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Research Article

The pathological technical and tactical movements of a soccer player during return to sport predicts a second anterior cruciate ligament injury

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Abstract

Background: Return to sport after Anterior Cruciate Ligament (ACL) reconstruction remains a difficult decision-making process that is not structured on shared and homogeneous assessments. This greatly elevates the risk factors for second injuries.

Objective: Highlight football-specific gestural, pathological, technical-tactical patterns that contribute to new ACL injuries (ipsilateral graft rupture or contralateral rupture of the native ACL).

Material and method: For the purpose of this literature review, peer-reviewed and nonpeer-reviewed indexed journals were consulted from 1979 to the present. Studies were identified by searching them on PubMed/MEDLINE databases. The following search terms were used: "second ACL injury," "cutting maneuver and ACL", "sidestep cutting technique and ACL" "Valgus knee in sport" "change of direction and ACL injury" "pressing soccer" tackle in soccer". The literature search was directed, also, to the Gray Literature.

Result: An immediate pressing or re-aggression on the adversary, tackle, or cutting maneuver is clinically read as moments of risk factors, injury, or re-injury, for both the ball bearer and the defender. We found how a good deal of literature emphasizes how side-to-side gestural asymmetries, during technical and tactical movements, present during return to sport can elevate risk factors for second ACL injuries. During ball recovery, 4 main game situations have been found to elevate the risk factors of knee capsular ligament injuries: (1) during tactical moments of collective pressing or individual pressure; (2) in the postural rebalancing phase after moments of instability following the kicking of the ball; (3) dysfunctional moments from gestural instability, in landing, after a header in single-pedal support; (4) during a tackle by direct contact or indirect contact on the joint.

Conclusion: Residual pathological movement's side-to-side asymmetries and postural-dysfunctional pictures related to specific gestures after ACL reconstructive surgery are predictive factors of second ipsilateral ACL injury or injury to the contralateral limb. Given, however, the subjective interpretation of movement quality assessments, their relative reliability and validity in the diagnostic and therapeutic use of complex sports gestures, pressing, and cutting maneuvers, during the process of return to sport should be analyzed together and clinical assessments to identify other and consistent predictors of second ACL injuries.

Abbreviation

ACL: Anterior Cruciate Ligament; RtSc: Return to Sports Continuum; H/Q: Hamstring /Quadriceps; (H.ecc/Q.con): Hamstring. Eccentric/Quadriceps concentric; (H.con/Q.ecc): Hamstring concentric/Quadriceps eccentric; RtS: Return to sport; OR: Odds Ratio; RTT: Return to training; UEFA: Union of European Football Associations; GRF: Ground Reaction Force; KJL: Knee Joint Load; RE: External Rotation

Introduction

Numerous studies have attempted to determine risk factors regarding ACL injuries including hormonal, biomechanical, functional, and specific sports related. However, the incidence of Anterior Cruciate Ligament (ACL) injuries are increasing especially in soccer teams changing coaches and players moving to a higher division [1].

In soccer, the athlete, performs, during competition/training dynamic force actions whose activation and interval times are not stereotyped [2]. These partners require a neurophysiological ability to modulate and control, the various and diverse expressions of force and disequilibrium, in a substantially coherent interplay between joint biomechanics, muscle activity, and neuromuscular control [3].

The soccer player expresses during technical and tactical gestures a high level of repetitiveness of rotational and lateral movements [3]. These, over time, result in side-to-side asymmetries with posture-dysfunctional frameworks that are predictors of pathological movement patterns [3,4].

From a biomechanical aspect, a decrease in expressiveness and postural/functional control of the lower limb will result in "pathological movements" of the varus-valgus of the knee, combined with internal/external rotation with increased risk factors of second ACL injuries [3].

To decrement this risk, the literature suggests delaying Return to Sport (RtS), to at least 9 months after surgery. Return to the sport should be validated after functional screening but especially the analysis of the quality of simple and complex movements that can be linked back to technical/athletic expressiveness [5].

The injuries in the Serie A soccer league are not well cataloged. Just as there are very few linear and uniform epidemiological studies in the Literature.

