PROPULSION PHASE ANALYSIS OF SINGLE-LEG HOP IN MALE HIGH SCHOOL SOCCER PLAYERS

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Introduction and purpose

Single-leg hop (SLH) is used to assess physical readiness for return to play. While SLH typically divides motion into propulsion and landing phases, few studies have compared propulsion phase movements between the dominant and non-dominant legs in soccer players. This study analyzed three-dimensional motion and ground reaction force to examine these differences in male high school soccer players.

Methods

Thirty male high school soccer players (mean age 16.4±0.5 years) with no sports injuries in the past 6 months participated. The dominant leg was defined as the kicking leg. SLH measurements were performed twice per side using a force measurement platform (AMTI), with the maximum value normalized by height. Eighteen reflective markers were attached bilaterally on anatomical landmarks (acromion, greater trochanter, lateral femoral condyle, fibular head, lateral malleolus, fifth metatarsal head, anterior superior iliac spine, mid-knee, and mid-ankle). SLH propulsion phase movements were captured from the frontal and sagittal planes using a three-dimensional motion analysis system (VICON). The period from movement initiation to maximum knee flexion was defined as the loading phase (LP), and the period from maximum knee flexion to toe-off was defined as the propulsion phase (PP). Using motion analysis software (SPORTS SENSING), the following were measured for each phase: pelvic lateral tilt in the frontal plane, knee valgus, and trunk tilt in the sagittal plane, along with amount of change at the knee and ankle joints. Regarding changes in each joint angle, trunk tilt was defined as forward tilt, knee joint as flexion, ankle joint as dorsiflexion, pelvic lateral tilt as tilt toward the support side, and knee valgus was defined with valgus as +. As ground reaction force indicators, the vertical peak ground reaction force (pVGRF) and the horizontal peak ground reaction force (pHGRF) during the SLH propulsion phase were normalized by body weight. Comparisons between dominant and non-dominant legs for each measurement item were performed using paired t-tests. Correlations between SLH and ground reaction force indices and the changes in joint angles during LP and PP were examined using Pearson's correlation coefficient (significance level: $P < 0.05$)

Results

Table 1 summarizes the mean values for each measurement item. Trunk forward tilt during LP was significantly smaller in the non-dominant leg, while no other significant side differences were observed. For the dominant leg, SLH correlated positively with knee valgus in LP and ankle plantar flexion in PP, pVGRF with pelvic lateral tilt in LP, and pHGRF with ankle plantar flexion in PP. pVGRF correlated negatively with trunk extension in PP. For the non-dominant leg, SLH positively correlated with trunk extension, knee extension, and ankle plantar flexion in PP, and pHGRF correlated positively with ankle plantar flexion in PP.

Conclusions

This study found that male high school soccer players showed less forward tilt angle for the non-dominant leg during LP of SLH propulsion. For the dominant leg, a relationship was observed between knee valgus and ankle plantar flexion during PP and jump distance. Since LP is the phase where the vertical ground reaction force accompanying the descent of the center of gravity is absorbed by the lower limbs(1), this suggests that a movement strategy prioritizing postural stability may be employed during the propulsion phase for the non-dominant leg. Conversely, the dominant leg appeared to generate propulsive force through lower limb extension movements, particularly at the ankle joint. These findings suggest that when evaluating the SLH in high school male soccer players, it is important to assess not only jump distance but also movement characteristics, particularly the dynamic lower limb alignment of the dominant leg.

Measurement Items		Dominant leg	Non-dominant leg	*P*-value
SLH		1.23±0.57	1.23±0.70	0.44
pVGRF(N/kg)		20.90±2.40	21.3±2.40	0.30
pHGRF(N/kg)		7.40±0.20	7.50±0.30	0.66
Pelvic lateral tilt (°)	LP	-3.20±6.40	-2.70±6.40	0.37
	PP	9.90±6.00	9.40±5.90	0.37
Knee valgus (°)	LP	17.10±9.70	18.60±11.90	0.30
	PP	-15.00±11.80	-15.40±11.70	0.45
Trunk tilt (°)	LP	62.90±16.30	54.20±16.60	0.02*
	PP	-75.00±17.10	-68.40±19.10	0.08
Knee joint (°)	LP	44.40±13.20	41.40±12.70	0.19
	PP	-36.20±16.50	-30.80±17.50	0.11
Ankle joint (°)	LP	20.30±6.30	20.50±7.70	0.41
	PP	-65.10±9.30	-67.00±17.50	0.24

*$P< 0.05$

Table 1.
Mean values for each measurement item and comparison between dominant and non-dominant legs

Measurement items		Pelvic lateral tilt (°)		Knee valgus (°)		Trunk tilt (°)		Knee joint (°)		Ankle joint (°)	
		LP	PP	LP	PP	LP	PP	LP	PP	LP	PP
SLH	Dominant leg	-0.16	0.16	0.40*	0.34	0.32	0.45*	0.19	0.24	0.37*	0.63**
	Non-dominant leg	0.13	-0.07	-0.10	-0.04	0.40*	0.50**	0.34	0.41*	0.31	0.43*
pVGRF (N/kg)	Dominant leg	0.56**	-0.38*	0.29	0.05	-0.46*	-0.44*	-0.46*	-0.34	-0.04	0.11
	Non-dominant leg	0.26	0.08	-0.16	-0.31	-0.50**	-0.34	-0.11	-0.33	-0.05	0.17
pHGRF (N/kg)	Dominant leg	0.22	-0.19	0.12	-0.02	0.15	0.12	0.30	0.18	0.46*	0.44*
	Non-dominant leg	0.95	0.09	-0.13	0.16	-0.03	0.60	0.30	0.30	0.36	0.44*

*=$P<0.05$

**=$P<0.01$

Table 2. Correlations among measurement items

References

1. Rush JL, Murray AM, Sherman DA, Gokeler A, Norte GE. Single-Leg Hop Performance After Anterior Cruciate Ligament Reconstruction: Ready for Landing but Cleared for Take-Off? J Athl Train. 2024 Nov 1;59(11):1100-1109.