

Center of Pressure Displacement and Abductor/Adductor Activation for Variable Landing Heights and Foot Spacings

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Introduction

Landing techniques are essential for sport

- Gymnastics
- Basketball
- Volleyball
- Parachuting
- Football
- Soccer



<https://athletesacceleration.com/jumping-landing-progressions-volleyball/>

Purpose

Understand the biomechanical effects of landing from variable heights and foot spacings

Overall goals

- Determine maximal vertical Ground Reaction Forces (GRFs)
- Measure Center of Pressure (CoP) displacement
- Measure Abductor/Adductor activation
- Determine maximal knee angles (sagittal plane)

Methods

2 landing heights

- 30.48cm (12in)
- 60.96cm (24in)

3 foot spacings

- 20cm (8in)
- 40cm (16in)
- 60cm (24in)



<https://gifer.com/en/ATfH>



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Experimental Design

3 trials for each height/foot spacing condition

- 1 male, recreationally active
 - Age: 39 years
 - Height: 190.5cm (75in)
 - Weight: 93.9kg (207lbs)
- Subject instructed to step forward off box without jumping and land with toes on measured spacing markers
 - No other instruction provided



<https://gifer.com/en/ATfH>

Equipment

Vicon Motion Capture System

- Lower body plug-in gait markers
- 100Hz

AMTI Force Plates

- 1000Hz

EMG

- 1000Hz



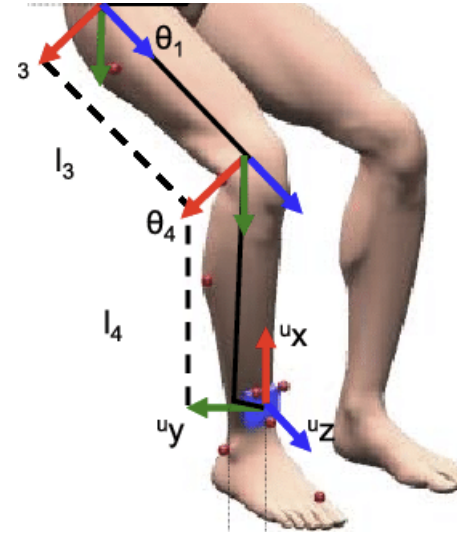
<https://www.facebook.com/Vicon>



Data Collection

Right Leg Only

- Vertical Ground Reaction Force (GRF)
- Knee angle
- Center of Pressure (CoP)
- Abductor EMG
- Adductor EMG

