SPORT KINESIOLOGY BASED ON THE CONCEPT OF HEALTH AND FITNESS

CINESIOLOGIA ESPORTIVA BASEADA NO CONCEITO DE SAÚDE E APTIDÃO FÍSICA

KINESIOLOGÍA DEPORTIVA BASADA EN EL CONCEPTO DE SALUD Y APTITUD FÍSICA

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ABSTRACT

Introduction: Exercise is the most effective way to improve physical fitness. One can achieve the effect of wellness and fitness through scientific exercise. Running is a relatively common method of physical exercise. It plays a significant role in improving physical fitness. Objective: This study aimed to investigate the characteristics of lower extremity movements during running. The results of this study may provide better exercise planning for runners. Methods: This paper selects several runners as the research subject. The subjects started running after attaching a motion detector sensor patch to their body. Then, this paper collected kinematic data. The kinematic data includes the joint angles and range of motion (ROM) of the hip, knee, and ankle joints. Results: There was no significant difference in the distribution of peak tibial acceleration, plantar pressure, and maximum pressure of athletes under different track materials (P>0.05). There was a significant age difference between the hip and knee joints of the athletes in the overhead stage (P<0.05). Conclusion: There may not be a necessary connection between ground and lower limb impact in running athletes. Through its adjustment, the human body can dampen the load effect of the foot contact surface. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: Healthy Lifestyle; Running; Physical Fitness Testing; Lower Limbs.

RESUMO

Introdução: O exercício físico é a forma mais eficaz de melhorar a aptidão física. Pode-se alcançar o efeito do bem-estar e da boa forma física por meio da prática de exercícios físicos. A corrida é um método relativamente comum de exercício físico. Ele desempenha um papel significativo na melhora da aptidão física. Objetivo: Este estudo teve como objetivo investigar as características dos movimentos das extremidades inferiores durante a corrida. Os resultados deste estudo podem proporcionar melhores planejamentos de exercícios para os corredores. Métodos: Este trabalho seleciona vários corredores como o objeto de pesquisa. Os sujeitos começaram a correr após anexar um adesivo com sensor detector de movimento em seu corpo. Em seguida, este trabalho coletou dados cinemáticos. Os dados cinemáticos incluem os ângulos articulares e a amplitude de movimento (ROM) das articulações do quadril, joelho e tornozelo. Resultados: Não houve diferença significativa na distribuição do pico de aceleração tibial, pressão plantar e pressão máxima dos atletas sob diferentes materiais de pista (P>0,05). Houve uma diferença de idade significativa entre as articulações do quadril e do joelho dos atletas na etapa aérea (P<0,05). Conclusão: Pode não haver uma conexão necessária entre o solo e o impacto dos membros inferiores em atletas de corrida. Através de seu ajuste, o corpo humano pode amortecer o efeito de carga da superfície de contato com o pé. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

Descritores: *Estilo de Vida Saudável; Corrida; Teste de aptidão física; Membros inferiores.*

RESUMEN

*Introducción: El ejercicio físico es la forma más eficaz de mejorar la forma física. Se puede conseguir el efecto de bienestar y de puesta en forma a través del ejercicio físico. Correr es un método de ejercicio físico relativamente común. Desempeña un papel importante en la mejora de la condición física. Objetivo: Este estudio tiene como objetivo investigar las características de los movimientos de las extremidades inferiores durante la carrera. Los resultados de este estudio pueden proporcionar una mejor planificación del ejercicio para los corredores. Métodos: Este trabajo selecciona a varios corredores como objeto de investigación. Los sujetos empezaron a correr tras colocarse un parche sensor de movimiento en el cuerpo. A continuación, este trabajo recogió datos cinemáticos. Los datos cinemáticos incluyen los ángulos articulares y la amplitud de movimiento (ROM) de las articulaciones de la cadera, la rodilla y el tobillo. Resultados: No hubo diferencias significativas en la distribución de la aceleración tibial máxima, la presión plantar y la presión máxima de los atletas con diferentes materiales de pista (P>0,05). Hubo una diferencia de edad significativa entre las articulaciones de la cadera y la rodilla de los atletas en la etapa de sobrecarga (P<0,05). Conclusión: Puede que no exista una conexión necesaria entre el impacto en el suelo y en las extremidades inferiores en los atletas que corren. Mediante su ajuste, el cuerpo humano puede amortiguar el efecto de carga de la superficie de contacto del pie****. Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

Descriptores: *Estilo de Vida Saludable; Carrera; Prueba de Esfuerzo; Extremidades Inferiores.*

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INTRODUCTION

Running is a healthy physical activity. Barefoot running may have the effect of reducing the incidence of injuries. Many runners and athletes have chosen to run barefoot or wear barefoot shoes in recent years. This innate natural way of running is starting to get people's attention. Barefoot running generally adopts forefoot landing (FFS) and midfoot landing (MFS). However, barefoot running does have positive implications for some groups of people. It can enhance certain aspects of athletic ability.[1] However, individual differences may increase the probability of injury. This article analyzes the kinematics of the lower limbs of 12 runners who wear shoes with their hind feet on the ground during barefoot running. This paper explores the effect of barefoot running on human movement characteristics and its possible mechanisms. This paper provides a theoretical basis for runners and athletes to choose suitable running exercises.