Grassi [6] has investigated, through the online soccer archive " (Transfermarkt GmbH & Co. KG Wandsbeker Zollstraße 5° 22041 Hamburg) 7 consecutive seasons of the Serie A Championship (2011-2012 to 2017- 2018). This was to identify players with an Anterior Cruciate Ligament (ACL) injury in matches or training.

There have been 84 ACL injuries (mean age of players, 25.3 ± 4.2 years). Overall, 25% of ACL injuries were rupture (15%) or contralateral injuries (10%).

The incidence rate of injuries, during Italian Serie A Championship matches, of the ACL was 0.4215 per 1000 playing hours, 0.0305 per 1000 training hours (rate ratio [RR], 13.8; 95% CI, 8.4-22.7; $p < 0.0001$) and 0.0618 per 1000 total playing hours [6].

The author [6] says that in the Italian Serie A Championship, there is a 14 times greater risk, of incurring an ACL injury in matches compared to training. Most injuries occurred in the months of October and March with the values almost doubling in teams ranked in the top 4 positions in the league [6].

We, too, carried out through Transfermarkt [4] (Transfermarkt GmbH & Co. KG Wandsbeker Zollstraße 5° 22041 Hamburg) an analysis of injuries in the Italian Serie A Championship 2022 -2023 before the World Cup pause. Recorded injuries were researched, from August 13 to November 13 (day 15). From our analysis, 250 total injuries were found, of which 110 were muscle injuries and 10 were reinjuries [Graph 1] [7].

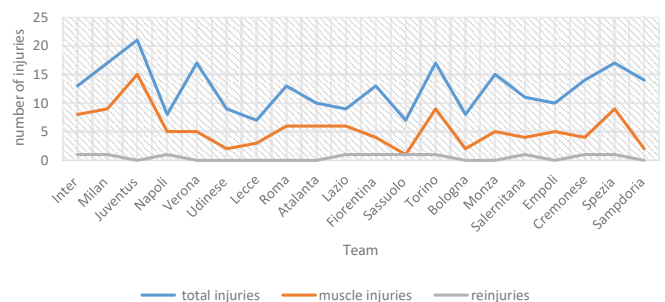
Recently (September 2022) the Calcio&finanza website [2] reported that in the five major European leagues, the number of injuries in the 2021 -2022 season was 4,810 with an increase of 20% compared to the 2020/21 season (the 2020/21 total number of injuries was 3,988). This is according to a study conducted by the Howden Insurance Group [8], which found that this has cost clubs more than 600 million euros.

An analysis conducted on the Italian Serie A Championship a total of € 97.82 million shows that Juventus leads this particular ranking, having suffered 88 injuries costing €22.6 million. Also on the podium is Napoli, with 71 injuries that cost 11.78 million euros. Closing in third place is Milan, with 9.76 million for 55 injuries. Thus, more than 20 years of research and studies have failed to reduce the disparity of ACL injury rates in sports [9].

Return to Sport (RtS) criteria after ACL reconstruction present, today, nonhomogeneous metrics that are often structured on subjective assessments [10]. The lack of a clear shared terminology accentuates clinical programmatic/rehabilitation discomfort during the return to sport after ACL reconstruction [10].

Injuries after 15 matches of Italian Serie A

Championship 2022-2023



Graph 1: Injuries after 15 days of the Serie A Championship - 2022 -2023 – Before the pause for the World Cup in Qatar.

Underlying the ultimate success is homogeneity in scientific language as well as a rehabilitation architecture that combines the biological healing process associated with the “Return to Sports Continuum”(RtSc) [10].

Recently, a study [11] demonstrated a relationship between a longer duration of postoperative rehabilitation (≥ 6 months) and greater quadriceps and limb symmetry with single-leg hopping [11].

Side-to-side asymmetries present in athletes, who have returned to the sport are at high risk of injury especially ipsilateral muscle or contralateral limb injury [12]. Thus technical gesture/postural asymmetries significantly elevate the risk factors for second ACL injury [3] Graph 2.

