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Predict Anterior Cruciate Ligament Injury In Elite Male Soccer Players? Focus On The Five Factors Maximum Model

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ABSTRACT

Background: For years, the rupture of the anterior cruciate ligament (ACL) has been a feared injury in young soccer players since it causes physiological and psychological changes while incurring significant economic losses.

Methods: Through clinical research, understanding the mechanisms and identifying risk factors has enabled sports and performance professionals to establish robust models to predict and reduce the risk of ACL injury. Developments in medical devices also allow a more precise, more objective assessment and improve the traceability of the various quantitative and qualitative parameters necessary to detect the risk of ACL injury.

Results: While general preventive protocols have shown evidence for an overall reduction in injury, there are still limitations regarding ACL injury. Therefore, we can collect personalized data from these models and the variables involved, predict, prevent, and program performance throughout the season. Additionally, the multi-professional team supervising the athlete must establish a close relationship centered on feeling and listening to the player who remains in control of his performance.

Conclusion: Let the players decide on their career and not an injury.

Keywords: anterior cruciate ligament injury, prediction, prevention, risk reduction, model.

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BACKGROUND

Elite sport is the period of transition to the top level. This period is marked both by the attainment of biological maturity and the expertise in the specialization of the sport practiced. However, unfortunately, the young athlete can get injured during this period, slow down his progress, and see the dream of high level fly away. Indeed, the risk of overtraining or training not adapted to biological maturity can lead to severe injuries with extended downtime, particularly with the rupture of the anterior cruciate ligament (ACL). The study by Larruskain et al. (2021) shows that the rupture of the ACL is an injury that negatively impacts the young soccer players' career and progress [1].

Although this injury remains rare in the world of elite football, it causes significant physiological and psychological changes, bringing recurrence to 18% [2]. Note that according to the study by Gilchrist et al. (2008), 31% of elite soccer players have a history of knee injuries, including 14% with an ACL injury [3].

This is why it is necessary to have relevant assessments based on a valid scientific basis to predict ACL rupture and personalize injury prevention protocols to optimize performance. Among these assessments, the five factors maximum model [4] appears to be the most suitable in predicting ACL injuries in young soccer players.

The model

This model created by Timothy E Hewett, Kate Webster, and Wendy J Hurd [4] was developed through a logistic regression identifying five modifiable variables. These variables are represented by anthropometry, strength and coordination, biomechanics, proprioception, and psychology. Each variable corresponds to 20% risk. The risk is cumulative; we can identify both the variables involved and the percentage risk of ACL injury. As this assessment is personalized, it allows the young soccer players to be directed towards the health and / or adapted sports professional to correct the deficiencies and thus reduce the risk of ACL injury. In this dynamic, this modelis attractive since it takes on a multi-professional aspect inthe athlete's service and performance.

Anthropometry

Although very little is documented in the literature, the length of the lower limbs appears to impact ACL injuries. The study by Lazzaro et al. (2017) shows that a difference of 5mm between the two legs is a risk factor in young athletes [5]. It is found in 46% of patients with ACL rupture with a predominance of the lesion on the short leg.

Body mass index (BMI) appears to significantly impact non-contact ACL lesions since Uhorchak et al. (2003) identifies BMI greater than 25 as a risk factor with a relative risk of 3.5 [6].

In addition, various studies are also interested in the playing surface and the shoe. Although this is a parameter indirectly linked to the footballer, the fact remains that the shoe is the first interaction between the ground and the athlete. Therefore, it constitutes a risk factor in ACL lesions in elite soccer players [7-9]. This is why it seems necessary to have a podiatry assessment in the risk prediction of a soccer player's ACL to fully reflect the lower limbs and the proper and optimal shoe-playing surface interaction.

Perhaps the last aspect of anthropometry relates to genetics. Although indirectly modifiable, genetics plays an essential role in performance [10] and the risk of injury, particularly ACL. To date, there are genetic passports that can demonstrate the existence of genes identified as risk factors for ACL, as revealed by the articles by Béchaud et al. (2021) and Daong et al. (2020), who report a number of genetic variations in patients with an ACL tear [11, 12]. This genetic passport would be a significant step forward in the identification of at-risk players and in reducing the risk of ACL injury like the mapping of the menstrual cycle in the female sports world. It would identify players who are not "mechanically" at risk but whose preventive protocol to reduce the risk of injury would be more than relevant.

