Strength training for performance optimization and injury prevention in professional football

El entrenamiento de fuerza para la optimización del rendimiento y la prevención de lesiones en el fútbol profesional

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Football is an intermittent sport characterised by high-intensity actions such as sprinting, changes of direction (COD), jumps, kicks[1], etc. According to literature, one of the factors that most contributes to the performance of these actions is strength[1]. As such, it is suggested that football players require high levels of explosive strength[1-3]. In fact, 83% of goals are preceded by high-intensity action, whether the kick itself or the action before this[4]. On the other hand, we should be aware that these explosive actions are also the source of different football injuries[5]. By means of an example, in a recent study by Walden *et al*[6], it was revealed that in football the majority of anterior crossed ligament injuries (ACL) were associated to three typical actions such as: 1) pressure; 2) recovering balance after a kick; and 3) landing after a change of direction. Many factors may be linked to an injury[5], though strength deficits have been put forward as one of the main risk factors to take into account[7].

In terms of training strategies aimed at improving explosive strength, many suggestions have been put forward in literature for football players, such as training against resistance[1,8,9], plyometric[10,11], with dragging sled[12,13] or with eccentric overload[14,15]. Recently our work group analysed the effect of three different strength training programmes (complete squat [SQ], resisted sprint with dragging sled [RS] and plyometry combined with technical skills [PLYO]) with low-moderate load on the sprint, the jump and the COD in football players[16]. After 8 weeks of training, the results revealed a substantial improvement in jumping and speed between 30-50 m in the three training groups. Additionally, the subjects included in the SQ and PLYO groups revealed an improvement in the 0-50 m test. Furthermore, the SQ group also improved the acceleration speed in 10-20 m. The analysis between the groups revealed how the SQ group showed the more improvements in 10-20 m than RS and PLYO, and than RS in 30-50m[16].

We should also be aware that combining different work methods for the strength training may have beneficial effects on football players' performance[9,17]. Franco-Márquez *et al*[17] revealed how a strength training programme consisting in squats with a jump, jumps, sprints, triple jumps and exercises with COD performed twice a week on alternate days over a 6-week period led to a significant improvement in the jumping and sprinting capacity of young football players. These results, despite being relevant, were lower than those revealed by our work group in their jumping and sprinting capacity in a study that included the squats with loads that oscillated between 40-55% 1MR (~1.28 to 1.07 m/s), plyometric jumps, resisted sprint with sled and hamstring Yo-Yo (own data pending publication). These difference between studies may be due to the additional effect generated by two exercises used in our study (resisted sprint and Yo-Yo leg curl). In this regard, Bachero-Mena and González-Badillo[18] revealed a substantial improvement in the initial phase of the sprint (0-30 m) using a resisted sprint training method with loads of 20% of the body mass (BM) similar to those used in our study. Many studies have shown how the use of an additional load (20-30% BM) applied to a dragging sled requires an increase in the application of horizontal strength and of the demands to produce a horizontal drive[19]. This induces specific adaptations of the neuromuscular system, enabling a greater capacity to produce ground reaction force (GRF), which could theoretically increase acceleration capacity[13].

With regards to the potential effect of eccentric training focusing on the hamstring muscles in improving speed, in a recent review, Morin *et al.*[20] indicated that the horizontal component of GRF is the key - from a mechanical perspective - to improving acceleration capacity, and at the same time the improvement could be related to the capacity to generate eccentric strength by the hamstring muscles[21]. Various authors have suggested that during the final part of the "swing" phase, where the hamstrings are activated from an eccentric perspective, they contribute to the mechanical effectiveness during the start of the support phase by reducing the deceleration speed at the point of impact with the ground[20]. In agreement with this, Askling *et al.*[22], after 10 weeks of training the hamstring muscles using eccentric overload with a Yo-Yo

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device, observed an increase in the 30 m test. These results align with those revealed in our study. As such, it is crucial to include exercises that target the hamstrings where the eccentric phase is overloaded to improve sprinting capacity.

Focusing on the prevention of injuries, traditionally, strength programmes that targeted the reduction of injuries have been based on exercises where the stimulus is produced by a gravitational load[23]. However, the efficiency of these methods is fundamentally limited to the concentric phase, with little activation in the eccentric phase[24]. In accordance with the injury mechanism of the majority of the events that occur in sport in general, and in particular in football, exercises where the muscles are activated during the eccentric phase of the movement are essential for the success of these programmes[22]. It is worth recalling that, for example, a quadriceps muscle injury during a race occurs when this muscle is at its maximum length during the early moment of the swinging phase[23]. In the case of the hamstrings, injuries occur during the final phase of the swing, when the hamstrings are stretched in preparation for the foot to make contact with the ground[26]. In both cases injuries occur during an eccentric-type action[14]. In this respect, different studies have revealed how different eccentric training programmes for the quadriceps and hamstrings have reduced the ratio of muscle tears in football[14, 22]. In this way, our work group recently published a study in which an eccentric overload programme based on two exercises with YoYo® devices for the quadriceps (YoYo squat) and for the hamstrings (YoYo leg curl), performed for 10 weeks by young football players, led to a reduction in the number of days of leave taken following injury and a decrease in the incidence rate per 1,000 hours of matches[14].

To conclude, and considering existing literature, the strategies we could use to improve strength in football players are diverse, and have a double objective: to optimise performance and to reduce the injury rate. However, we should be capable of integrating different training methods that enable both objectives to be covered at the same time. In this way, complex training sessions that include different methods appear to be the best way to face the difficulty of fitting this kind of work into a training week for a professional football team.

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