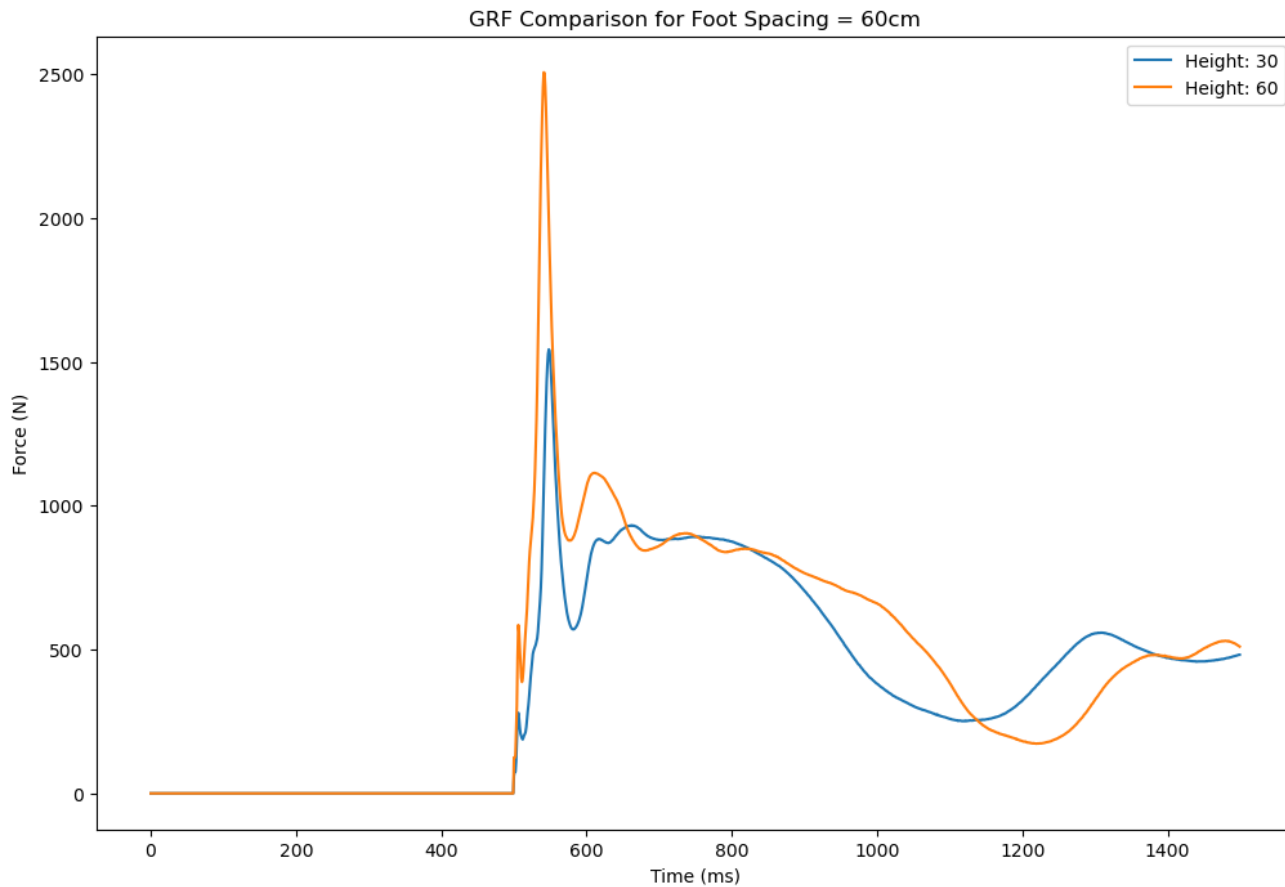


https://www.researchgate.net/figure/Four-degree-of-freedom-biomechanical-model-of-the-leg-system-Point-U-u-X-u-Y-u-Z_fig11_286765439

Results

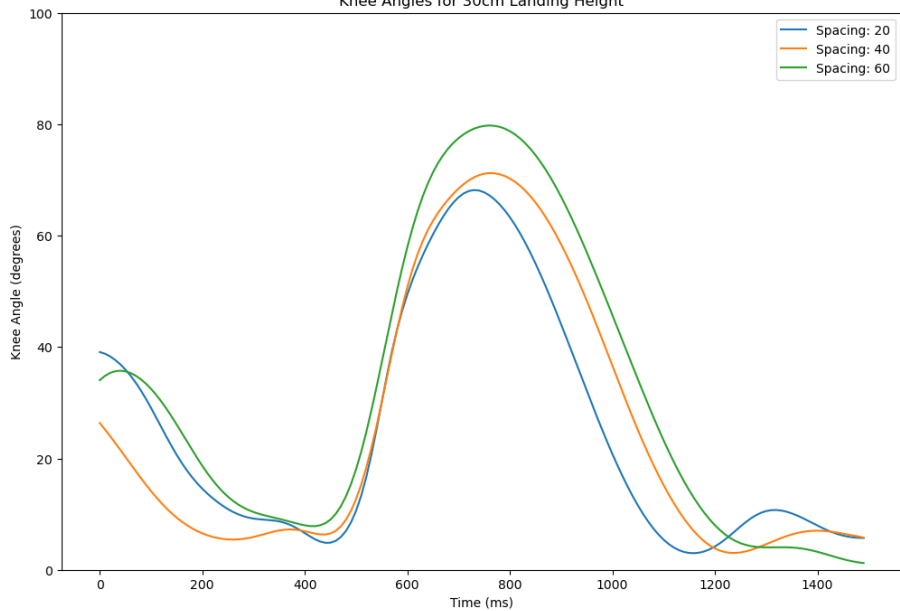
Height (cm)	Spacing (cm)	Peak GRF (N)	Peak Knee Angle (degrees)	Max CoP Lateral Displacement (mm)	Max Abductor EMG (mV)	Max Adductor EMG (mV)
30	20	2240.5	68	13.4	0.84	1.22
	40	1839.5	72	19.8	0.85	0.33
	60	2014.8	84	27.7	0.31	0.32
60	20	2305.1	96	22.2	0.24	1.27
	40	2356.4	95	22.8	1.09	0.31
	60	2506.1	96	36.8	1.50	0.32

