Effect Of 8 Weeks Of Inertial One Leg Squat On Drop Jump Biomechanics In Athletes With Anterior Cruciate Ligament Reconstruction After Return To Sport

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- Athletes with anterior cruciate ligament reconstruction (ACLR) have poor jumping biomechanics years after surgery [1], possibly due to reduced knee function [2].
- ACL injuries are common, so strength coaches often face poor jumping in their athletes.
- Methods to improve jumping biomechanics after ACLR are lacking.

Purpose

To evaluate changes in drop jump biomechanics following 8 weeks of deep knee flexion, exhausting Bulgarian squat on a flywheel device in athletes with ACLR who already had returned to sport.

Method

Participants
- 11 athletes (8 females, 3 males; 20.8 ± 2.7 y.o., 1.71 ± 0.09 m, 67.3 ± 11.2 kg, 546 ± 270 days from surgery) with unilateral ACLR who had completed supervised rehabilitation and returned to sport.

Intervention
- 16 sessions of exhausting deep knee flexion Bulgarian squats in the injured leg using a flywheel training device (8 weeks, twice a week).
- 1 set, as many repetitions as possible (AMRAP), knee range of motion limited to 60-100° of flexion.

Measure
- Single-leg 30-cm drop jumps (DJ), before and after training, using a 3D motion capture system and force platforms.

Variables
- *Pre-planned comparisons:*
  - Jump height (calculated from the velocity of the center of mass at takeoff),
  - Hip, knee, and ankle relative contribution (% of the three joints' combined work) in each leg.
- *Others:* peak vertical ground reaction force, impulse, contact duration, peak knee flexion angle, valgus angle.

Analysis
- All data were normalized by the participant's mass.
- The DJ was analyzed over the braking, propulsion, and contact (braking + propulsion) phases.
- *Pre-planned comparisons:* one-tailed paired t-test.
- *Others:* 2-way ANOVA (Time × Leg) & post hoc paired t-test.
- Effect size was calculated using Cohen's *d* ($d < 0.20$: small, $d < 0.50$: medium, $d < 0.80$: large).

Results

		Δ	*p*	*d*
Jump height reconstructed leg (cm)	↑	2.47 ± 4.68	.02	0.75
Knee contribution reconstructed - contact phase (%)	↑	5.2 ± 7.0	.03	0.63
Hip contribution reconstructed - contact phase (%)	↓	-7.5 ± 11.8	.02	0.68
Reconstructed leg's impulse - contact phase (N·s/kg)	↑	0.20 ± 0.32	.03	0.78
- propulsion phase (N·s/kg)	↑	0.15 ± 0.28	.04	0.73
Change in propulsion duration (ms)				
- reconstructed	↓	-42.4 ± 77.6	.03	0.74
- intact	↓	-43.2 ± 71.1	.02	0.81
Change in peak knee angle uninjured leg (°)	↓	-5.1 ± 8.8	.02	0.82

- interlimb difference ↓ from 7.1 ± 10.1° (p = .03, d = 0.76) to 2.7 ± 7.4° (N.S.)

Conclusion

Our intervention improved jump height in the reconstructed leg only. Participants displayed a normalized jumping strategy in the reconstructed leg by decreasing hip but increasing knee joint contributions. Changes came in part from greater force production over a shorter time, notably in the propulsion phase.

Practical Applications

Adding one set of deep knee flexion **flywheel Bulgarian squats** until exhaustion in the reconstructed leg is a time efficient way to **improve DJ biomechanics** in athletes with ACLR after return to sport.