Normal force values between agonists and antagonists are essential to modulate knee joint function and biomechanics during movement. This perfect mechanism is described, in the literature as “muscle balance” [12].

A “muscle imbalance” occurs when muscles offer tension abnormalities directions due to weakness and/or shortening of the same muscle.

When a muscle is too “shortened,” the joint loses its harmonicity, and the expressiveness of its movement such that the functionality and breadth of its joint range are limited. This dysfunctional picture if it persists greatly elevates the risk factors for second injuries.

For D’Onofrio [12] it is evidenced that asymmetries in the functional H/Q ratio have a significant impact, the athlete, on the incidence of risk factors of second ACL injuries.

The conventional ratio of percent H/Q is defined in the literature as the ratio of peak knee flexor to quadriceps force and is generally measured during a concentric contraction.

While H /Q, functional is defined as the % ratio of peak flexor force during an eccentric contraction to peak quadriceps force during a concentric contraction (Hecc / Qcon).

The force relationship between agonist/antagonist for knee extension and flexion can, however, be better described by the more functional relationships during [12]:

- Knee extension phase: the eccentric force of the Hamstrings and concentric force of the quadriceps (Hecc/Qcon).
- Knee flexion phase: Hamstring concentric force and quadriceps eccentric force (H.con /Qecc).

Athletes with persistent, force asymmetries showed a significant 4.66-fold increase in pelvic girdle and lower extremity injuries. Altered values of H/Q force ratio (< 0.6 per 60° s⁻¹) may also increase risk factors for anterior cruciate ligament (ACL) injuries [12].

The quadriceps and hamstrings control the analytical function of the knee joint in the soccer player; an imbalance between the extensor/flexor apparatus could create joint overstress with compensatory movement patterns, which can result in postural syndromes (Janda’s Crossed Syndromes). A complete, pre-season evaluation of the muscular and postural system is recommended.

The second ACL injuries

Athletes who return to sport after ACL reconstructive surgery have a higher risk of incurring a second injury to the same ligament (ipsilateral or contralateral limb injury) than athletes who have never sustained any injury to the ACL

Traditionally, RtS is set at an average of 6 months despite scientific evidence pointing to an increase in re-injury between months 6 and 12.

This concept is also emphasized by Paterno, who points out that young athletes have a high risk of suffering a second ACL injury within 24 months of returning to sports [13].

Wiggins [14] in a systematic review and meta-analysis (19 articles were included for review and aggregation) shows that the percentage rate, overall, of re-injury related to second ACL injuries is 15%, (with an ipsilateral re-injury rate of 7% and contralateral rate of 8%) (Figure 1).

Second injuries in young people (ipsilateral + contralateral age under 25 years) are 21%. Athletes younger than 25 years, who return to sports, have a second injury rate of ACL of 23%.

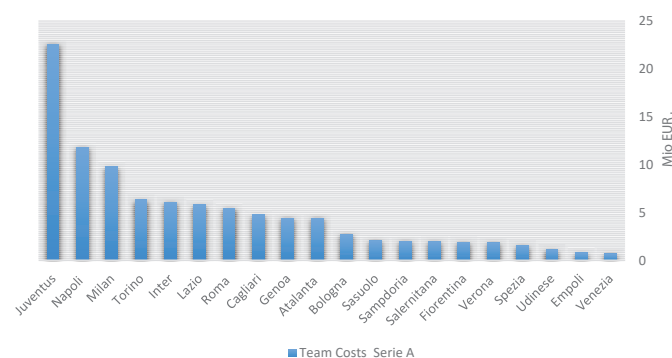
This work indicates how nearly 1 in 4 young athletes suffer an ACL injury The high rate of second ACL injuries in young athletes equates to a 30- to 40-fold increased risk of suffering an ACL injury compared with adolescents who have never suffered any ACL [14].

For Sandon [15] of the soccer players, who returned, [score of 51%], to play soccer:

- 28.7% (odds ratio [OR] 2.3, $p < .001$) had a further ACL injury
- 9.7% (OR 2.9, $p < .001$) had graft failure, and
- 20.6% (OR 2.1, $p < .001$) had contralateral ACL injury

Della Villa [16] in a 2021 paper highlights that out of 118

Total injury cost Serie A Championship 2021-2022



Graph 2: Total overall cost, for the team of injuries. Championship 2021-2022 [7].

