Gluteus Maximus Activity during Bilateral Countermovement Jump in D1 Female Athletes

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Abstract

The objective of this study was to compare left and right Gluteus Maximus muscle activation in division one (D1) female basketball players, while performing a countermovement jump (CMJ). The study asked, "What impact does the bilateral CMJ have on gluteal activation in D1 female athletes?" The null hypothesis stated no significant differences would be found in gluteal activation between the right and left Gluteus Maximus muscles. Nine female participants volunteered for the study. Pre-screening of participants involved assessment of the Functional Movement Screen™ squat pattern and muscular voluntary isometric contractions (MVIC) of the right and left Gluteus Maximus. Surface electrodes were placed on the belly of each gluteus maximus to record muscle activation while performing three trials of the CMJ. Data was analyzed using the Delsys EMGWorks® software. Root mean square (RMS) values were normalized to the MVIC for each Gluteus Maximus. A matched paired *t*-test compared the right and left Gluteus Maximus activation for the CMJ and the landing. Results indicated no statistically significant differences in Gluteus Maximus during CMJ task. The null hypothesis is accepted.

Introduction

A bilateral countermovement jump is used to evaluate muscle activation of the lower extremities.[2] A countermovement jump activates the gluteal muscles and provides a relationship between muscle activation and vertical jump height.[2] Vertical jump height during the countermovement is affected by depth squat and gluteal activation.[2] Gluteus Maximus provides stability, explosiveness, strength, aids in daily life tasks, and controls gait.[3] The Gluteus Maximus is the prime mover during hip extension and lateral rotation.[3] Gluteal weakness will alter the function of the gluteus maximus and may cause disruption of the kinetic chain.[3] Kinetic chain disruption alters how the human body functions and may be a result of inflammation, hip flexor tightness, pelvic alignment, and core weakness.[1] Evaluation of gluteal activation provides useful information in sports-related, therapy, and training settings.[4]

Figure 1
CMJ Loading

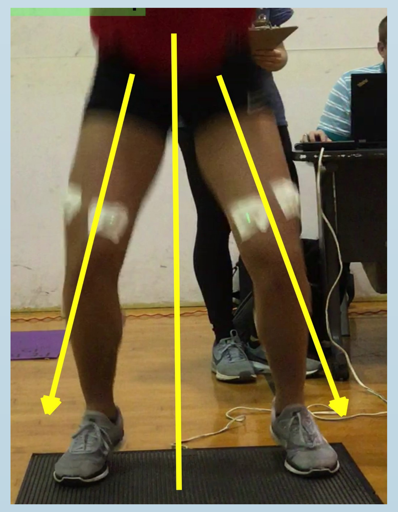


Figure 2
CMJ Landing

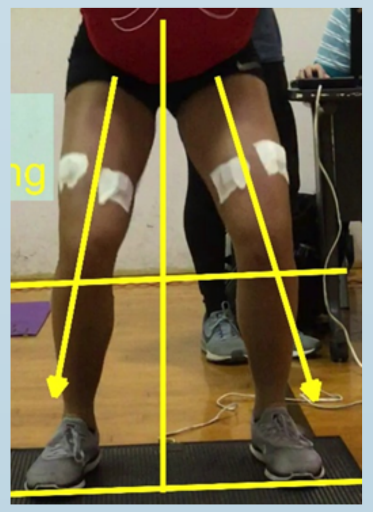


Figure 3
CMJ Loading

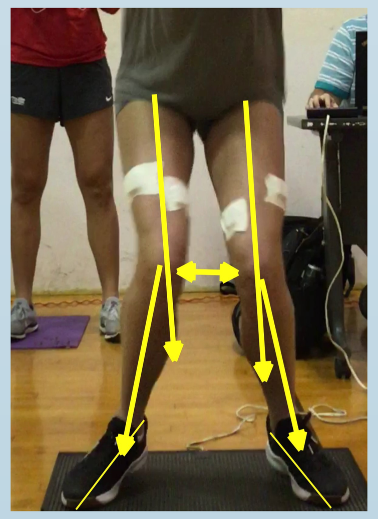
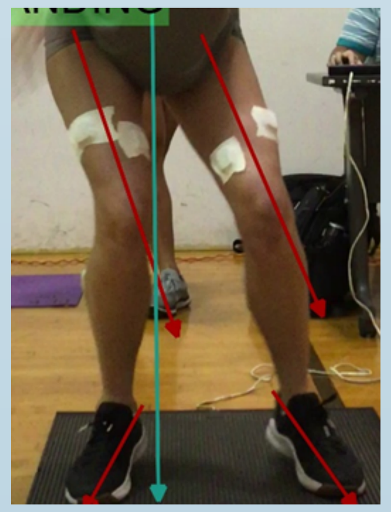


Figure 4
CMJ Landing



Figures 1 and 2 indicate appropriate take-off and balanced landing mechanics. Figures 3 and 4 indicate poor take-off and landing mechanics, where balance and stability are compromised.