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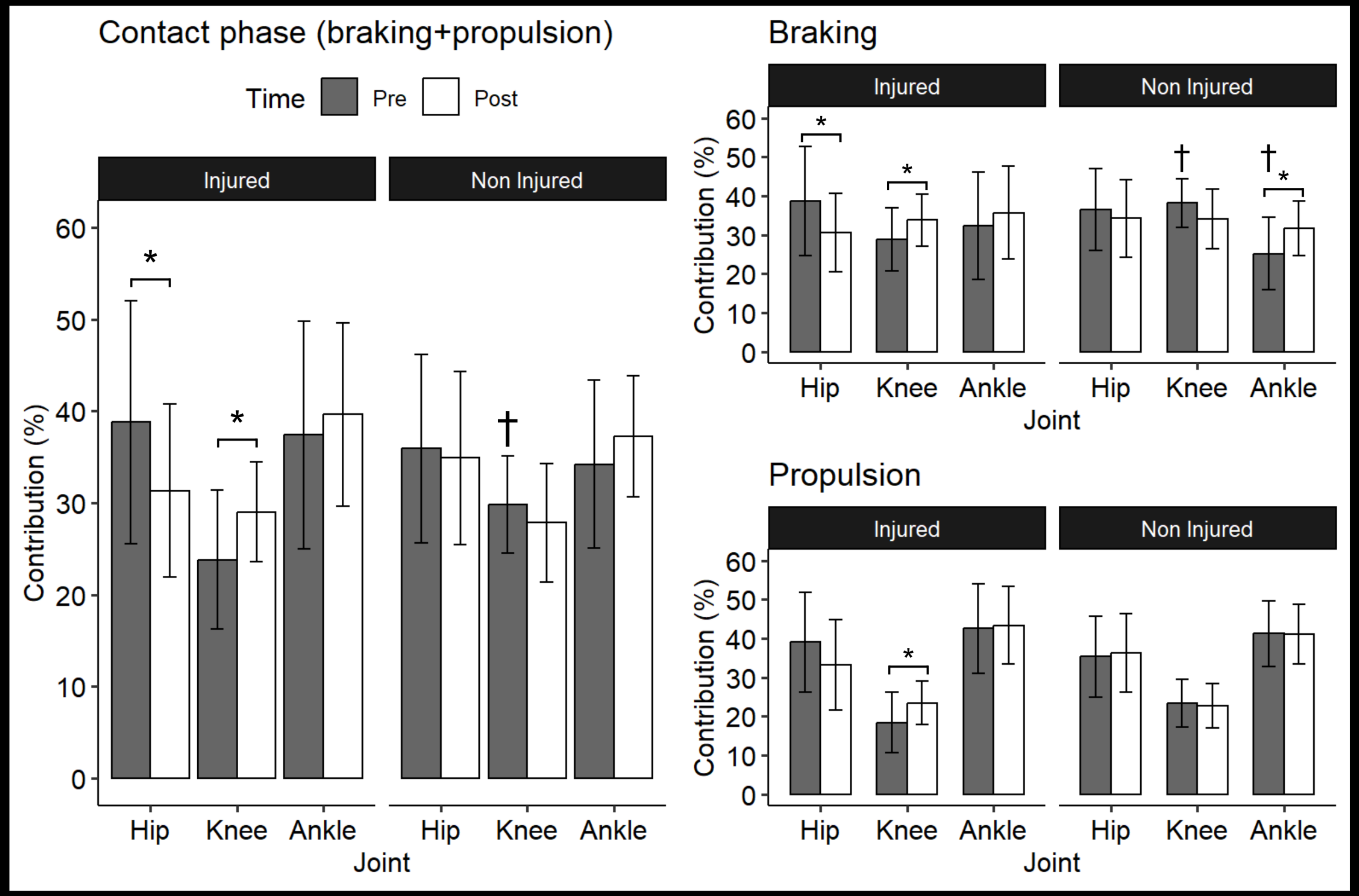
A single set of deep knee flexion **inertial Bulgarian squats** until exhaustion **restores normal joint contribution** in drop jumps **in athletes with ACL reconstruction** after return to sport.

Changes in relative joint contribution during single-leg drop jump (DJ).
*: significant pre-post difference, $p < .05$;
†: significant interlimb difference, $p < .05$.
Injured: reconstructed leg;
Non injured: intact leg.



In all phases of the DJ (whole contact phase, braking phase only, or propulsion phase only), while the non-injured leg showed almost no change, the ***injured leg*** *consistently showed* ***increased knee contribution*** *along with* ***decreased hip contribution****. Interestingly, interlimb differences were rarely significant.*

Participants information.

