Predictors of Peak Impact Forces During a Jump Landing Assessment in Patients After Anterior Cruciate Ligament Reconstruction

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Summary

Anterior cruciate ligament reconstruction (ACLR) is a common procedure for athletes with the goal of returning to sport (RTS) after ACL injury. This study examined the impact of predictors of peak impact forces (PIF) during the first and second landing of a drop jump landing assessment in athletes recovering from ACLR. Predictors for PIF differed between the first and second landing, and between involved and uninvolved limbs.

Introduction

Adolescent athletes incur anterior cruciate ligament (ACL) injuries at a rate of 0.06 per 1000 athlete exposures [1]. Many athletes undergo ACLR with the goal of RTS with 81% of ACLR patients returning to some level of sport participation [2]. Jump landing testing can assist clinicians in safely progressing athletes during RTS [3]. The purpose of this study was to examine the effects of age, sex, time since surgery, primary sport, graft type, hamstring strength, and quadriceps strength on PIF during the first and second landing of a jump landing maneuver in patients post-ACLR.

Methods

Eighty-one patients with unilateral ACLR participated (age: 18.9 ± 4.1 years, height: 1.7 ± 0.1 m, weight: 74.2 ± 12.9 kg, sex: 32 females, 49 males). Jump landing data were collected at the first jump landing assessment patients completed post-surgery (time since surgery: 7.7 ± 1.9 months). Participants were outfitted with force sensor insoles before they dropped from a 30cm box and then jumped off the ground as quickly as possible. Instructions were only provided for the first landing. Insole force data were collected at 200 Hz and bilateral PIF during the first (PIF1) and second (PIF2) landings was normalized to body weight (N). The average of three trials was reported. Limb symmetry index (LSI) was calculated for PIF1 and PIF2 by dividing the involved limb value by the uninvolved limb value and multiplying by 100. A series of backwards stepwise linear regression analyses were performed to identify predictors for PIF1 and PIF2 on the involved and uninvolved limbs and the accompanying LSI values. Predictors included age, sex, time since surgery, primary sport (other: n = 19; court: n = 16; field: n = 46), graft type (bone-patellar tendon-bone: n = 67; quadricep tendon: n = 14), hamstring strength (involved: 1.18 ± 0.31 Nm/kg; uninvolved: 1.21 ± 0.25 Nm/kg; LSI: 97.28 ± 14.88%), and quadriceps strength (involved: 1.96 ± 0.54 Nm/kg; uninvolved: 2.74 ± 0.44 Nm/kg; LSI: 71.16 ± 14.73%).

Results and Discussion

Descriptive statistics for PIF1 and PIF2 are listed in Table 1. For both landings, PIF was greater in the uninvolved limb compared to the involved limb.

Table 1: Descriptive statistics for PIF1 and PIF2.

Response Variables	Mean	SD
PIF1 Involved (xBW)	1.62	0.57
PIF1 Uninvolved (xBW)	2.27	0.64
PIF1 LSI (%)	76.23	39.16
PIF2 Involved (xBW)	1.67	0.53
PIF2 Uninvolved (xBW)	2.28	0.71
PIF2 LSI (%)	80.28	34.70

Statistically significant regression equations were identified for the six response variables (See Table 2). For PIF1, graft type, age, and primary sport were the most frequent predictors, however for PIF2, sex and time since surgery were most frequent.

Conclusions

Predictors of PIF differed between the first and second landing, as well as between the involved and uninvolved limbs. These findings highlight the complexity of ACLR RTS measures, suggesting that during a landing maneuver, a variety of predictors explain variance in PIF.

References

[1] Bram JT et al. (2021) *Am J Sports Med*. **49:** 1962-1972
[2] Ardern CL et al. (2014) *Br J Sports Med*. **48:** 1543-1552
[3] Waldron K et al. (2022) *Arthroscopy, Sports Med, and Rehab*. **4:** 175 - 179

Table 2: Results of the backward stepwise linear regression for the first and second jump landing.

	Predictor 1 (ΔR^2)	Predictor 2 (ΔR^2)	Predictor 3 (ΔR^2)	Full Model R^2	Full Model p
PIF1 Involved	Graft Source (.12)	Age (.03)	Primary Sport (.05)	.20	< .001
PIF1 Uninvolved	Time Since Sx (.05)	Ham Strength (.03)	N.A.	.08	.04
PIF1 LSI	Age (.03)	Primary Sport (.04)	Graft Source (.03)	.10	.04
PIF2 Involved	Quad Strength (.10)	Graft Source (.02)	N.A.	.12	.01
PIF2 Uninvolved	Sex (.14)	Time Since Sx (.08)	N.A.	.22	<.001
PIF2 LSI	Sex (.05)	Time Since Sx (.03)	N.A.	.08	.03

Note. Sx = Surgery, Quad = Quadricep, Ham = Hamstring