The Effect of Shin-Torso Alignment and Biomechanical Positioning on Muscle Activity of the Lower Extremity in Ice Hockey Players

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ABSTRACT

Ice hockey is a sport prevalent with overuse injuries occurring throughout a season. These overuse injuries are commonly due to fatigue-related degradation of mechanics. There is a large variation in the technique used for ice hockey skating. The positioning of a hockey player while skating is vital because it can impact muscle activation. Improper positioning can cause increased activation in a particular muscle, which places more stress on that muscle. Over time this can lead to muscle fatigue and an increased likelihood of injury. PURPOSE: To measure muscle activation patterns and joint angle changes of the lower extremity in ice hockey players during three different simulated skating positions. METHODS: Electromyography sensors were placed on muscles of the quadriceps, hamstrings, and low back. Additionally, electrogoniometers were placed on the hip, knee, and ankle joints. Players performed 45-second trials on a slide board in three different positions: forward lean (FL), shin torso alignment (STA), and upright (UR). Muscle activation and joint angle differences were recorded and analyzed using a repeated measures ANOVA with $\alpha = 0.05$. RESULTS: Across the three positions, significant differences ($p \leq 0.029$) were found for muscle activation in the posterior musculature: gluteus maximus and semitendinosus (FL > STA > UR). A significant difference ($p < 0.035$) was found for the vastus lateralis (UR > STA). Large effect sizes were found for the vastus lateralis ($\eta 2 = 0.214$) and a medium effect size was found for the rectus femoris ($\eta 2 = 0.061$) across all positions. Significant differences were present for joint angles across trials. CONCLUSIONS: The FL exhibits greater posterior muscle activation and UR exhibits more anterior muscle activation. The STA skating position provides more of an equal distribution of muscle activation and could result in a reduction of fatigue-related injuries that may otherwise be present over an extended period of time.

INTRODUCTION

- Ice Hockey has many prevalent overuse injuries that commonly occur throughout a season, the most common being knee medial collateral ligament sprains and ankle sprains.
- One of the most important risk factors for these overuse injuries is improper biomechanical form. Anecdotally, arguments have been made that aligning the angle of the torso to be parallel to the angle of the shin is optimal from a performance and injury prevention standpoint.
- In this aligned position, there should be an equal distribution of musculature contraction on the anterior and posterior aspects of the thigh.
- The purpose of this study was to see how three different skating positions (forward lean, neutral, and upright) effect muscular activation in the lower body.
- It was hypothesized that there would be more balanced muscle activity in the lower extremity during a simulated skating stride when proper shin-torso alignment was used compared to the forward lean and upright skating positions.
- In the upright position, it was expected that the anterior musculature would be more activated and in the forward lean position, the posterior musculature would be more activated.

EXPERIMENTAL DESIGN AND METHODS

STUDY DESIGN & SUBJECTS

- Cross-sectional study design was utilized with Twenty male hockey players (21.63 ± 1.3 years, 177.53 ± 6.03 cm, and 80.82 ± 5.32 kg)

PROCEDURES

- Participants were assessed in three different skating positions (Forward Lean, Shin Torso Alignment, and Upright; Figure 3)
- Trials were 45 seconds on a slide board.
- Order of positioning was randomized, and the middle 15 seconds of each trial was analysed for each subject.
- Surface Electromyography (EMG) sensors (which measure muscle activation) were placed on the rectus femoris (RF), vastus medialis (VM), vastus lateralis (VL), semitendinosus (ST), biceps femoris (BF), gluteus maximus (GM), erector spinae longissimus (ESL), and erector spinae iliacus (ESI).
- System used was DataLite Wireless Sensors and Systems. WS1800 (Biometrics Ltd, Newport, United Kingdom)

Or, if you have a player already skating this way, in the weight room, you can help them focus on strengthening the muscles he's using.