Strength and Coordination

The literature abounds in publications that abound in the direction of the development of force, particularly by plyometric reinforcement and the development of coordination by neuromuscular work to prevent ACL rupture [13,14]. However, while protocols such as FIFA 11+ show a reduced risk of knee injuries [15], Silvers-Granelli et al. (2017) qualify its effectiveness in preventing the risk of ACL rupture in elite soccer players [16]. Indeed, the FIFA 11+ program does not reduce the incidence and prevalence of ACL ruptures regardless of the position of elite soccer players; perhaps in particular, for the lack of singularity in the approach of this preventive protocol.

Therefore, it seems necessary to determine the plyometric and coordination qualities of elite soccer players to propose an optimal approach in the prevention of ACL injuries. To do this, we will use jump tests like the countermovement jump (CMJ), the countermovement jump with the arms (CMJ arms), the Drop Vertical Jump (DVJ), and the Squat jump (SJ).

Thus the coordination index will be subtracting the CMJ arms and CMJ. A score equivalent to 10 cm is expected, with a score below 6 cm being deemed insufficient. The plyometric index is determined by the subtraction between the DVJ and the SJ. The score must be greater than 6 cm, a negative score reflecting poor plyometric quality.

The strength parameter is just as interesting in determining the ratio between the hamstrings and the quadriceps (H / Q). Indeed, the study by Kyritsis et al. (2016) found that a 10% decrease in the H / Q ratio at 60 °·s-1 increases the iterative rupture of the ACL by 10.6 times [17]. Suppose the quantitative approach seems to be inevitable. In that case, the qualitative approach seems just as important as revealed by Pietrosimone et al. (2016), with a relative force of the quadriceps having to reach 3.1 Nm.kg-1 in soccer players [18].

Biomechanics

The involvement of dynamic knee valgus in an ACL rupture in soccer players is well established. Nevertheless, it is necessary to evaluate it during, in particular, the DVJ on the landing phase. Indeed, Hewett et al. (4) show that an increase in the abductor moment of the knee during a landing has a sensitivity of 84% and a specificity of 94% with regard to ACL lesions. Suppose the abductor momentof the knee depends on 3 variables (maximum angle of abduction of the knee, maximum moment of the extensor of the knee, range of motion in flexion of the knee). In thatcase, the fact remains that it can be influenced through environmental and competitive interactions. Thus Della Villa et al. (2020) observed that the placement of the trunk, hip, and foot in situations leading to ACL injuries in soccerplayers directly impacts the placement of the knee indynamic valgus [19]. Environmental and neurocognitive interactions can then drive this poor segmental placement.

Therefore, it appears essential to assess both the dynamic valgus of the knee while combining it with an objective assessment of the trunk and foot during landing to determine the systemic risk potentially involved.

This assessment can be done with single leg squat and a modified single hop test (forwardl jump from a distance equal to half the height of the player) using the QASLS scale. The score must be less than 1 for a good quality of movement [20].Besides, it is interesting to assess the cutting movement during running. So, we can assess the quality of movement (trunk hip, knee, ankle and foot) with CMAS tool in frontal and sagittal plane. For a good quality of movement the CMAS score must be less than 3. [21]

Proprioception

In a more quantified practice, the potential proprioceptive defect is evaluated via the stabilometric analysis, which can be carried out according to several methods: bipodal, unipodal, with vision, or without ... Indeed, stabilometry platforms are made up of pressure sensors allowing, not only, to obtain a map of plantar pressures but also a projection of the center of gravity, the center of mass, similar to the center of pressure. The study of mobility and its variations of the center of pressure allows us to project the quality of overall proprioception and the quality of postural adaptation. Postural control is a motor skill derived from the interaction between complex sensory and motor processes necessary for the perception and maintenance of balance or precision movement.