Methods

Setting

- Small DI Midwestern University laboratory
- Fall 2019

Participants

- 9 female Division I basketball players

Procedures

- Five-minute dynamic warm-up on exercise bike.
- FMS™ squat assessment was performed and video was recorded.
- Skin surface above R & L Gluteus Maximus prepared and secured with electrode sensors.
- MVIC collected for each muscle.
- 3 CMJs performed while video-recorded.
- Jump heights were recorded for each CMJ.
- Electrodes detecting muscle activity sent data via Bluetooth to computer program.
- Matched-paired *t*-test with replication used to analyze the data.

Results

Table 1
Mean Countermovement Jump Height (in)

Participant	1	2	3	4	5	6	7	8	9	x̄
x̄	20.6	16.1	20.6	16.7	15.7	16.6	17.1	19.1	18.4	17.9

Table 2
Comparison of mean percent MVIC muscle activation: CMJ

Participant	1	2	3	4	5	6	7	8	9	x̄
RGM	82.0	35.8	197.3	179.7	152.0	20.2	68.8	86.3	139.7	102.8
LGM	90.3	42.5	83.5	112.3	122.8	16.1	92.6	33.4	331.3	74.17
|Δ|	8.3	6.7	113.9	67.4	29.2	4.1	23.8	52.9	191.7	55.3

***RGM = Right Gluteus Maximus; LGM = Left Gluteus Maximus**

Table 3
Comparison of mean percent MVIC muscle activation: Landing

Participant	1	2	3	4	5	6	7	8	9	x̄
RGM	70.1	25.7	153.5	226.7	48.4	24.1	n/a	19.9	128	81.2
LGM	43.0	26.1	24.0	77.6	36.8	16.1	n/a	59.6	74.8	40.5
|Δ|	27.2	0.4	129.5	149.1	11.6	7.9	n/a	39.7	54.0	52.2

Excludes participant #7

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Results cont.