Results

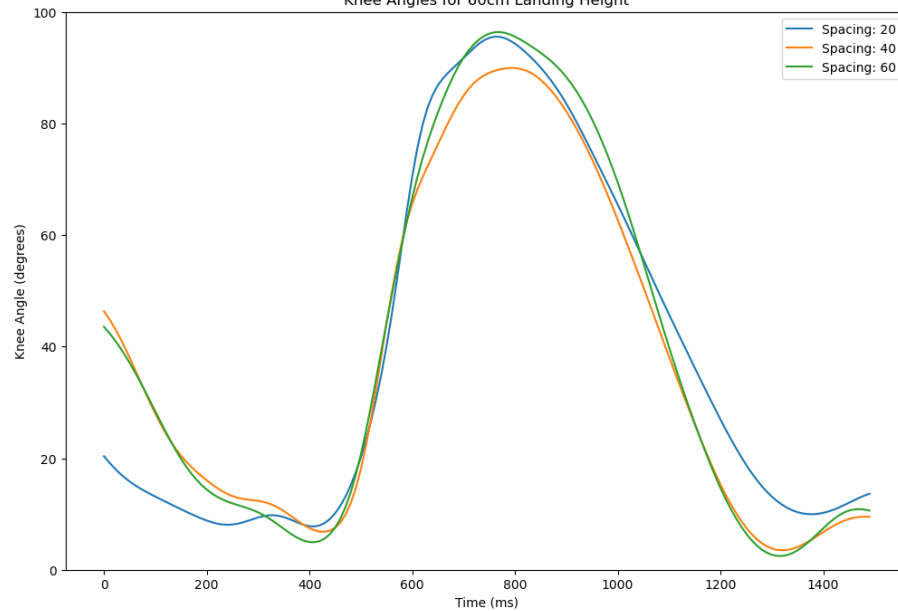


Results

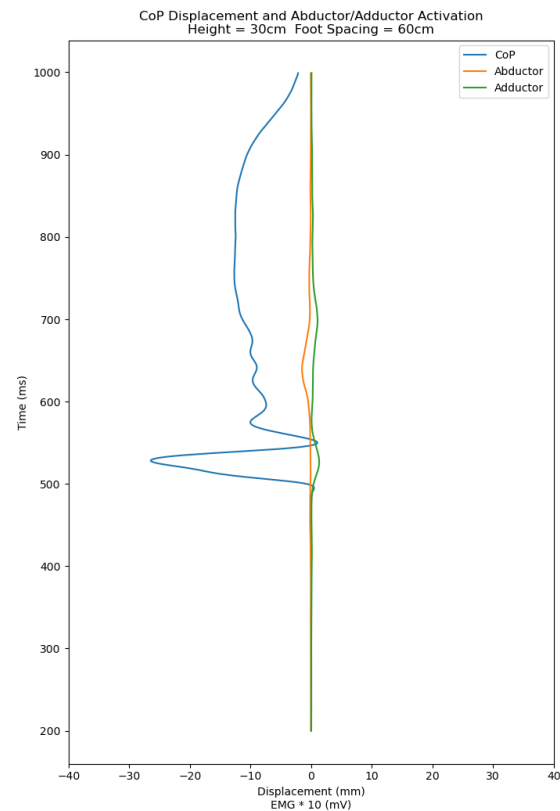
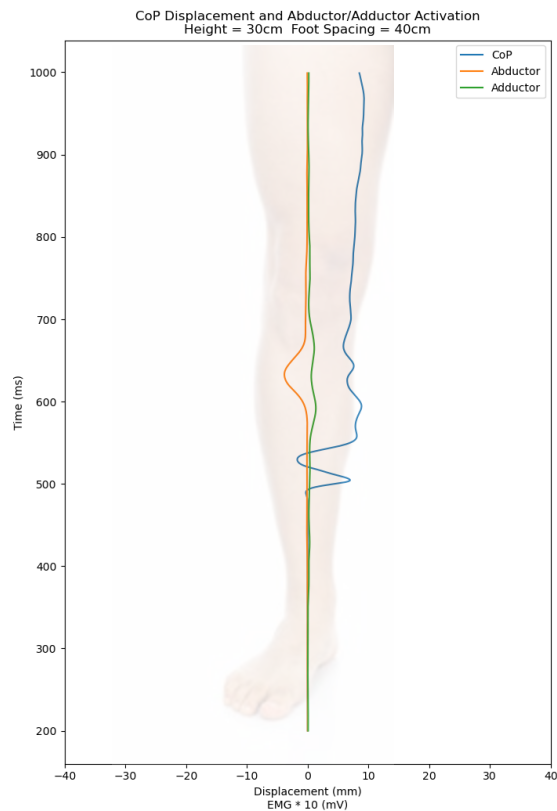
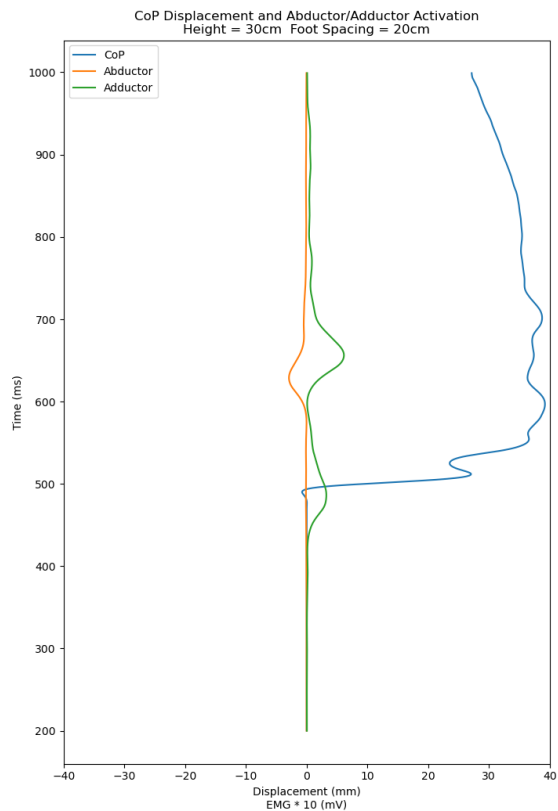
Knee Angles for 30cm Landing Height



