THE UNIVERSITY OF MEMPHIS | School of Health Studies

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I TrainFundamentals Acute Comparisons Report

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OBJECTIVE

The objective of this study was to assess if using the I Train Fundamentals *Defensive Slide Bar* would alter athlete motion, force production, and muscle activity during an athletic movement.

PURPOSE

The purpose of the study was therefore to compare ground reaction force production, body motions and positions, and lower limb muscle activation in college-aged individuals with an athletic background while performing side-to-side shuffling movements with and without the I Train Fundamentals *Defensive Slide Bar* during a single testing session. The findings from this study presents information about participant movement during acute use of the I Train Fundamentals *Defensive Slide Bar* and without prior to training using the I Train Fundamentals *Defensive Slide Bar*. The second study within our U of Memphis project will assess the ***training effects*** of the I Train Fundamentals *Defensive Slide Bar* on movement and athletic performance.

METHODS

Participants

Twenty college-aged young adults (6 women and 14 men) with a strong background in athletics including basketball, soccer, rugby, football, volleyball, lacrosse, hockey and tennis were recruited from the University of Memphis community for this study (Table 1). Inclusion criteria for athletic experience included high school, intramural or some collegiate sports experience. Participants did not have any lower limb musculoskeletal injuries at time of testing, were currently participating in weekly organized athletics/sports, and had a body mass index (BMI) below 30 (i.e., non-obese).

Table 1. Participant Characteristics

Participant Characteristics			
Age (years)	21.6	±	2.1
Height (m)	1.73	±	0.08
Mass (kg)	71.9	±	11.2
Body Mass Index (kg/m2)	23.8	±	2.5

Testing Equipment and Procedures

All participants took part in one laboratory testing session in the Musculoskeletal Analysis Laboratory (room 171 of the Elma Roane Fieldhouse) on University of Memphis campus and provided informed consent as well as completed activity readiness surveys. The testing movement consisted of side-to-side (medial/lateral) shuffling in a defensive stance at an average speed of 2.4 ± 0.4 m/s. Participants were instructed to use a “defensive stance” while shuffling laterally. No other instructions were provided during testing to allow particpants to perform the shuffling task in a natural manner. The training component of the larger project addressed the instruction of maintaining a low-to-the-ground defensive stance. All participants completed five shuffling trials in each direction to measure swing (i.e., foot off the ground) and stance (i.e., foot on the ground) phase muscle activity with and wthout the I Train Fundamentals *Defensive Slide Bar*. Therefore, participants completed a total of 20 shuffling trials. Testing speed was monitored and controlled using two photocells placed three meters apart at shoulder height and an electronic timer (Lafayette Instruments, USA). Before testing movements, spherical reflective markers were placed over the right thigh, right lower leg, right foot, left heel and the pelvis to track limb/joint motions using a 3D motion capture system (240Hz, Oqus 100, Qualisys AB). Wireless electrodes were placed on the skin over seven muscles to record muscle activity (1500Hz, Telemyo, Noraxon, USA). Muscles of interest included: tibialis anterior, medial gastrocnemius, vastus medialis, rectus femoris, gluteus medius, and gluteus maximus. Electrode

placement was based on guidelines from the SENIAM project [1]. Ground reaction forces (GRF) were measured using a 3D force platform (1200Hz, BP900600, AMTI, Inc, USA) during testing movements.

Table 2. Muscle Definitions

Muscle Definitions	
Muscles	**Functions**
Biceps Femoris	Hip extensor and Knee flexor
Gluteus Medius	Hip abductor, extensor, external rotator
Gluteus Maximus	Hip extensor and external rotator
Medial Gastroc	Ankle plantarflexor and Knee Flexor
Rectus Femoris	Knee extensor and Hip flexor
Tibialis Anterior	Ankle dorsiflexor and invertor
Vastus Medialis	Knee extensor

Data Processing and Analyses

Visual3D software (C-Motion, Inc., MD, USA) was used to compute all variables of interest. Kinematic data were interpolated using a least-squares fit of a 3rd order polynomial with a three data point fitting and a maximum gap of 10 frames. Kinematic and GRF data were then filtered using a fourth-order Butterworth low-pass filter with cutoff frequencies of 8 Hz and 40 Hz, respectively. GRF data were normalized to body mass (N/kg) and body motion variables were normalized to body height (% Height). The muscle activity data during shuffling were band-pass filtered with cut-off frequencies of 20 Hz and 450 Hz. These signals were then full-wave rectified and smoothed using the root-mean-square (RMS) filter with a moving window of 129 ms. Muscle activity signals were then integrated (iEMG; V·s) across the stance and swing phases of the shuffling movement. For each dependent variable, the average of the five shuffling trials were included in statistical analyses.