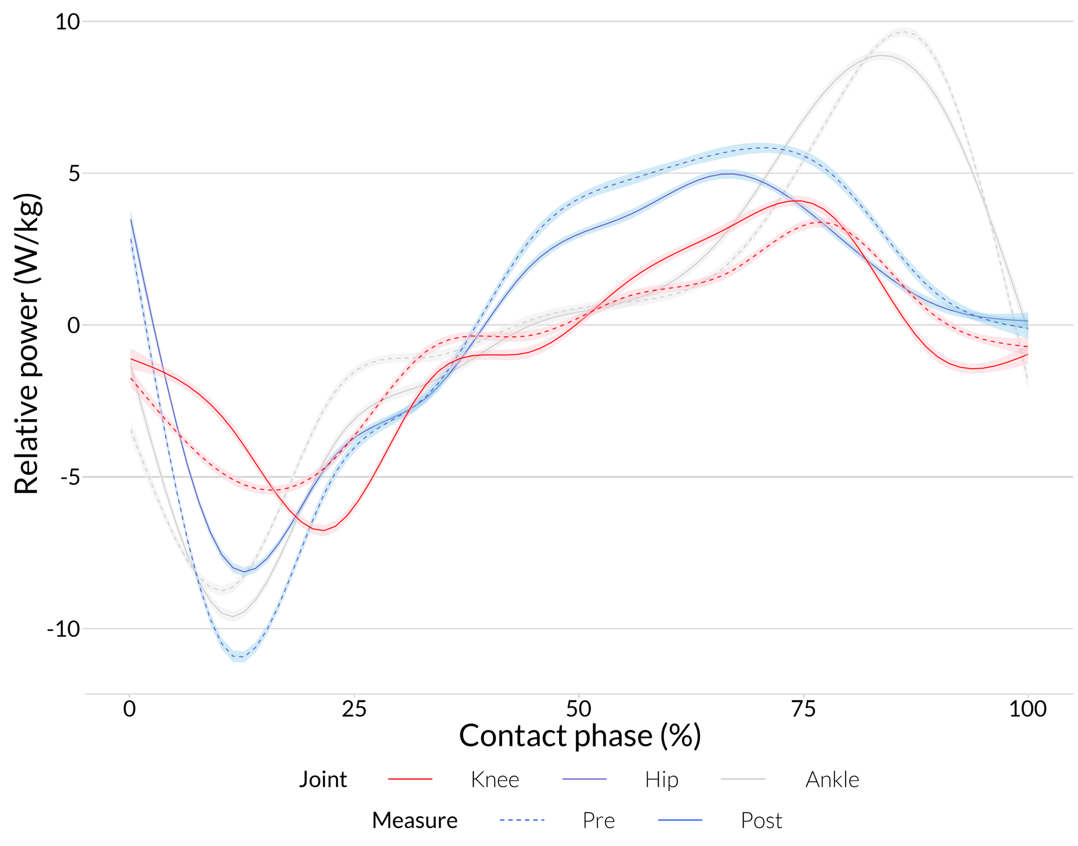
	Age (yrs)	Height (cm)	Weight (kg)	Dom. Leg	Inj. Leg	Graft	Sport	Sex	Days from surgery
1	21	1.72	60.3	L	L	H	HB	F	405
2	22	1.75	93.1	L	L	Q	HB	M	858
3	21	1.63	63.5	L	R	H	HB	F	354
4	19	1.61	57.8	L	L	H	HB	F	374
5	20	1.64	58.3	R	R	H	HB	F	346
6	20	1.71	66.1	L	L	H	Soc	M	288
7	19	1.63	57.0	L	L	B	VB	F	343
8	19	1.73	76.5	L	R	H	HB	F	1053
9	28	1.83	66.6	L	R	H	VB	F	783
10	19	1.86	73.5	L	L	H	BB	M	657
11	19	1.59	58.6	R	L	H	HB	F	589
Mean	20.8	1.71	67.3						546.1
SD	2.7	0.09	11.2						270.2

L: Left, R: Right; H: Hamstring, Q: Quadriceps, B: Bone-Patellar Tendon-Bone; HB: Handball, Soc: Soccer, VB: Volleyball, BB: Basketball; F: Female, M: Male.

Experimental design.

30 cm height, 3 valid trials per leg (averaged) | *Injured leg, 1 set only, AMRAP, ROM: from a knee angle of 100 to 60°, 16 sessions* | *30 cm height, 3 valid trials per leg (averaged)*

Change in average power curves of the hip, knee, and ankle in the injured leg.



Before (pre) and after (post) intervention, expressed as a percent of the contact phase (the contact phase was shorter after). Curves were averaged and smoothed using a generalized additive model (GAM). Power at the ankle was mostly unchanged and is displayed in light grey.

References

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