DYNAMIC COORDINATION OF LEG MUSCULATURE IS ASSOCIATED WITH AGILITY IN HIGH SCHOOL SOCCER ATHLETES

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INTRODUCTION

Dynamic maneuvers involving rapid whole-body deceleration and change in direction are essential in many sports, but also commonly cause injuries. Because such maneuvers require dynamic interactions among muscles to control momentum and stabilize joints, appropriate dynamic coordination may be critical to athletic performance and to mitigate the risk of injury. Measures of maximal jump height and muscle strength have been studied as potential indicators of agility, but they have only shown modest correlation at best with various agility tasks [1]. Therefore, here we investigate the association of dynamic lower extremity coordination with agility. Recently, we developed a lower extremity coordination test (LEC-test) that is highly reliable and is independent of muscle strength (a lower extremity version of the Strength-Dexterity Test [2,3]). Here we tested whether or not LEC-test performance (as opposed to strength) is associated with agility.

METHODS

Sixteen high school soccer athletes (8 female, 8 male) participated in this study. First, maximal muscle torques during isometric hip extension, knee extension, and knee flexion were measured using a Humac Norm Dynamometer [CSMi, Stoughton, MA]. Participants then performed the LEC-test, which is a dynamic contact control task that requires participants to compress a helical compression spring with the foot (Fig 1, [2,3]). Subjects were instructed to slowly compress the spring so as to achieve and sustain the highest possible vertical compression force during 16-second trials while provided with visual force feedback. The compression force was considered to be *"sustained"* if the coefficient of variation was ≤ 10%. Because the spring becomes more unstable with increased compression, the highest force sustained is representative of maximal coordination [3]. The maximal compressive force held during the 16-second trial was determined by a 10-second moving average. The average maximal compressive force from the best 3 out of 25 trials was used for statistical analysis.

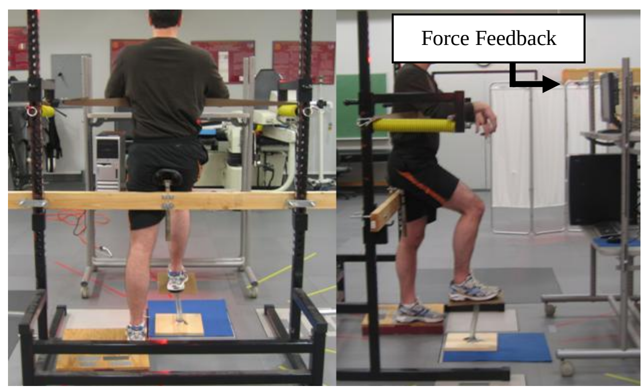

Figure 1: Lower extremity coordination test

Agility was assessed by having participants complete a hopping sequence using their dominant leg with arms akimbo. Four target positions were marked on a force plate (1.2 x 1.2 m) 30 cm anterior, posterior, right, and left of a center position (Fig 2). Participants were instructed to hop as quickly and accurately as possible to each target and then back to the center moving in a clockwise direction for 2 complete cycles. The time to complete the task was determined by the vertical ground reaction force. The average of the best 3 of 6 trials was considered agility performance. Following the agility test, participants' maximal height achieved during a countermovement vertical jump was recorded.

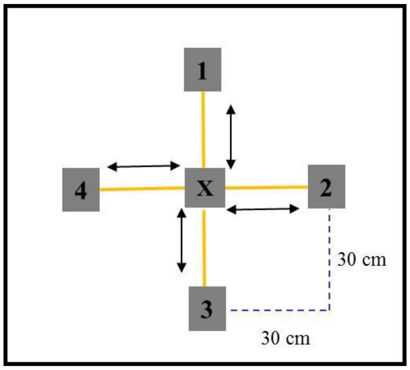

Figure 2: Single-leg agility hopping sequence

The dependent variable was the time to complete the agility test, while the independent variables included the maximal compressive force held during the LEC-test, maximal muscle torques (normalized to body mass), and the maximum vertical jump height. Multiple linear regression models were used to examine the association between agility performance and each independent variable while controlling for the potential influence of gender.

RESULTS AND DISCUSSION

Agility vs. LEC-test performance is plotted in Figure 3, and a significant correlation (r=-0.82, p<0.001, Table1) is seen after controlling for gender. This indicates that better dynamical coordination of leg musculature to control the instability of the spring was associated with faster times to complete the agility task.

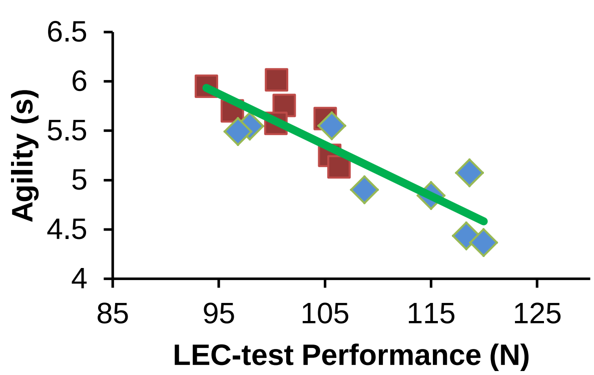

Figure 3: Association between agility and LEC-test performance. Red squares and blue diamonds are female and male athletes, respectively.

In contrast, lower extremity strength and vertical jump height were not significantly correlated with agility performance after controlling for gender (p>>0.05, Table 1). These findings indicate that strength was not a critical determinant for successful performance on the agility task even though the single leg hopping sequence requires significant lower extremity muscular effort. Therefore the LEC-test, as is also seen in the upper extremity [4], assesses an experimental construct that reveals a dimension of dynamic function that is independent of leg strength and power, but informative of agility. As such, this study is the first to identify a strong association between dynamic coordination of leg musculature and agility.

Table 1. Partial correlations between agility performance and each independent variable after controlling for gender.

	Partial correlation, r	p
LEC-test	-0.82	<0.001
Vertical Jump Height	-0.34	0.22
Hip Extensor Strength	-0.26	0.35
Knee Extensor Strength	0.24	0.39
Knee Flexor Strength	0.05	0.86

CONCLUSIONS

This study provides preliminary evidence that lower extremity coordination as assessed by the LEC-test may provide useful information about the sensorimotor integration required for sudden deceleration and change of direction. Given that most sports injuries occur during rapid transition maneuvers, the LEC-test may have important implications for predicting the risk of non-contact lower extremity injury. This work now enables the framing of hypotheses regarding dynamic muscle coordination during rapid maneuvers. In addition, future research is needed to examine how these factors are associated with the risk of injury.

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