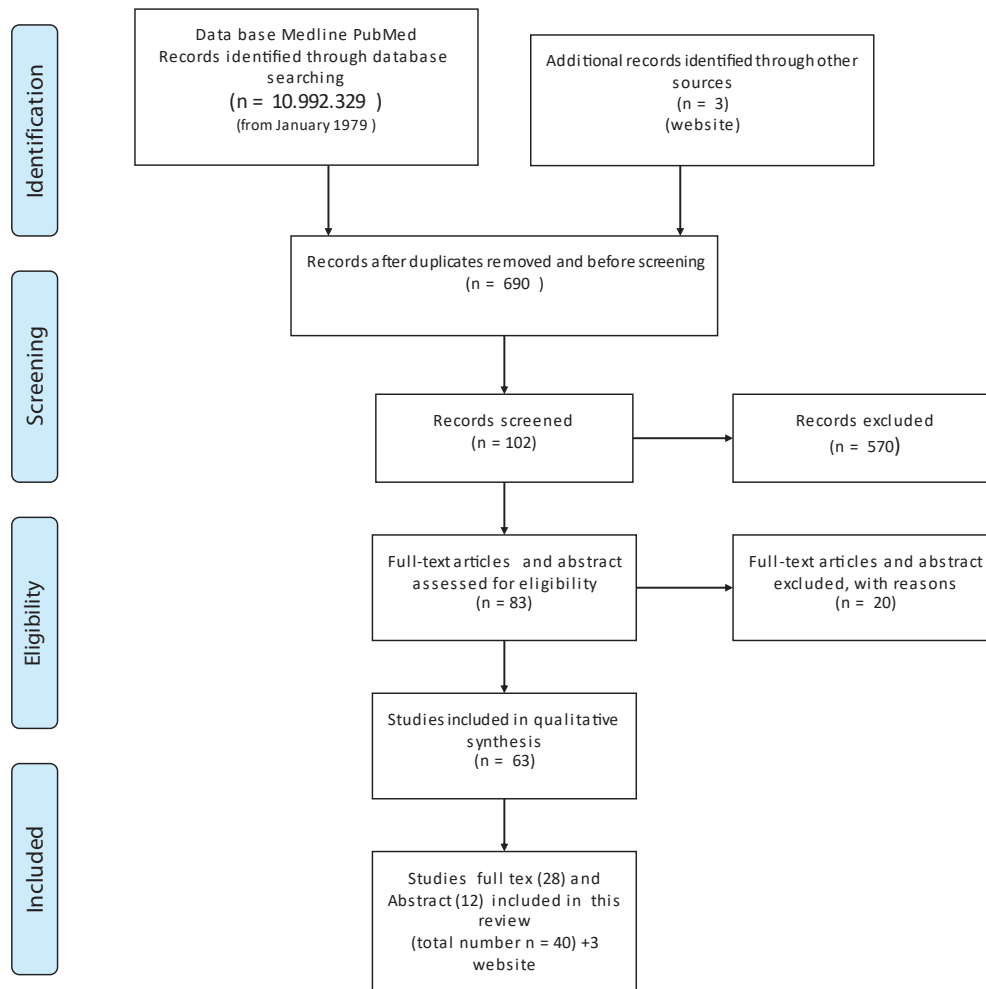


Figure 1: Studies were identified by searching them on PubMed/MEDLINE databases [44].

soccer players in the UEFA Elite Club, the rate of a second ACL injury after return to training (Return to training; RTT) is 17.8% ($n = 21$), with 9.3% ($n = 11$) at the ipsilateral knee and 8.5% ($n = 10$) at the contralateral knee

Webster [17] reports, among young people rates of second ACL injury, 25% and 35%.

For Beischer [17] return to contact/contrast sports before 9 months after reconstruction is associated with a 7 times higher risk rate for incurring re-injury.