METHOD

Research objects

We selected 15 male runners. Their weekly running distance was (16.1±4.8) km. All subjects had no previous running barefoot or wearing barefoot shoes.[2] They are accustomed to running with their hind feet on the ground.

Data collection

The subjects first ran on a treadmill at three m/s for 5 min wearing shoes. The kinematic data were collected synchronously in the last 1 min. Then the issues took off their shoes and performed three sets of 10min barefoot running exercises on the treadmill.[3] Rest 5 minutes between each set of barefoot running exercises. A total of 24 infrared-reflective marker points were fixed on the body surface of the subjects when we collected the kinematic data. Kinematic data included joint angles and range of motion (ROM) of the hip, knee, and ankle joints.

Data processing

This paper uses motion-analysis acquisition and processing software CORTEX to identify the collected landmarks. In this way, we get the three-dimensional coordinate value of each marker point.[4] We calculate the coordinates of the center of the three links of the hip, knee, and ankle through the three-dimensional coordinate value of the marker point. The hip joint center is obtained by regression equations (1) to (3).

$$\begin{aligned} Right\ HJCx &= -0.096L \\ Left\ HJCx &= -0.096L \end{aligned} \quad (1)$$

$$\begin{aligned} Right\ HJCz &= -0.09PW + 111 \\ Left\ HJCz &= 0.09PW - 111 \end{aligned} \quad (2)$$

$$\begin{aligned} Right\ HJCy &= -0.31PD \\ Left\ HJCy &= -0.31PD \end{aligned} \quad (3)$$

PW is the distance between the left and right anterior superior iliac spines. PD is the distance between the midpoints of the left and right anterior superior iliac spines and the left and right posterior superior iliac spines. L is the distance from the ipsilateral anterior superior iliac spine to the medial malleolus.

Statistical analysis

We use SPSS16.0 and Excel2007 software to summarize the data obtained from the experiment. Results are presented as mean ± standard deviation.[5] We used analysis of variance to test the differences in biomechanical indexes of lower extremities under different shoe-wearing states. The significant level of contrast is indicated by P<0.05.

There is no need for a code of ethics for this type of study.

RESULTS

Changes in the way of foot landing

In the process of foot landing, if the vertical speed of the heel point decreases to the minimum value first, it is the rear foot landing method.[6] If the first metatarsophalangeal joint's sheer velocity decreases to the minimum value, the forefoot touches the ground.

Changes in lower extremity joint angles

In this paper, the differences in the joint angles of the lower limbs when the feet touch the ground with different shoes and bare feet can reflect the changes in body posture during running.[7] The results showed that the hip joint angle in the shoe-on state before barefoot running was 42.3°. The hip flexion angle of each stage of barefoot running and the state of wearing shoes after barefoot running were significantly different from before barefoot running (P<0.05).

When the foot touched the ground, the ankle joint angles before and after the barefoot running were 7.6° and 4.5°, respectively. This is significantly greater than the ankle angle at each stage of barefoot running.[8] The ankle joint angle of each step of barefoot running was substantially different from that of barefoot running before wearing shoes. There was no significant difference between the ankle joint angle of barefoot running after barefoot running and that of barefoot running before barefoot running). (P=0.18). There was no significant difference in knee joint angle among various states when the foot touched the ground (P=0.16).

The hip joint angle during barefoot running was lower than that in shoes running. The ankle joint angle decreases during barefoot running. But when running again with the shoes on, the ankle angle returned to a more significant level.

Changes in lower extremity joint ROM

Joint ROM is the maximum arc achieved during collaborative activity and is one of the indicators to evaluate joint motor function.[9] Table 1 shows the average ROM of each joint of the lower extremity during the foot landing period and the kicking-off period.

The results showed that both knee and ankle ROMs decreased during barefoot running. The difference was significant compared with running shoes (P<0.05). There was no significant difference in hip ROM between barefoot running and shoe running.[10] The ankle ROM in the kick-off phase of barefoot running was significantly reduced. The difference was significant compared with running with shoes (P<0.05). There was no

Table 1. ROM of each joint of the lower extremity.

