TITLE	**Return-to-play according to GAP in muscle injuries by L-BIA measurements: clinical prognosis**
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Introduction and Purpose
The muscle injury grading systems are based in part on ultrasound (US) and magnetic resonance imaging (MRI). However, the prognosis by MRI is not clear. There is evidence that part of the return-to-play is conditioned by the severity of the injury [1], and in our experience, this severity is associated with muscle gap (quantifiable retraction between fibers). Recently, a new classification of muscle injury has been proposed [2] in which the gap plays an important role, with the drawback that it is difficult to identify by MRI. The localized bioimpedance measurement (L-BIA) emerges as alternative, low-cost or accessible technique for supporting the US and MRI to quantify the disrupted soft tissue structure in muscle injuries [3]. The aim of this work is to relate the return-to-play with the severity of the injury according to the gap, through L-BIA measurements.

Methods
Twenty two muscle injuries (12 hamstrings, 6 rectus femurs, 3 adductor longus and 1 gastrocnemius –medial head-) in 18 male professional football players (20-28 yr) were considered taking into account the presence of a gap, supported by 3.0T MRI system as grade 1, 2f and 2g [Grade 1= small area of edema, either myotendinous or myofascial (<10% of cross sectional area (CSA) of the muscle affected and <5 cm of craneocaudal length) with no gap; Grade 2f= moderate amount of edema (10-50% of CSA and 5-15 cm of length) with feather-like image and no gap and Grade 2g= moderate amount of edema (10-50% of CSA and 5-15 cm of length) with feather-like and gap image.
 The L-BIA measurements were done 24-h after injury and the day of return-to-play to quantify the percent of change, respect to contralateral non-injured side, in resistance (R-edema), reactance (Xc-disrupted soft tissue structure) and phase-angle (PA) using BIA-101 Anniversary (AKERN-Srl, Florence, Italy). The electrodes Ag/AgCl were placed in the area of the injured muscle according to previous works [3]. One-way ANOVA statistical analysis with Scheffé post-hoc test or T2-Tamahne was used to determine statistical differences between percent of change in R, Xc and PA among grade 1, 2f and 2g; in addition to determine statistical differences respect to days to return-to-play for muscle injury grade 1, 2f and 2g. The statistical significance was set at $P < 0.05$.

Results
Seven muscle injuries classified as grade 1, eight as grade 2f and seven injuries as grade 2g showed high statistical significance among grade 1, 2f and 2g for R (F=9.126, p<0.002), Xc (F=46.269, p<0.000) and PA (F=24.164, p<0.000). The post-hoc analysis reveals high statistical difference in Xc and PA contrasting grade-1 with grade-2f, grade-1 with grade-2g and grade-2f with grade-2g.
Regarding to return-to-play grade 1 (7±2 days), 2f (14±6 days), and 2g (48±15 days), we found also high statistically difference (F=41.286, p<0.000). The results of the T2-Tamahne post hoc test, shows high statistical difference contrasting grade 1 with 2g, 2f with 2g and mild statistical difference between grade 1 with 2f.

Conclusion
The severity of injury degree is proportional to the size of the gap. These results reveal that gap and severity of muscle disruption adversely affected time to return-to-play. The L-BIA could to help to manage the diagnosis and prognosis of muscle injury.

References
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