Achieving symmetric muscle function or quadriceps strength was not associated with re-injury of the anterior cruciate ligament in young athletes [18].

Structuring of the research and selection criteria

For this literature review, peer-reviewed and nonpeer-reviewed indexed journals were consulted. The choice of items was made in relation to the objectives.

The articles were chosen according to the objectives. Studies were identified by searching them on PubMed/MEDLINE databases. The following search terms were used: "Second ACL injury," "Cutting Manoeuvre and ACL", "Sidestep Cutting

technique and ACL", "Valgus knee in sport" and "change of direction and ACL injury".

The search algorithm was, at first intentionally generalized to maximize scanning and then selective in relation to the research objectives.

All the publications, containing the keywords with no date limit, range 1979 - 2022 were examined. Bibliographies of included studies were reviewed to identify additional publications that could further clarify and facilitate the writing of this article.

Consensus and definitions

Variations in definitions, language, and research methodologies have made it difficult to compare studies. Thus, the results obtained from studies on calcium injuries have resulted in a lack of consensus guidelines applicable in practical reality.

For this reason, an Injury Consensus Group has been established under the auspices of the Fédération Internationale de Football Association Medical Assessment and Research Centre-. Within the Injury.



Consensus Group, it is highlighted and determined that an injury that occurs between 2 and 12 months after the player has returned to full competitive activity is described as a “late re-injury “ [19].

A re-injury that occurs after 12 months and then after return to full competitive participation is classified as “retarded recurrence” [19].

Recently Paterno asserts that recurrent lesions have been defined as lesions of the same type and at the same lesion site. He defines injuries < 2 months as early recurrences and > 2 months as delayed recurrences. The same author points out that young athletes have a high risk of sustaining a second ACL injury within 24 months of RTS [13].

Results

Improper and inappropriate return to sport after ACL reconstructive surgery elevates, significantly the risk factors of contralateral or the same-side re-injury [1,3,5,6,10,20,21].

In particular, we found, also, how a good deal of literature [4-6,8,13,18], emphasizes how side-to-side gestural asymmetries, during technical and tactical movements, can elevate the risk factors of second ACL injuries.

It also emerges from our review that during competition/training an action of pressing or immediate re-aggression on the opponent is clinically read as moments of risk factors, both for the attacker and the defender, of injury or re-injury.

Within these tactical situations, we can include injurious mechanisms that can be linked to gestural movements such as:

- a. Rapid deceleration before a change of direction, feinting and running dribbling
- b. After a jump in the monopodial relapse phase

While contact/contrast play situations consist if we want to speak in technical terms in the classic situation called “tackle”:

- a) Lateral,
- b) Frontal
- c) Slipped

Our analysis shows, however, how there is conflicting and inconsistent evidence, subjectively based, to determine altered patterns and postural-dysfunctional frameworks related to specific gestures during dynamic expressiveness of techniques and tactics that can be traced back to competition patterns.

a) Game situations and gestures associated with ball recovery and ACL injuries

Technical and tactical gestural patterns that can be expressed when receiving and passing the ball, are part of those technical skills that the player acquires, during his soccer career.

For different reasons, these patterns are definable as pathological in that over time they can create posture/dysfunctional frameworks [4]. These greatly elevate injury risk factors during the development of various individual tactical-technical skills, both at offensive and defensive levels.

The literature evidences that 85% of ACL injuries occur during various situational phases of play attributable to non-contact or indirect contact mechanisms.

During ball recovery, 4 main game situations have been found to elevate risk factors for knee capsular ligament injuries [Table 1] [22]:

1. During tactical moments of collective pressing or individual pressure;
2. During the postural rebalancing phase after moments of instability following the kicking of the ball;
3. Dysfunctional moments from gestural instability, in landing, after a header in monopodial support;
4. During a tackle by direct contact or indirect contact on the joint.

Moments of dynamic adaptive valgus of the knee were frequently observed in non-contact, pressing-related game situations and in consequent changes of direction and/or cutting maneuvers.

Valgus collapses are often, present in direct contact injuries on the knee joint.