Figure 1. Biometric Ltd Equipment

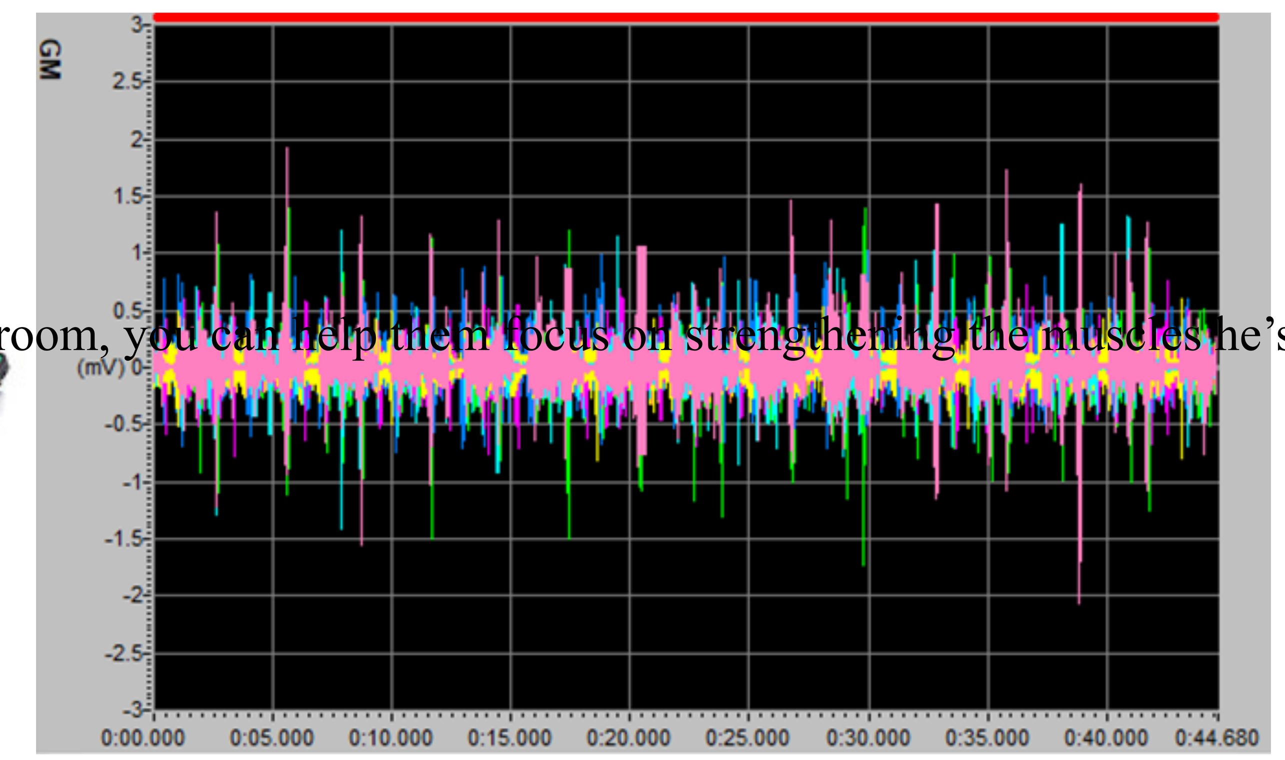

Figure 2. Data Lite Output

STATISTICAL ANALYSIS

- Normality was assessed with the Shapiro Wilk test.
- Repeated measures one-way ANOVA's were utilized to analyze the data for normally distributed values: Mean ± S.D. reported and η^2 for effect sizes.
- Friedman ANOVA was used for non-normally distributed values: medians reported and $\bar{r}$ for effect size.
- All Variables analysed by SPSS (v23, SPSS Inc.)

	FL		STA		UR		*p*-value	Effect Size	Group Comparison
	Mean ± SD	Median	Mean ± SD	Median	Mean ± SD	Median			
GM*	0.658 ± 0.428	0.504	0.592 ± 0.393	0.412	0.550 ± 0.392	0.482	0.012	0.634	FL>STA>UR
BF*	1.465 ± 1.837	0.561	0.899 ± 1.542	0.424	0.866 ± 1.411	0.375	0.607	0.230	
ST*	0.571 ± 0.337	0.489	0.558 ± 0.325	0.466	0.487 ± 0.322	0.411	0.465	0.067	FL>STA>UR
RF	0.895 ± 0.330	0.866	1.082 ± 0.647	0.952	0.992 ± 0.445	0.903	0.074	-0.166	
VM*	1.439 ± 0.776	1.206	1.325 ± 0.511	1.204	1.509 ± 0.753	1.356	0.029	0.315	
VL	1.297 ± 0.515	1.190	1.385 ± 0.775	1.172	1.506 ± 0.963	1.301	0.331	0.135	UR>STA
ESL*	0.540 ± 0.349	0.417	0.530 ± 0.236	0.519	0.528 ± 0.283	0.445	0.035	0.217	
ESI*	0.800 ± 0.634	0.626	0.600 ± 0.321	0.452	0.745 ± 0.452	0.633	0.365	0.368	

Table 1. Average values of muscle activation: Mean ± SD, Median, Effect Sizes, *P* Value and Significance. Effect Size for Repeated Measures ANOVA (η^2): 0.01 = S 0.06 = M 0.14 = L. Effect Size for Friedman's ANOVA ($\bar{r}$): 0.1=S 0.3=M 0.5=L*

RESULTS

- Significant differences ($p \leq 0.029$) were found for muscle activation in the posterior musculature: GM and ST (FL > STA > UR).
- A significant difference ($p < 0.035$) was also found for the VL (UR > STA)
- Large effect sizes were found for the GM ($\eta 2 = 0.634$) and RF ($\eta 2 = 0.166$)
- Medium effect sizes were found for ESI ($\eta 2 = 0.368$), VM ($\eta 2 = 0.315$), VL ($\eta 2 = 0.135$) the across all positions.
- Significant differences were present for joint angles across trials.