Knee Angles for 60cm Landing Height

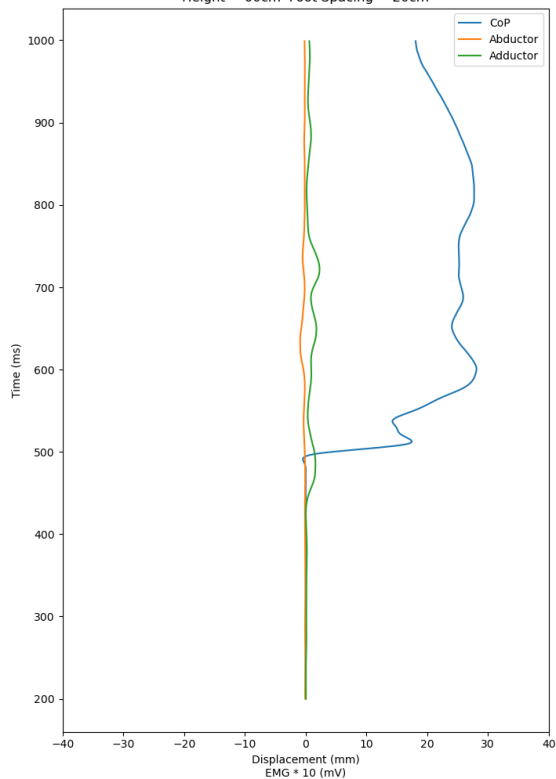


Results

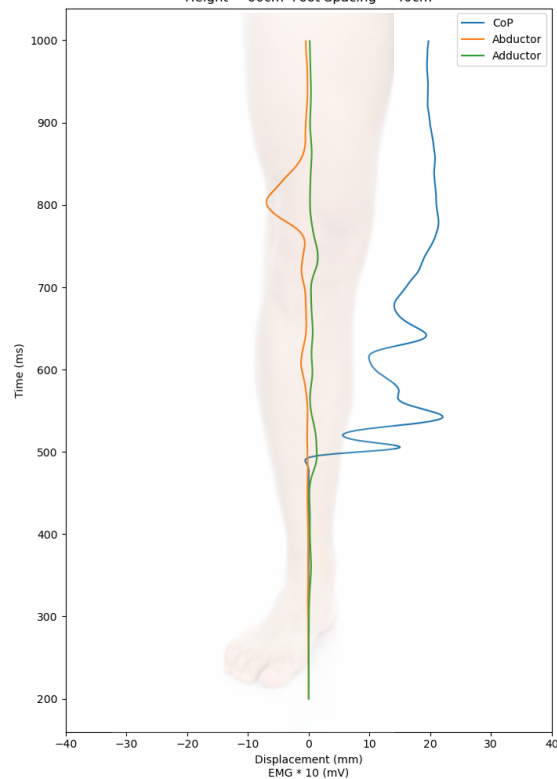


Results

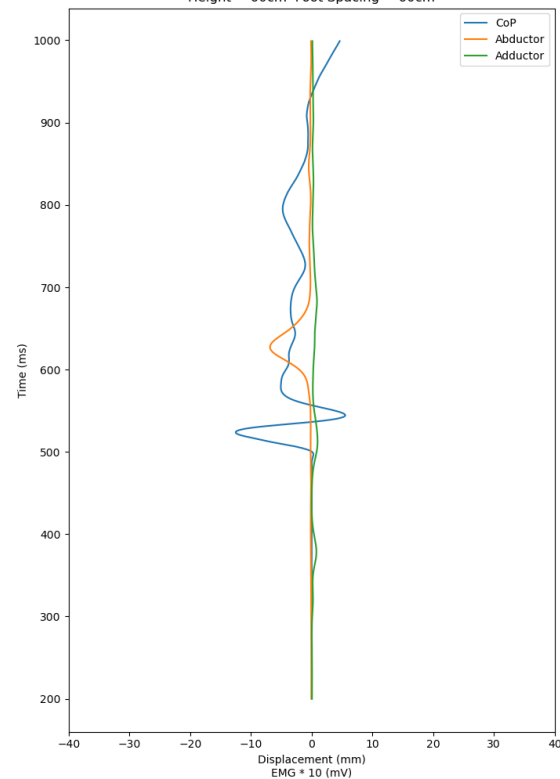
CoP Displacement and Abductor/Adductor Activation
Height = 60cm Foot Spacing = 20cm



CoP Displacement and Abductor/Adductor Activation
Height = 60cm Foot Spacing = 40cm



CoP Displacement and Abductor/Adductor Activation
Height = 60cm Foot Spacing = 60cm



Discussion

Vertical GRFs ↑ as height ↑ - no significant change with foot spacings

Knee angle

- 30cm height: knee angle ↑ as foot spacings ↑
- 60cm height: knee angle was greater than knee angle for 30cm height
 - Remained consistent across foot spacings

CoP

- 20cm foot spacing: medial displacement > 20mm
- 40cm foot spacing: undulating medial displacement
- 60cm foot spacing: undulating lateral displacement > 10mm

Abductor/Adductor Activation

- 20cm foot spacing: greater adductor response
- 40cm foot spacing: greater abductor response
- 60cm foot spacing: greater abductor response (60cm height only)

Conclusion

Increased foot spacing associated with lower injury risk factors when landing from variable heights^{1,2}

- ↑ knee angle (sagittal plane)
- ↑ lateral CoP displacement
- ↑ stabilizer activation

Larger study needed to test initial findings



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References

- 1) Durall CJ, Kernozek TW, Kersten M, Nitz M, Setz J, Beck S. Associations Between Single-Leg Postural Control and Drop-Landing Mechanics in Healthy Women. *Journal of Sport Rehabilitation*. 2011;20(4):406-418. doi:10.1123/jsr.20.4.406
- 2) Wang J, Fu W. Asymmetry between the dominant and non-dominant legs in the lower limb biomechanics during single-leg landings in females. *Advances in Mechanical Engineering*. May 2019. doi:10.1177/1687814019849794

Results