Repeated measures analyses of variance were used to compare within subject differences in shuffling with or without the I Train Fundamentals *Defensive Slide Bar* (20.0, IBM SPSS, Chicago, IL). Mauchly's Test of Sphericity was used to test the assumption of equal variances of the difference between repeated measures. When the assumption of sphericity was not met (i.e., $p<0.05$), the Greenhouse-Geisser adjustment was used to assess within-subject differences. Significance was set at 0.05 for all tests. Cohen's *d* effect size estimates were reported for mean differences with values less than 0.30 representing a small effect, values between 0.30 and 0.80 representing a moderate effect, and values greater than 0.80 representing a large effect [2].

Table 3. Definition of Variables

Variables	Definition
Muscle Activity	Electrical activity output during muscle contraction
Max Step Width	Distance between feet during widest step position
Min Step Width	Distance between feet during narrowest step position
Mean Pelvis Vertical Position	Height of pelvis during a complete shuffling step
Braking Impulse	Average force over time to decelerate the body in horizontal direction
Vertical Impulse	Average force over time to move the body in vertical direction
Peak Braking Force	Maximal force to decelerate the body
Peak Vertical Force	Maximal force to move the body in vertical direction

RESULTS

Swing Phase Muscle Activity

The I Train Fundamentals *Defensive Slide Bar* resulted in large increases in gluteus maximus (hip extensor and external rotator) activity when the lead leg is off the ground pushing out (i.e., swing phase) (Table 4). Moderate increases in both gluteus medius (hip abductor, extensor and external rotator) and rectus femoris (hip flexors and knee extensor) are observed during the swing phase while using the I Train Fundamentals *Defensive Slide Bar* (Table 4). No differences in muscle activity were observed for all other muscles when using the I Train Fundamentals *Defensive Slide Bar* during the swing phase of the movement (Table 4).

Table 4. Swing phase muscle activity for all muscles with and without bar use (mean±standard deviation)

Swing Phase Integrated Muscle Activity (V·s)							Statistics		
	No Bar			**Bar**			***p-value***	***d***	***Effect***
Biceps Femoris	17.74	±	14.14	16.34	±	12.91	0.29	-0.15	small
Gluteus Medius	22.43	±	11.24	28.56	±	16.64	**0.063**	**0.61**	**moderate**
Gluteus Maximus	16.38	±	7.24	21.86	±	10.91	**0.01**	**0.84**	**large**
Medial Gastroc	19.80	±	13.78	19.38	±	13.72	0.81	-0.04	small
Rectus Femoris	18.15	±	9.79	24.02	±	16.55	**0.09**	**0.61**	**moderate**
Tibialis Anterior	34.96	±	25.88	32.72	±	24.98	0.36	-0.12	small
Vastus Medialis	12.14	±	6.67	12.95	±	7.77	0.59	0.16	small

Stance Phase Muscle Activity

When the foot is pushing off the ground (i.e., stance phase), no worthwhile differences in muscle activity were observed for any muscles when using the I Train Fundamentals *Defensive Slide Bar* (Table 5).

