bases for guiding scientific sports training and sports medicine treatment, preventing knee joint sports injury, preventing knee joint inflammation, and reasonably improving sports performance.

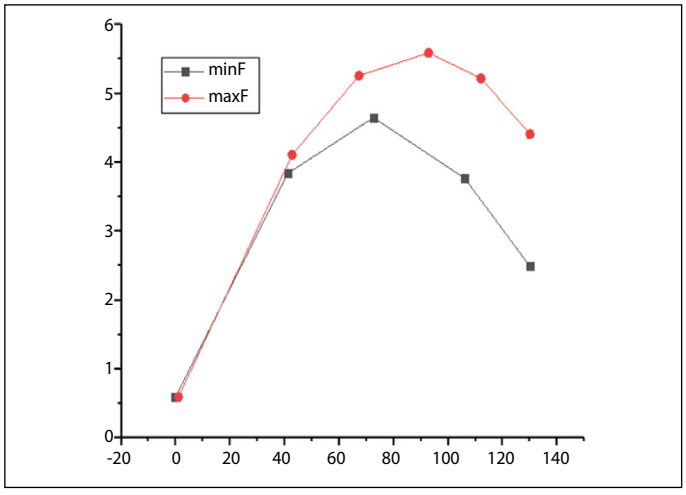


Figure 3. Relationship between femoral inclination Angle α and knee support force F.

Table 1. The corresponding table of knee bending Angle and knee joint force.

Variable	The numerical						
α	0	10	20	30	40	50	60
α	0.00	2.40	4.70	7.00	9.20	11.30	13.20
k	0.33	0.33	0.33	0.33	0.33	0.33	0.33
maxF	0.48	1.10	2.31	3.14	3.88	4.50	4.99
β	0.00	4.70	9.30	14.00	18.60	23.20	27.80
K	0.33	0.93	0.93	0.93	0.93	0.93	0.93
minF	0.48	1.41	2.28	3.07	3.72	4.22	4.54

DISCUSSION

New understanding and theory

To understand the importance of exercise from the height of the whole life cycle, the object of clinical exercise guidance includes all people from infants to the elderly; To recognize the role of sports in the whole process of prevention, treatment and rehabilitation of a variety of clinical diseases, to recognize the effectiveness of sports in the whole process of disease, to observe the effect of sports from the perspective of competitive sports training, For example, the high intensity interval training commonly used by competitive sports athletes has been widely applied in clinical practice and the deep understanding of the essence of sports training with the rapid development of modern sports science. To understand the relationship between exercise and disease and health from the application of exercise in each clinical department. The most important theory in sports medicine is the theory of the relationship between sports and health diseases, that is, sports is nutrition theory. The theory holds that exercise is stimulation while health is adaptation. Different sports bring different stimulation and provide different healthy nutrition. Sports medicine studies the physical and mental health of people can not do without the elements of sports health, the lack of sports will lead to what diseases, how to organize the elements of sports health. Sport has many attributes and functions. The core theory is to study how to solve the safety, effectiveness and sustainability of sports.[7]

The safety of sports should be considered comprehensively, not just the function of one organ, "robbing Peter to pay Paul", but the safety, effectiveness and sustainability of scientific exercise should be considered across multiple disciplines. Sports is a part of life. In order to solve the boredom of sports, sports culture should be introduced into clinical practice. In line with the purpose of "I exercise, I am healthy and I am happy", patients' communication group should be established to promote education or communication between patients and patients, and mutual guidance and encouragement can greatly increase the sustainability of sports. Exercise stimulates the body, the body ADAPTS to the stimulation, and the result of the adaptation is the effect of rehabilitation. If the stimulus intensity is too large, the body cannot produce the result of adaptation; Stimulation intensity is too small, the body is not necessary to produce new adaptation, resulting in no effect of rehabilitation. The generation of adaptation needs two basic conditions. One is sufficient time. After effective stimulation, there must be sufficient recovery time to produce adaptation. The second is sufficient nutrient elements. Nutrient supplementation is carried out when the blood of the trained muscle is full, and the adaptation effect is the most obvious. This is one of the basic principles of sports nutrition.[8]

Exercise is nutrition, is a necessary means to maintain health. But in the process of urbanization, people inadvertently lost a lot of health can not do without exercise, such as squatting toilet, sitting in a chair, so that we lost the opportunity to exercise the quadriceps and knee joint fully closed.

CONCLUSION

The effect of sports medicine on biomechanical energy metabolism of human health was proposed. Based on the biomechanical model of knee joint stress, the motion and contact behaviors of knee joint flexion were analyzed, and the variation law and peak value of the stress on the contact surface of tibiofemoral joint were obtained. Prove that sports medicine has effectiveness in improving human health, and recognize the importance of exercise from the height of the whole life cycle. The object of clinical exercise guidance includes all people from infants to the elderly. The function of exercise is recognized from the effect of the whole process of prevention, treatment and rehabilitation of a variety of clinical diseases, and the effectiveness of exercise in the whole process of disease is recognized. There will be more sports medicine in the future. The research of sports medicine includes the requirement and collocation principle of the health of the patients with internal and external gynaecology, the interaction between different drugs and different elements of sports health, the interaction between different nutrients and different elements of sports health and the related mechanism research. Every doctor, whether from personal health or business development, needs to understand the content of sports medicine.

The author declare no potential conflict of interest related to this article

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