In this context, organized pressing or individual pressure, the 1Vs1 is intended to induce the ball bearer into a force play that is essentially predictable (induced dribbling, change of direction, forced passing) or casual, allowing the ball to be regained [22].

A pressing action or immediate re-aggression on the opponent is read clinically as moments of risk factors, injury, or re-injury, for both the attacker and the defender. In contrast, the tackle remains the contrast at high risk of injury, especially to the lower extremity [22].

Table 1: Noncontact and Contact ACL injury mechanisms attributable to tactical technical gestures.

Noncontact ACL injury mechanisms attributable to tactical technical gestures	
Pressing	During Cutting Manoeuvre, Sidestep Cutting technique, pressure in 1Vs1
After kicking the ball	Regaining posture-dynamic balance in an unstable situation)
After a jump	Landing, in a monopodal stance
After hitting the ball head-on	To the constant search for postural control after a flight and landing phase.
Contact ACL injury mechanisms attributable to tactical technical gestures	
Contact/contrast	From direct contact on the knee joint
Tackle	Indirect contrast injuries on the knee

We can state how during technical abilities, the knee, which is in slight flexion with the hip, is positioned in two moments of relative stability from which it subsequently expresses risky gestural moments such as valgus + tibial external rotation and varus + tibial internal rotation [23].

These movements, in sports traumatology, represent true etiopathogenetic mechanisms that greatly elevate the risk factors to the capsuloligamentous components of the knee joint.

Thus, for example, abnormal trunk tilt during a dribble, and changes of direction torsional and cutting movements result in increased laterally directed GRF (Ground Reaction Force) with a significant increase in Knee joint load - KJL) [24-26].

We have evidenced recently, how a reduction in hip internal rotation, results in increased tensional stress on the ACL and May, therefore, increase in sports that require specific cutting and pivoting movements [27].

However, independent of limb, athletes with > 9 months of rehabilitation had greater frontal plane knee motion than those with < 9 months.

In any case, the implications of this study are that time or duration of rehabilitation alone cannot be used to determine when an athlete is ready to be discharged from physical therapy or ready to return to play [3,11].

b) Pathological movement during technical-tactical gestures and second ACL injuries

Moments of dynamic adaptive valgus of the knee have frequently been observed in non-contact, game situations related to pressing and subsequent changes of direction and/or cutting maneuvers. In contrast, valgus collapses are, often, present in direct contact injuries on the knee joint [28].

i) Pressing: The organized pressing or individual pressure, the 1Vs1, aims to induce the ball bearer into a force play that is essentially predictable or unpredictable (induced dribbling, change of direction, forced passing) or random, allowing the ball to be regained.

Team pressing and individual pressing (marking, intercepting, optimistic and pessimistic oriented positioning...) incorporate gestural moments (patterns, open and closed receiving, and passing posture) definable as a moment of increasing injury risk factors (changes of direction, dribbling cutting maneuver, crossover, and side step cutting, run and cut, shuttle run) at the lower limb [21].

One of the most commonly used classifications to define the type of pressing implemented by a team concerns the zone of the field where this collective tactic is systematically applied.

We speak in football literature, of pressing (offensive, ultra-offensive, or defensive). However, other classifications may be useful, in football language, to indicate the ways in which a team (presses) defensively. It is possible to distinguish sectoral pressing from full-field pressing, and subject pressing

from general pressing¹⁶ during collective pressing movements, gestural moments at risk with pathological patterns such as a (dynamic adaptive valgus) occur at the expense of both the ball bearer and the defender. These situations have been identified as load parameters that have the potential to increase ACL strain and are, subsequently, used as compensations for the risk of non-contact knee capsular ligament injuries.

A pressing action or immediate re-aggression on the opponent to recover the ball [22] are clinically read as moments of risk factors, injury, or re-injury, for both the ball bearer and the defender [22].

The tackle, within individual pressing, remains the contrast at high risk of ACL injury for both athletes [21,29]. We can state how dynamic dysfunctional postures during technical-athletic expressions elevate risk factors for new injuries and re-injury [22]. These initially silent pathological pictures are related to decrements in movement quality arising from (a) previous injuries and (b) abnormal gestural patterns acquired in learning basic techniques at the young age [29].