Table 5. Stance phase muscle activity for all muscles with and without bar use (mean±standard deviation)

Stance Phase Integrated Muscle Activity (V·s)							Statistics		
	No Bar			Bar			*p-value*	*d*	*Effect*
Biceps Femoris	19.10	±	11.57	16.94	±	9.85	0.19	-0.28	small
Gluteus Medius	25.38	±	18.45	24.95	±	12.70	0.86	-0.04	small
Gluteus Maximus	19.17	±	9.57	20.44	±	10.07	0.29	0.18	small
Medial Gastroc	34.50	±	18.59	34.57	±	15.51	0.97	0.01	small
Rectus Femoris	27.93	±	16.79	29.75	±	14.67	0.4	0.16	small
Tibialis Anterior	33.49	±	19.18	33.38	±	19.47	0.96	-0.01	small
Vastus Medialis	28.67	±	16.51	30.36	±	16.55	0.46	0.15	small

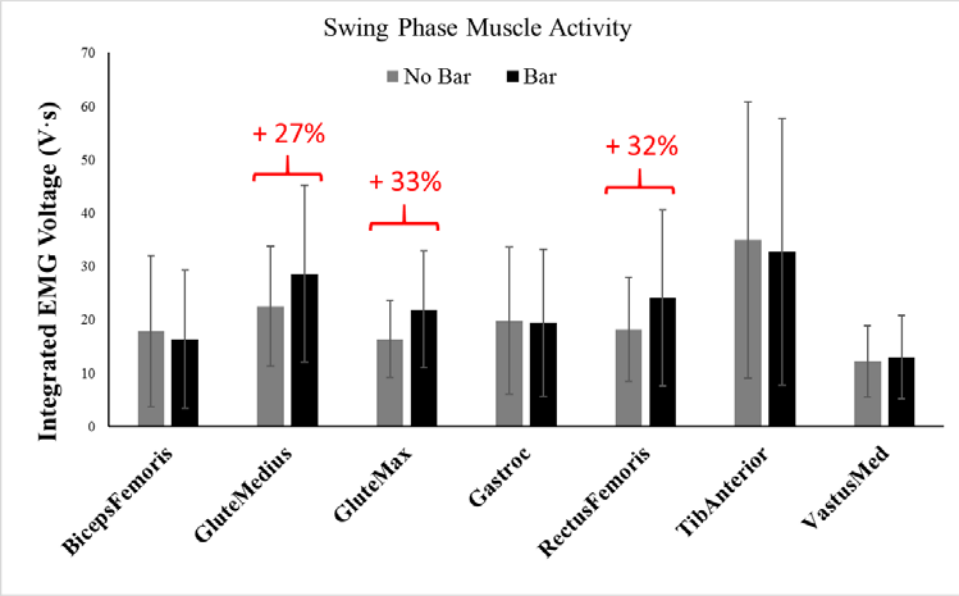

Figure 1. Muscle activity during the swing phase (foot off the ground moving away from stance foot) of the shuffling movement (mean±standard deviation) of all tested muscles with no bar (grey) and bar (black).

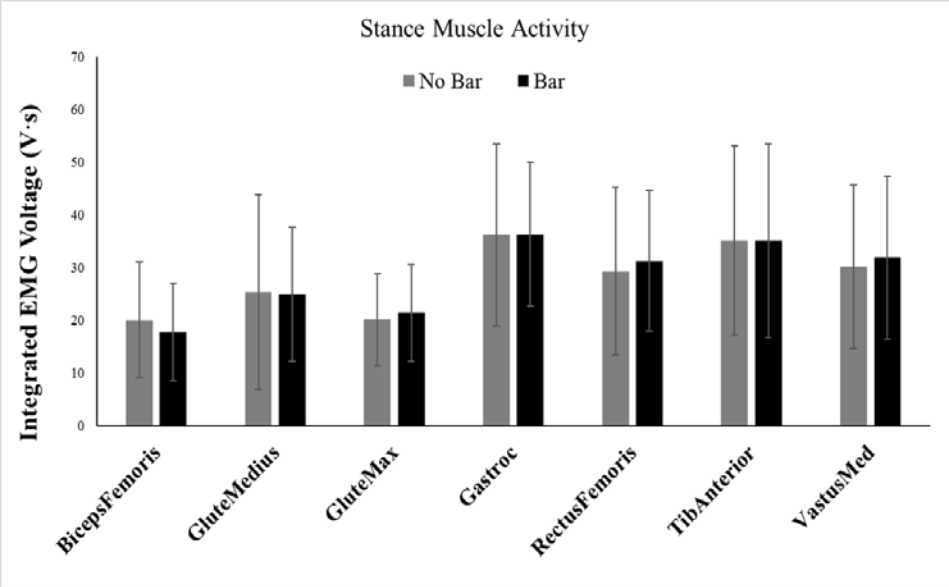

Figure 2. Muscle activity during the stance phase (foot on the ground while pushing off) of the shuffling movement (mean±standard deviation) of all tested muscles with no bar (grey) and bar (black).