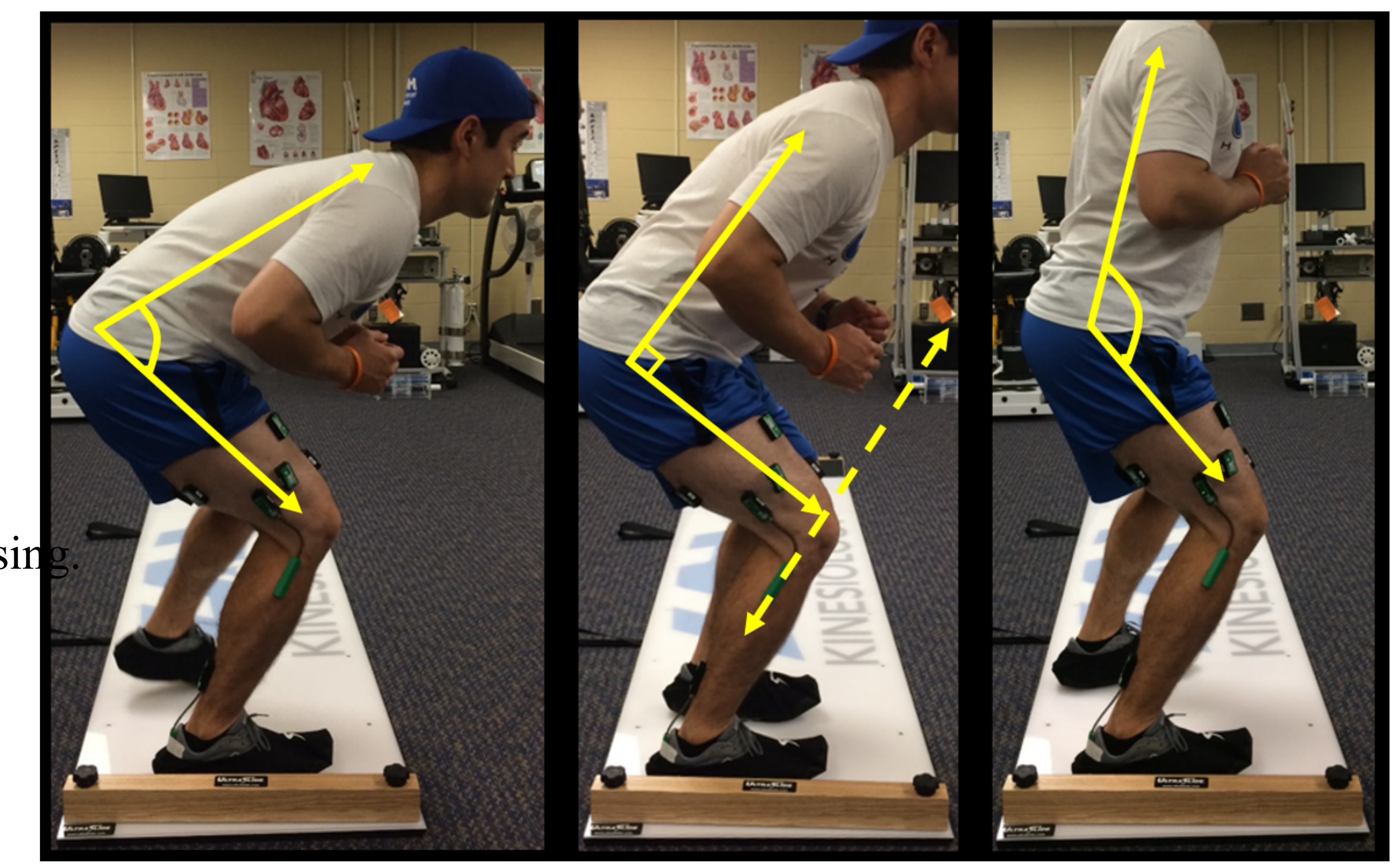

Figure 3. Three Positions : (left to right) Forward Lean, Shin-torso Alignment, Upright

CONCLUSION

- This knowledge can help hockey coaches and strength coaches prevent overuse injuries throughout a season by adjusting biomechanical positioning and skating technique. By achieving equal distribution of muscle activation in the anterior and posterior musculature of the lower extremity there could be a lower chance of fatigue and injury throughout the season.
- Potential limitations:
  - Participants relied on verbal feedback in order to maintain positioning.
- Future studies:
  - Investigate the potential differences on muscle activity while holding a hockey stick compared to not holding a stick to see if that helps with the validity of the results.

ACKNOWLEDGEMENTS

Thanks to Stacy Solomon and Dr. Ryan Conners
Special thanks to Dave Cook, Dr. Vogler of the RCEU Staff and to the Alabama Space Grant Consortium, Office of Provost, President, and VP for Research and Economic Development for sponsorship of this project

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