Experimental stage	ROM/(°) during landing			ROM/(°) during the kick-off		
	Hip joint	Knee joint	Ankle joint	Hip joint	Knee joint	Ankle joint
Take off your shoes_before	26.3±22.2	30.2±5.5	38.7±22.6	47.7±27.6	26.7±6.5	44.2±28.2
Bare feet_1	23.6±8.3	23.2±5.3	33.5±8.7	38.5±27.4	24.8±7.7	36.8±8.8
Bare feet_5	24.2±6.2	22.8±3.6	28.7±5.8	48.7±7.6	23.3±5.4	26.5±6.2
Barefoot_10	25.3±5.7	23.5±5.6	30.7±7.2	46.6±7.3	23.6±5.5	25.2±6.3
Barefoot_15	24.3±4.8	23.2±4.8	32.4±5.4	45.6±6.8	22.8±5.2	26.8±7.8
Barefoot_20	25.2±4.3	23.8±6.2	32.3±4.8	45.2±5.2	23.2±7.2	26.2±6.6
Barefoot_25	27.2±5.6	24.8±5.2	28.6±6.2	48.8±8.4	23.2±5.2	28.6±7.3
Barefoot_30	24.8±4.2	23.7±5.8	28.7±6.5	47.4±6.4	22.6±6.3	26.4±8.0
After wearing shoes	28.5±6.2	28.2±7.0	40.2±22.2	48.7±7.3	27.0±5.0	32.3±7.8

significant difference in the ROM of the hip and knee joints between barefoot running and running with shoes. The above shows that the range of motion of the hip joint does not change significantly during barefoot running compared with running with shoes. The content of motion of the knee and ankle joints showed a decreasing trend.

DISCUSSION

The kinematics and other biomechanical characteristics of the lower limbs of the human body will change when running with shoes on to barefoot running. The foot landing pattern will vary from running with shoes' rear foot landing pattern to the forefoot or midfoot landing pattern of barefoot running.[11] Existing studies are tests conducted after subjects are acclimated to barefoot running for 4 minutes to 10 days. Then they compared the differences in human movement characteristics when running with shoes and barefoot. There is no academic study that shows the biomechanical changes that occur in the human body during the transition from running with shoes to running with bare feet. The results of this study suggest that runners maintain a rear-foot-on-the-ground running style during the 30 min of the transition from running with shoes to running with bare feet. They don't directly translate to forefoot or midfoot running. This shows that the change from running with shoes to running with bare feet is gradual. Thirty minutes of barefoot running practice is not enough for runners accustomed to running with shoes to adapt and convert to barefoot running. Runners take longer to get used to running barefoot.

The hip joint angle during barefoot running is lower than that during running with shoes. This indicates that the flexion of the hip joint is reduced when running barefoot on the ground compared to running with shoes. Complete the barefoot running movement with the hip joint in a relatively extended state. This state continued until the process of wearing shoes and running again. This shows that in the 30min barefoot running exercise, the movement changes of the hip joint have formed an action stereotype. The ankle joint angle was significantly reduced during barefoot running. This shows that compared with running with shoes, the dorsiflexion of the ankle joint is reduced when running barefoot.[12] The ankle joint is more plantarflexed to complete the barefoot running. There is a tendency to change from the rear foot to the midfoot or forefoot in the process. But when the athlete ran with the shoes on again, the ankles returned to dorsiflexion. It can be seen that the proximal part of the human body can adapt to barefoot running faster and form an action stereotype. The process of adapting to barefoot running at the far end is slower. The extended barefoot running time causes the ankle to land in a more plantarflexed position. There was no significant change in the knee joint angle when the athlete sprinted barefoot. This may be due to the better cushioning of the treadmill surface than the solid ground. At this time, the body does not need the body to absorb the impact of the environment through more knee-bending movements.

The results of lower extremity joint ROM showed that the ROM of the hip joint during the landing and kick-off phases of barefoot running did not change significantly compared with running with shoes. The ROM of the knee joint decreased during the landing period. The ROM of the ankle joint was reduced considerably during the landing and kick-off phases. When running in shoes, the sole with a certain thickness can help the runner buffer the ground's impact. The foot will hit the ground first with the heel in a more dorsiflexed state. Then the body gradually transitions from the midfoot landing to the front foot landing and kicking off the dirt. Therefore, the ROM of the lower extremity segment was larger when running with shoes. When running barefoot, the human body will actively increase the landing area when the foot touches the ground. This reduces the range of motion in the sagittal plane of the foot. This will reduce the ROM of the lower extremity segment.

Thirty minutes of barefoot running practice is not enough for runners accustomed to running with shoes to adapt and convert to barefoot running. Runners take longer to get used to running barefoot. Therefore, the research on the changes of human gait characteristics during barefoot running should be carried out with a more extended tracking test. In this way, we can obtain the changing law of the gait of the lower limbs in changing the way the human body touches the ground. In this way, we can further explore the effect of barefoot running on human movement characteristics and its possible mechanisms.

CONCLUSION

The gait characteristics of the lower limbs of the human body changed significantly after switching from running with shoes to running with bare feet. The hip joint is in a more extended state. The ankle joint is in a more plantarflexed condition. The proximal link can adapt to barefoot running faster than the distal link and form movement stereotypes. The way of landing on the feet did not change significantly. At this time, the athlete's body is still running with the rear foot on the ground.

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