Body Motions and Positions

When using the I Train Fundamentals *Defensive Slide Bar*, athletes shuffled with a narrower maximal step width due to resistance provided by the band. Participants also had a wider minimal step width when using the I Train Fundamentals *Defensive Slide Bar* due to the physical limitation of the bar (Table 6). These findings confirm that the bar keeps the feet apart and that the I Train Fundamentals *Defensive Slide Bar* provides resistance to moving the feet apart during shuffling.

In addition, athletes maintained a taller position while shuffling with the I Train Fundamentals *Defensive Slide Bar* (Table 6). This is likely due to the greater resistance from the bar in a lower body position which requires a wider stance (see Tension Testing report previously submitted).

Table 6. Body motion and positions with and without bar use (mean±standard deviation)

Step Width & Pelvis Kinematics							Statistics		
	No Bar			**Bar**			***p-value***	***d***	***Effect***
Max Step Width (% Height)	0.58	±	0.05	0.54	±	0.04	**<0.001**	**-1.30**	**large**
Min Step Width (% Height)	0.11	±	0.03	0.21	±	0.02	**<0.001**	**5.21**	**large**
Mean Pelvis Vertical Position (% Height)	0.35	±	0.03	0.38	±	0.03	**<0.001**	**1.09**	**large**

Ground Reaction Forces

A large reduction in braking impulse and a moderate reduction in peak braking force were observed when using the I Train Fundamentals *Defensive Slide Bar* (Table 7). These findings indicate that use of the I

Train Fundamentals *Defensive Slide Bar* reduced the eccentric demand of lower limb muscles to decelerate the body during shuffling steps.

Finally, a moderate reduction in vertical impulse was observed when using the I Train Fundamentals *Defensive Slide Bar* (Table 7). This suggests that athletes were not applying as much force to the ground when pushing off likely due to the taller position during the shuffling task.

Table 7. Ground reaction force variables with and without bar use (mean±standard deviation)

Lead Leg Ground Reaction Forces							Statistics		
	No Bar			**Bar**			***p-value***	***d***	***Effect***
Braking Impulse (N/kg·s)	-0.50	±	0.16	-0.39	±	0.12	**<0.001**	**1.07**	**large**
Vertical Impulse (N/kg·s)	2.42	±	0.52	2.31	±	0.39	**0.016**	**-0.35**	**moderate**
Peak Braking Force (N/kg)	-4.30	±	1.03	-3.97	±	1.06	**0.043**	**0.45**	**moderate**
Peak Vertical Force (N/kg)	15.24	±	2.77	15.76	±	2.70	0.084	0.27	small

Recommendations for Marketing:

Based on our findings the following statements are supported by the data and are recommended for marketing purposes:

Initial use of the I Train Fundamentals Defensive Slide bar:

1. Increases the recruitment of hip abductor, hip extensor, hip flexor, hip external rotator, and knee extensor muscles during side-to-side defensive-style shuffling.
    a. Allows coaches and trainers to target specific muscles to address athlete weaknesses
2. Prevents a narrow stance during the return phase of shuffling.
    a. Ensures proper wide stance foot work
3. Increases the difficulty in stepping out during shuffling.
    a. Promotes a potentially larger training stimulus.
4. Reduces the eccentric demand on lower limb muscles during shuffling.
    a. This might have positive implications for athletes training when they are sore.

For more info and interpretations on these results, please feel free to contact Dr. Max Paquette at mrpqette@memphis.edu.

References

1. Seniam Guidelines: http://seniam.org/

2. Cohen J. Statistical power analysis for the behavioral sciences. Hillsdale, New Jersey: Lawrence Erlbaum Associates, Inc.; 1988.