Abnormalities of lateral trunk tilt [24], in the frontal plane, during changes of direction and/or dribbling, are associated with increased knee abduction moments and increased hip internal rotation with external rotation (RE) of the tibia. This biomechanical framework exposes the anterior cruciate ligament (valgus + RE), at high risk of injury [21].

Thus, an injury of the Anterior Cruciate Ligament, (ACL) in football players, occurs, in most cases, during training and competitions in gestural situations identifiable by noncontact with the knee going, basically, in valgus, flexion external rotation and with the foot that, often, does not accompany the gestural movement remaining blocked in the field of play [21,28,29].

Female athletes express the same trauma mechanism as their male colleagues, but manifest greater adaptive valgus angles, significantly higher in the landing phase after a jump.

Such dynamic adaptive valgus is associated with angles, of the knee, near its full extension (0° - 20-30°), elevating, thus, significantly the risk factors of anterior cruciate ligament injury [21,28].

Similarly, valgus movements associated with a quadriceps contraction develop a significantly greater "Anterior Shear Force" [24 with a 30% to 40% increase in stress on the ACL compared to a single valgus movement without quadriceps contraction.

We can evidence how the literature correlates dynamic adaptive knee valgus, cutting maneuver, Core stability, and gluteal muscle activity [21].

D'Onofrio [12,21,23,27] states how the amount of knee valgus, observed during a specific gestural movement suggests, often, an inability of the quadriceps/flexor group, or rather of the active anatomical defense lines (particularly of the sartorius, semitendinosus, gracilis,) muscles. These anatomical

defense lines oppose valgus movement in the landing phase after a jump or during a classic cutting maneuver [27].

ii) Tackle: During ball recovery, the bearer remains the kicker most at risk of injury (80%). Brophy pointed out that (73%) of injuries, to the knee, occur during side tackle (51%) followed by changes of direction (15%) [20].

Waldén [30] reports in a 2015 study a total of 39 injuries at the ACL of which 25 of these were non-contact, 8 were indirect contact, and 6 were direct contact injuries.

Thus, author [30] states how the most frequent tactical situation, of an injury, is ball recovery within the press followed by kicking the ball and landing after a headshot.

No injuries occurred during set play (inactive balls). Therefore, three main categories of injury mechanisms are identified, from non-contact and two from direct contact verifiable during play situations [29].

Fuller [31] defined a tackle as any incident during normal game situations in which there was an obvious contrast between at least two players with the player suffering the tackle in possession of the ball.

It has been reported that contrast and collision injuries are responsible for between (44%) and (87%) of all traumatic injuries in men's, women's, and adolescent soccer [32]. Andersen [33] pointed out that (70%) of in-game injuries are the result of tackle actions (lateral, frontal, from the back).

Tscholl [34] studied video recordings of 24 representative matches from six high-level women's tournaments with 3531 tackles evidenced. Side tackles were more than (50%) of the total. Of all tackles, (2.7%) were classified as situational at risk.

Krosshaug [35] points out that injuries after an occurred: a) from behind with a lateral impact on the knee joint leading to a strong valgus collapse; b) frontal tackle there is an anterolateral impact to the lower leg.

iii) Cutting maneuver: Studies [6,13,14,16,19] indicate that the majority of ACL injuries in soccer occur during pathological movement's attributable mainly to non-contact "game situations":

- Injuries occur during gestural movements such as cutting, jumping, and single-leg and landing maneuvers.

The "cutting maneuver" is a typical gestural movement specific to sports such as Football, Basketball, and Handball. On the field of play, it is represented, schematically, by dribbling, and changes of direction with and without the ball.

In changes of direction, the eccentric contraction, of the quadriceps, that precedes the concentric phase of the movement gives rise to an increase in the "anterior shear force" of the tibia from a progressive range from 45° up to 0° to full extension [36].

In football gestural expressiveness, during a cutting maneuver, there is a forward tilt of the trunk during the first 50% of the stance phase [9].

