Comparison of electromyographic activity of rectus femoris between isokinetic knee extension training and roundhouse kicks - case study

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Introduction

Roundhouse kick is one of the most commonly used leg technique in many martial arts [Gavagan, Sayers 2017]. Its main power is generated by knee extension at final stage of technique execution [Thibordee, Prasartwuth 2014]. Proper power training needs to imitate electromyographic activity of muscles generated during the roundhouse kick execution to reduce need of motor learning transfer [Moreira *et al*. 2021]. The aim is to analyse the contribution of the data collected with BIODEX isokinetic device in better understanding the execution of the roundhouse kick.

Methods

33 years old karateka with 13 years of experience performed 10 roundhouse kicks to a shield and 10 repetition of knee extension in isokinetic test protocol on BIODEX SYSTEM 4 PRO with maximum speed of 500 deg/s, both with right leg. EMG electrode was attached to rectus femoris accordingly to SENIAM protocol (Figure 1). NORAXON Ultium IMU sensors was used to measure EMG activity of right rectus femoris muscle, angular velocity of knee extension movement and foot acceleration.

Figure 1. Electrode and IMU sensors placement on a right lower limb.

Figure 2. Video motion capture presentation on both movements executed during this experiment.

Results

For both roundhouse kick and isokinetic knee extension, occurrence of maximum angular velocity was before the occurrence of maximum acceleration with mean time difference was 0.01s and 0.034s, respectively. In both cases peak activation of rectus femoris occurs before reaching maximum angular velocity and acceleration (x =0.138s and x=0.064s respectively). For roundhouse kick, mean maximal electromyographic activity of rectus femoris was 644.68 uV±67.35. For isokinetic knee extension mean maximal electromyographic activity of rectus femoris was 593.02 uV± 147.13uV (Table 1).

Table 1. Differences in the time of occurrence for maximal values of studied variables.

	Roundhouse kick				Isokinetic knee extension			
Move	T_{EMGmax}- T_{amax}	T_{EMGmax} --$T_{\omega max}$	$T_{\omega max}$ - T_{amax}	Peak muscle activity (uV)	T_{EMGmax} --ta	T_{EMGmax}- - $T_{\omega max}$	$T_{\omega max}$ - T_{amax}	Peak muscle activity (uV)
1	-0.325	-0.123	-0.202	701.89	-0.096	-0.059	-0.037	317.37
2	-0.102	-0.115	0.013	614.92	0.013	0.052	-0.039	455.48
3	-0.125	-0.137	0.012	665.23	-0.183	-0.148	-0.035	508.05
4	-0.112	-0.123	0.011	499.10	-0.053	-0.014	-0.039	610.38
5	-0.111	-0.122	0.011	684.36	-0.022	0.014	-0.036	616.34
6	-0.114	-0.124	0.010	641.31	-0.042	-0.009	-0.033	578.00
7	-0.113	-0.123	0.010	678.01	-0.100	-0.069	-0.030	704.51
8	-0.147	-0.161	0.014	549.84	-0.022	0.010	-0.032	876.78
9	-0.122	-0.126	0.004	692.72	-0.092	-0.063	-0.030	538.48
10	-0.111	-0.126	0.015	719.44	-0.042	-0.008	-0.034	724.84
mean	**-0.138**	**-0.128**	**-0.010**	**644.68**	**-0.064**	**-0.029**	**-0.034**	**593.02**

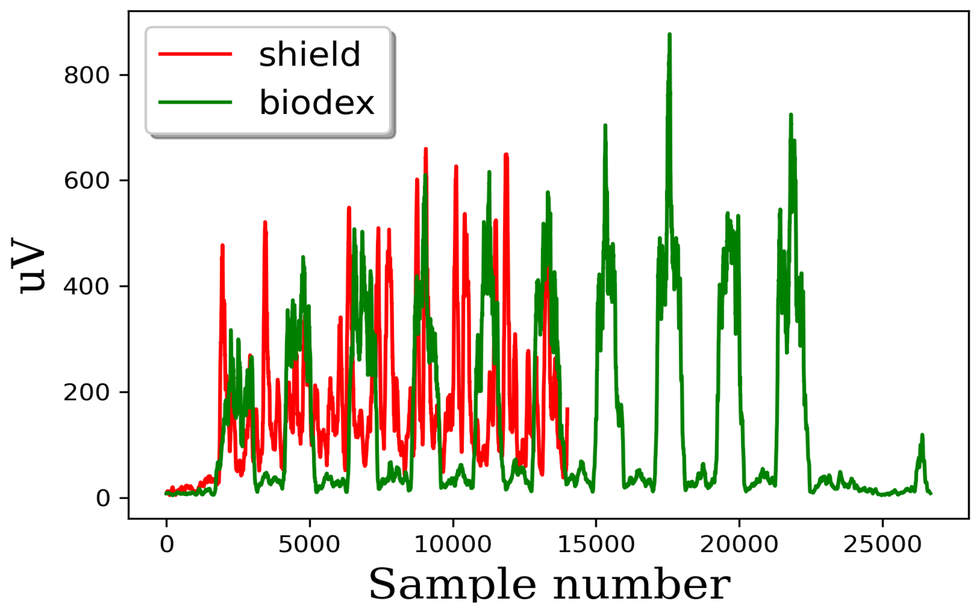

Figure 3. Raw electromyography record of two samples. Red is for kick to a shield and green one is for isokinetic knee extension on BIODEX.

Discussion and conclusion

Angular velocity of knee extension during roundhouse kick (over 2000 deg/s) exceeds the possibility of isokinetic machine adjustment, making impossible to imitate the speed of fast kicking techniques on BIODEX (fixed on 500 deg/s). Contrary to previous studies, no muscle fatigue was observed as peak muscle activity varies without decreasing tendency through this experiment [Quinzi *et al*. 2016]. Similar level of rectus femoris activity during the execution of both moves in 5 trials suggest that trained martial artist can maintain muscle control of knee extension in different circumstances, even if physical target of a kick is not present [Kim *et al*. 2011]. Shorter time between maximum muscle activity and maximum movement speed justifies use of isolated isokinetic training for shaping power of roundhouse kick, which is concurrent with other study, where frontal kick was tested [Quinzi *et al*. 2013]. As karate type of roundhouse kick have faster onset of peak angular velocities than Taekwondo athletes [Barnamehei *et al*. 2020], but lower maximal velocity of a kicks [Gavagan, Sayers 2017], isokinetic training could be beneficial as training transfer tool in changing motor pattern of technique execution, depending on training goals. High speed isokinetic training could be beneficial for rehabilitation after lower limb injuries to regain similar muscle control before going back to martial arts practice.

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