Participation of the agonist and antagonist knee extensor muscles in drop kick, placing kick and up and under kick, in rugby athletes

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Background

Rugby is a sport that implies constant physical contact, hence the high injury risk. Hip injuries lead to an average of 109 days absence from training during a full season (1). While shooting the ball, the *quadriceps femoris* is the muscle sustaining the highest numbers of injury. The main cause has been identified as the exact moment of impact with the ball (2). Understanding what happens during impact may enable a proper development of muscular injury prevention programs (3).

Objectives

The purpose of this study was to verify the muscular recruitment patterns and overall participation immediately before and during the moment of impact, while performing three different types of kicks (Figure 1).

Figure 1 – Placed Kick, Drop Kick, Up and Under

Methods

A sample of players was obtained from Sport Lisboa e Benfica senior male rugby team. All players, despite playing position, were included as long as they were able to shoot without any type of physical complaint at the lower limb. Data collection took place at their training ground in Lisbon. After skin cleaning (fig. 2), electromyographic (sEMG) sensors were applied to the *rectus femoris* (RF) and *biceps femoris* (BF) muscle bellies (figure 3). A triaxial accelerometer (ACC) was placed at the malleolus fibularis. Synchronization between the sEMG and ACC signals guaranteed the capture of muscle activity at the exact moment of impact (4). After a quick warm-up exercise, each player executed three repetitions of the different types of kicks. Using the information at three distinct moments, "430ms before ball impact", "at the moment of ball impact" and "430ms after ball impact", we were able to determine the maximum mean value of the BF and the RF activation (graph 1, 2 and 3). Collected sEMG and ACC data was analyzed using the mean ($\bar{x}$) and the standard deviation (SD) from all kicks of all players with Microsoft Excel and software's Matlab® and AcqKnowledge®. The study was approved by Sport Lisboa e Benfica and all participants gave their informed consent.

Figure 2 – Skin cleaning after electrodes application

Figure 3 – Electrodes application

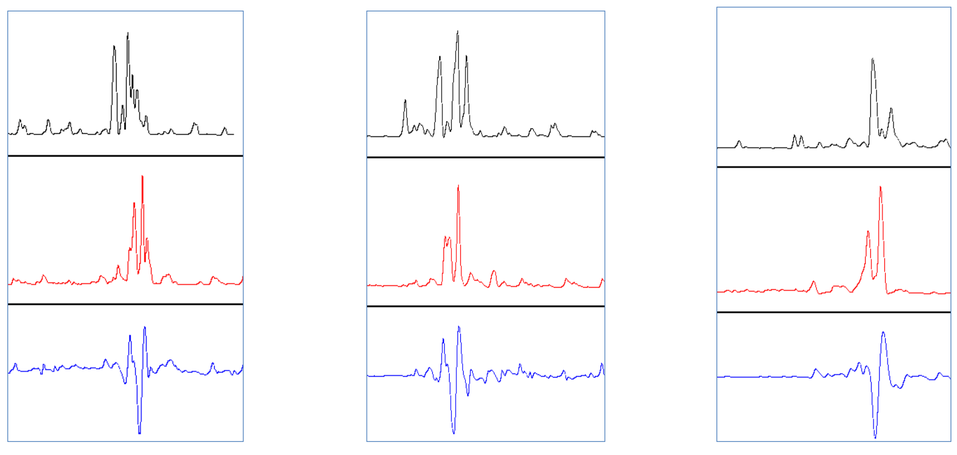
Results

A total of 12 athletes were evaluated. The participants mean age was 22.75±2.73, the mean of experience on Rugby was 10.33±5.00 and 83% of the participants are right-handed. On the next two tables, there are the mean and the standard deviation from the three kicks of all players (table 1).

Table 1 – Mean and standard deviation values of muscles activation

	RF_ Beginning (before_ ms)	BF_ Beginning (before_ ms)	430ms Before impact RF (% $\bar{x}$)	430ms before impact BF (% $\bar{x}$)	RF_ impact (%max)	BF_ impact (%max)	RF_ 100ms after impact (%max)	BF_ 100ms after impact (%max)	RF_ 430ms after impact (% $\bar{x}$)	BF_ 430ms after impact (% $\bar{x}$)
Placed kick	-134.5±24.5	-277.8±43.8	29.2±14.5	35.9±12.6	78.7±10.9	25.4±15.1	79.1±11.4	40.5±20.8	26.2±10.9	23.6±11.8
Drop Kick	-166.9±61.5	-309.6±92.1	24.2±7.7	34.2±8.5	77.0±12.6	25.9±23.1	80.4±9.0	54.8±28.2	35.7±14.6	21.5±6.0
Up and Under	-162.8±27.3	-343.8±33.0	26.0±7.3	31.1±8.6	80.9±8.4	25.8±20.0	81.0±8.7	42.4±24.1	27.6±8.6	15.4±6.3

RF – *Rectus Femoris*; BF – *Biceps Femoris*; ms – milliseconds; % – percentage; max – maximum; $\bar{x}$ – mean



Graph 1 – Placed Kick **Graph 2 –** Drop Kick **Graph 3 –** Up and Under

Discussion and Conclusions

Based on the results, before the ball impact a bigger BF activation has been recorded in the three kicks compared to RF. On the moment of impact and 100ms after, there was a bigger RF activation in all kicks, although the BF showed a bigger increase in activation, between the two moments. 430ms after the ball impact, both muscles showed an activation decrease, never-the-less RF's decrease was bigger. The previous statements support the triphasic activation pattern, as described on literature (5-7).The activation peak in all kicks occurs 100ms after the ball impact. In what concerns injury risks, the RF has a bigger injury risk during the ball impact moment and 100ms after that. The BF has a bigger injury risk 430ms before the ball impact and 100ms after the ball impact. As it was possible to observe on the videos, kicks with larger angles have bigger antagonist's activation, as described on the literature (7). It was possible to identify a triphasic pattern on the ballistic gesture (kick), as described in the literature (5). An activation of the muscles that decelerate the movement (antagonists), immediately before impact, precedes the activation of the agonist's muscles. Prevention programs should consider focusing on this triphasic pattern during their development and application. Follow-up studies with larger samples should further research this issue with relation to the injury risk of the *quadriceps femoris* in rugby players.

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