THE RELATIONSHIP BETWEEN HAMSTRING INJURY RISK SCREENING TEST AND LOWER LIMB BIOMECHANICS DURING SPRINT

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The purpose of this study was to explore the relationship between hamstring injury risk screening test scores and lower limb biomechanical characteristics during sprint, and to select more appropriate screening tests from the perspective of biomechanics. Soccer players(n=18) experienced three kinds of hamstring injury screening tests(Nordic hamstring test, ultrasound test, straight-leg-raising test) and collected kinematics data and dynamics data of the lower extremities during sprint. The result of the Nordic Hamstring Test was significantly positively correlated with the peak force of semimembranosus muscle, semitendinosus muscle and biceps femoris long head during sprint ($P<0.05$), and the correlation coefficients were 0.504, 0.506 and 0.429, respectively. It was significantly negatively correlated with the peak strain ($P<0.05$), and the correlation coefficients were -0.462, -0.460 and -0.385, respectively.There was no significant correlation among other data. The Nordic hamstring test is the most suitable for the risk screening of hamstring injury. Ultrasound test may has a certain screening effect, but it is difficult to operate and spread. The straight-leg-raising test is not recommended for continued use.

KEYWORDS:hamstring strain, screening tests, ultrasound, sprint, OpenSim.

INTRODUCTION:

Hamstring strain injuries (HSI) are common in sports and can reduce athletic performance, resulting in financial losses for the athlete and sports team. Although there have been a large number of prevention and rehabilitation exercises for HSI, the incidence of HSI is still increasing(Ekstrand,Walden &Hagglund 2016). Therefore, it is important for injury prevention to find out appropriate indicators of injury risk screening. The hamstring eccentric strength, biceps femoris long head muscle fascicle length and flexibility of hamstring are risk factors of HSI(Timmins,Bourne,Shield et al. 2016, Yu,Liu &Garrett 2017).The Nordic hamstring test (NHT), ultrasound test, straight-leg-raising test (SLR) are common screening tests for these factors. Their screening effects were inconsistent and their rationality needs to be further verified.

Hamstring muscle force and strain are considered to be the biomechanical mechanisms of HSI during sprint(Daly,Persson,Twycross-Lewis et al. 2016). These screening tests were all measured in a static environment, and it remains to be seen whether the results correlate with the biomechanical performance of sprint. The purpose of this study was to explore the relationship between hamstring injury risk screening test scores and lower limb biomechanical characteristics during sprint, and to provide a theoretical basis for the selection of the screening test for hamstring strain.

METHODS:

Eighteen soccer players were selected for the study. The NBE-0530 equipment was used for NHT test, it can output the peak torque of knee flexion. Each subject repeated the action five times, and the results were averaged. Biceps femoris long head muscle fascicle length was determined from GE color ultrasound images and it was estimated by Blazevich's equation (Blazevich,Gill &Zhou 2006). Finally, We used SLR test to estimated the range of motion (ROM) in hip. A camra recorded the whole process and videos were analyzed by Kinovea software. (Figure 1)

Figure 1: NBE-0530 equipment, GE color ultrasound and SLR test

The kinematics and dynamics data of their bilateral lower limbs during sprint were simultaneously collected by the 8-cameras Motion acquisition system and the Kistler three-dimensional force platform, and the hamstring force and strain at vulnerable moments were calculated by Static Optimization in OpenSim.
Pearson correlation was used to analyze the correlation between the results of each screening test and the hamstring peak force and peak strain during sprint.

RESULTS:
There was no significant correlation between biceps femoris long head muscle fascicle length measured by ultrasound and the peak force and peak strain of biceps femoris long head during sprint (shown in Table 1).

Table 1:Relationship between bifemlh fascicle length and biomechanical characteristics during sprint

	Peak force	Peak strain
Correlation coefficients	-0.199	0.130
P value	0.244	0.448

There was no significant correlation between the ROM measured by the SLR test and the hamstring peak force and peak strain during sprint (shown in Table 2).

Table 2:Relationship between ROM and biomechanical characteristics during sprint

	Peak force			Peak strain		
	Semimem	Semiten	Bifemlh	Semimem	Semiten	Bifemlh
Correlation coefficients	0.053	0.040	0.160	-0.076	-0.079	-0.132
P value	0.760	0.815	0.352	0.660	0.649	0.443

The peak torque of the Nordic Hamstring Test was significantly positively correlated with the peak force of semimembranosus, semitendinosus and biceps femoris long head during sprint ($P<0.05$), and the correlation coefficients were 0.504, 0.506 and 0.429, respectively (shown in Figure 2). It was significantly negatively correlated with the peak strain (P<0.05), and the correlation coefficients were -0.462, -0.460 and -0.385, respectively (shown in Figure 2).