Table 4
Matched paired t-test: CMJ

	df	*n*	*p*
LGM	8	9	0.79
RGM		9	

*Percentage of MVIC

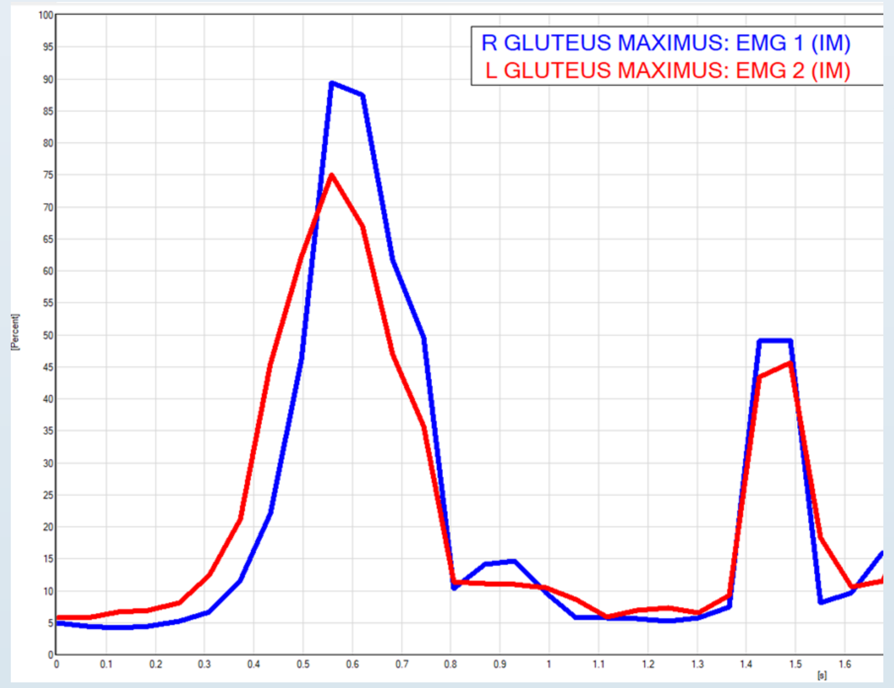
Table 5
Matched paired t-test: Landing

	df	*n*	*P*
LGM	7	8	0.11
RGM		8	

*Percentage of MVIC; excludes participant 7

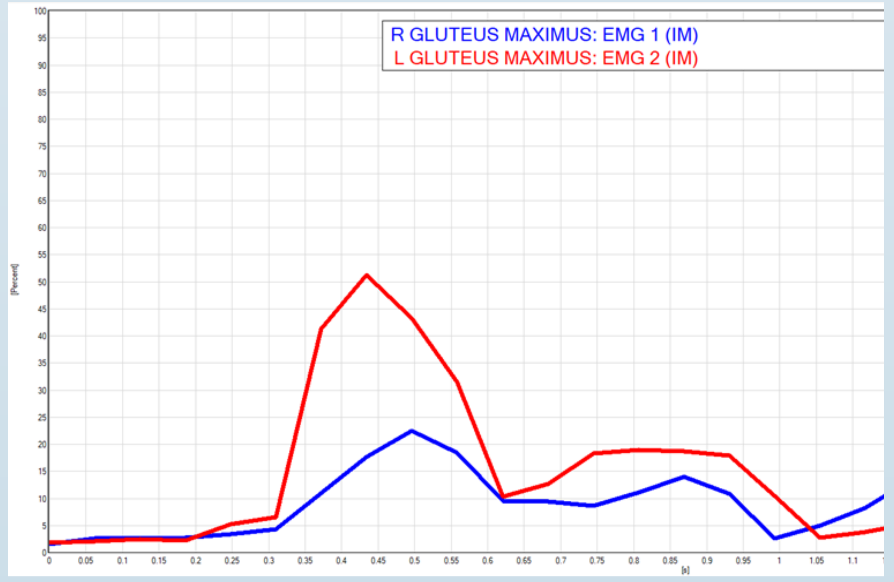
No significant difference was found between the left and right Gluteus Maximus muscle activation during bilateral CMJ.

Figure 5
EMG signals R & L Gluteus Maximus



EMG: Participant with similar muscle activation in right and left Gluteus Maximus muscles during CMJ; RGM= 90%; LGM=75% of MVIC

Figure 6
EMG signals R & L Gluteus Maximus



EMG: Participant with dissimilar muscle activation in right and left Gluteus Maximus muscles during CMJ;RGM=22%; LGM=51% of MVIC

Conclusion

Statistical analyses indicated no significant difference between left and right Gluteus Maximus muscle activation. However, differences in muscle activation between the right and left Gluteus Maximus muscles were found when comparing countermovement and landing portions of the jump. Continuous, unequal gluteal activation and favoring one side to another may result in an overuse injury and cause a gradual increase in muscle imbalances. Researcher concluded that EMG of the CMJ did not indicate a high degree of variance in muscle activity between right and left Gluteus Maximus. Future research should include a larger sample size, a more demanding and force generating bilateral movement, and increased amount of MVIC trials for normalizing data.

References

1. Buckthorpe, M., Stride, M., Villa, F. (2019) Assessing and treating gluteus maximus weakness – a clinical commentary. *The International Journal of Sports Physical Therapy.* 14(4), 655-669.
2. Gheller, R., Pupo, J., Pereira de Lima, L., Monteiro de Moura, B., Giovana dos Santos, S. (2014). Effect of squat depth on performance and biomechanical parameters of countermovement vertical jump. *Rev Bras Cineantropom Desempenho Hum,* 16(6), 658-668.
3. Wilson, J., Ferris, E., Heckler, A., Maitland, L., Taylor, C. (2005). A structured review of the role of the gluteus maximus in rehabilitation. *NZ Journal of Physiotherapy,* 33(3), 95-100.
4. Yoshioka, S., Nagano, A., Hay, D., Fukashiro, S. (2010). The effect of bilateral asymmetry of muscle strength on jumping height of the countermovement jump: a computer stimulation study. *Journal of Sports Sciences,* 28(2), 209-218.