The use of a stabilometry platform offers the possibility of calculating the Romberg quotient in bipodal mode, according to Ruhe et al. (2010), which quantifies visual dependence [22]. However, visual dependence occurs during a perceptual conflict between different sensory inputs, creating difficulties in changing reference frames using vestibular and proprioceptive afferents, according to Lubetzky-Vilnai et al. (2015) in young adults [23].

The Romberg quotient is calculated by the ratio of the ellipse area containing 90% of the points of the center of pressure with eyes closed over that with eyes open. According to Gagey et al. (1985) [24], visual input and vision are essential in postural control. According to the same authors, its result is physiologically close to 100 with a difference granted to plus or minus 20%. Beyond these values, an area of oscillation of the center of pressure with eyes closed greater than that obtained with eyes open indicates a visual dependence.

To overcome this visual dependence, the use of stroboscopic glasses associated with visuomotor training has demonstrated its effectiveness in particular in reducing reaction time, in improving muscle coactivation, and through the phenomenon of anticipation, which then makes it possible to reduce the risk of injury, particularly the ACL [25-31].

The Star Excursion Balance Test or Y Balance Test constitutes a reliable means [31] of also being able to predict the risk of injury to the lower limb and a fortiori that of the ACL in footballers, in particular in the study by Lee et al. (2015) who found a strong correlation with knee flexors and hip abductors [32]. Furthermore, Pilsky et al. (2009) explain that an asymmetry of 4cm in the anterior reach indicates a high risk of injury to the lower limb [33], as does Butler et al. (2013), who show 3.5 times higher riskin the event of asymmetry of less than 90% [34].

This asymmetry can be calculated in different ways [33]:

- Absolute range distance (cm) = (Range 1 + Range 2 + Range 3) / 3
- Relative (normalized) span (%) = Absolute span / limb length * 100
- Composite reach distance (%) = Sum of 3 reach directions /3 times limb length *100

For our practice we prefer to use the modified SEBT which excludes the movement of the upper limbs and the vision. [35]

Psychology

The psychological aspect plays a fundamental role in preventing the risk of injury, especially in young athletes. Indeed, Galambos et al. (2005) study show that half are associated with mood and stress out of 67% of athletes injured each year [36]. Therefore, it would be interesting to assess the psychological state of our players, whether during the season and/or after an injury. Many questionnaires or scales allow you to locate the player's state at the time of the assessment. Among these questionnaires, we find the Tempa Kinesiophobia Scale, whose score must be less than 40/68, the Rosenberg Self-Esteem Scale, whose score must not be below 31, and the General Anxiety Questionnaire of Spielberger, which must not exceed a score of 51.

If any discomfort is detected, it would be advisable to refer our player to a suitable professional and reassess his psychological state after the intervention. Gledhill et al. (2018) show that intervention in psychology can help reduce the risk of injury in the elite athlete [37].

The psychological risk that can be associated with aninjury,

particularly that of the ACL, which, if it does occur,will have a significant impact on the fear of returning to the sport, should therefore not be neglected [38,39].

What period?

It seems opportune to us to evaluate our football players over three periods to build solid models:

- In the pre-season, intervene before the start of the championship and introduce the appropriate preventive measures approximately six weeks before the start of the season [40] and evaluate them [41, 42].
- In mid-season, note the variations and adjust to compare with the previous assessment.
- In the post-season, assess the season's impact on the player.

CONCLUSION

The study of the five adjustable variables seems essential in predicting ACL injuries in top footballers. As shownabove, this type of injury can compromise access to the top level, and a fortiori destroys a player's career as the psychological and physiological changes are significant. Risk profiling by the health and performance professional team remains a challenge. Still, it is necessary to build strong models to reduce the risk of ACL injury and provide players and the team with a better understanding of the optimal level of performance throughout the season. Todo this, communication with the player remains one of theessential parameters both on his physical and psychologicalfeelings. We'll end by quoting Timothy Hewett in a meaningful quote from Abraham Lincoln: "The best way to predict your future is to create it. "

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