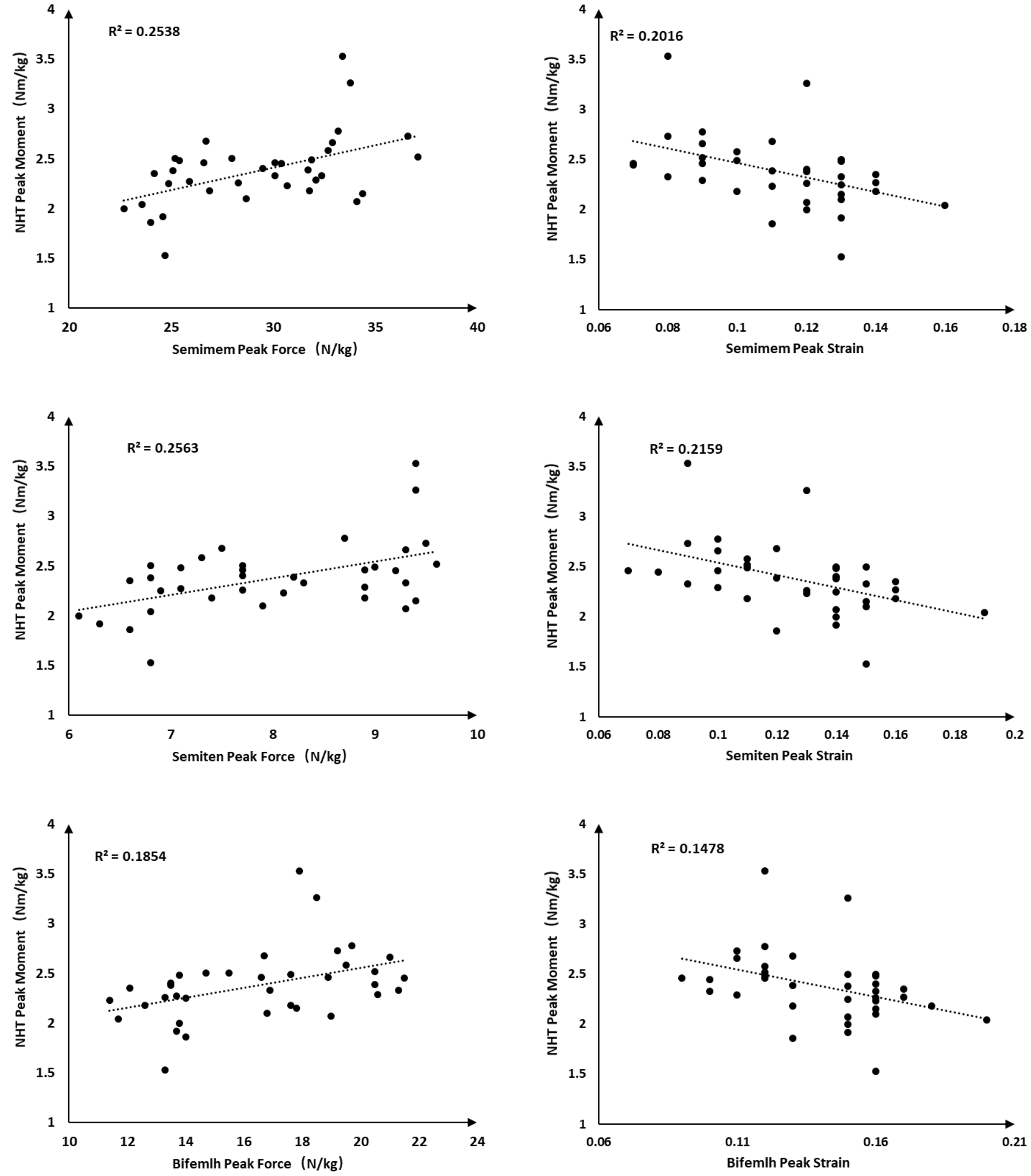

Figure 2: Relationship between result of NHT and biomechanical characteristics during sprint

DISCUSSION:

Nordic hamstring test(NHT) is suitable as a screening test for HSI. Strong hamstring eccentric strength leads to higher peak force and lower peak strain in sprinting. Lower strain can reduce the load of hamstring. Although the athletes with strong hamstring eccentric strength are also more heavily loaded during sprint, the stronger muscles can better protect themselves at the same time.

The results of ultrasound test showed that the longer muscle fascicle length did not directly reduce the value of peak strain and force, but it may reflect the tolerance of muscles. Longer fascicle lengths have a lower rate of injury, possibly because of the shift to the right of the

muscle length-force curve (Bourne,Timmins,Opar et al. 2018). It increases the muscle optimal length and makes the muscle stronger in the eccentric state. In addition, the muscle fascicle length measured by ultrasound mainly reflects the muscle fiber length, and the ratio of muscle to tendon is not the same in each person, so it is understandable that the muscle fascicle length is not related to the muscle-tendon length measured by OpenSim.
Hip range of motion (ROM) as a screening indicator for HSI may not be reasonable. The results of this paper show that ROM has no relationship with hamstring peak force and peak strain during sprint, and seems to have no relationship with the tolerance of muscles.ROM as a common indicator of flexibility has been controversial. ROM is easily confused with joint relaxation, and it has also been suggested that static flexibility does not reflect the dynamic flexibility of muscles(Wilson,Wood &Elliott 1991).

CONCLUSION: The score of the Nordic hamstring test reflects the load of hamstring during sprint and is easy to operate. It is the most suitable for the risk screening of hamstring injury. Ultrasound testing is more reflective of a muscle's ability to withstand loads, so it can also be used as a screening test, but the limitations of location and operation make it difficult to implement on a large scale. The ROM obtained by the straight-leg-raising test is not a good reflection of muscle flexibility, it is not recommended to continue to choose.

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