Subsequently, a tilt from the opposite side occurs during the first 40% of the stance phase with the knee and hip being in slight flexion, which is positioned in two moments of relative [37].

- valgus + tibial external rotation and b) varus + tibial internal rotation

These moments, in sports traumatology, represent true etiopathogenetic mechanisms, which elevate the risk factors to the capsuloligamentous components of the knee joint [21,23,27].

For Cross [36] during a "sidestep cutting" maneuver, the greatest values referring to internal tibial rotation occur during the swing phase, simultaneously with an increase in knee flexor joint range.

If ACL, is injured during a change of direction ("sidestep cutting maneuver") the etiopathogenesis among other possible is related to a decrease in neuromuscular activity, or rather to the loss by the athlete of neuromuscular control of the internal tibial rotation of the knee [36].

It has been noted [30] that decreased proprioceptive control of tibial rotational components is a constant in soccer players with previous injuries, especially in athletes after ACL reconstruction.

The literature affirms how repetitive soccer movements such as side stepping (dribbling with a side step) remain in any case, the gesture pattern that most contributes to elevating an excessive load on the ACL [37]. Either way, the negative overstress on the ACL, - with the lower limb assuming a valgus external rotation/varus internal rotation position - is diverse and can reach as much as twice the load compared to simple linear running [30].

During the cutting maneuver, the peak "push off," was lower in a knee flexion angle around a range of 30°, compared with a knee flexion of 45°.

We can argue how the athletes, perform the cutting maneuver in the in-out direction at different speeds, and different "cutting angles" in relation also to "one's" technical and postural ability [30,38].

Beiser [18] states that the magnitude of the peak "push off," may be a critical point for isolated ACL injuries during all phases of the game that require changes in direction.

It is highlighted [26,28] that an association between anterior tibial translatory force and an internal rotation, which is not physiological, can give a high load on the ACL especially, at angles near full knee extension [39]. The literature8 supports that knee stabilization is researched through:

- 1) A co-contraction of agonists - antagonists
- 2) Reciprocal activation of agonists and antagonists

The simultaneous contraction of the hamstrings and quadriceps, has a biomechanically stabilizing action, relative to



the knee joint, even during movements defined as pathologically active such as varus-valgus internal/external tibial rotation.

During football gestural movements a quadriceps/hamstring co-contraction creates a moment of maximum stability and protection at the knee joint.

It is thought that impaired neuromuscular control during a cutting maneuver could potentially increase “peak external valgus moments” [40-43].

Study limitations

This study is a literature review that is also based on technical opinions given the topic of football tactics and technique (pressing, the reaggession and the tackle). The limitation of the study is that to develop this technical-tactical part of our work, we investigated the opinions and unindexed articles of experienced authors and coaches on the topic with non-evidence-based papers from studies on the search engine used for this review.

Future directions

Information on the relationship between primary ACL injury in the soccer player should focus not only on the study of the clinical and rehabilitation process but also on the potential reduction of risk factors for a future second “contralateral or same-side” injury.

The development of a clinical decision-making algorithm to identify high-risk patients can serve as a basis for reevaluating the appropriate clinical dismissal criteria for Return to Sport (RTS).

This technical review indicates that modification of sports activity, improvement of rehabilitation guidelines, the use of neuromuscular training, complete recovery of simple and complex gestures both technical and tactical can help athletes reintegrate into the sport more safely and reduce second injuries in this at-risk population.

Our analysis has shown that future directions should be directed toward the study of simple and complex technical-tactical gestures in order to decrement the risk of second injuries.

Conclusions

Tactical patterns, and gestural-technical expressiveness, increase the risk factors for knee joint injuries. The knowledge and study of these technical-tactical gestural patterns in soccer such as pressing, pressure, tackles, and changes of direction are essential to be able to target, objectively, prevention strategies and subsequent return to sport.

The identification of modifiable factors predictive of a second ACL injury is necessary to effectively reduce this high risk of a second injury. This review indicates that activity modification, improved rehabilitation guidelines, and integrative neuromuscular training can help athletes reintegrate into the sport more safely and reduce the risk of a future second “contralateral or same-side” ACL injury.

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