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Neurocognitive errors are common in non-contact ACL injuries in professional male soccer players

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Title: Neurocognitive errors are common in non-contact ACL injuries in professional male soccer players

ABSTRACT

Context: Evidence is emerging that core neurocognitive function such as working memory or inhibitory control (motor response inhibition, attention) are linked to ACL injury risk. Thus far, research has been conducted in laboratory settings and the contribution of neurocognition to actual ACL injuries under real world conditions is unknown.

Objective: We hypothesized that errors in motor response inhibition and attentional inhibition contribute to non-contact ACL injuries in professional soccer players. In addition, we hypothesized high inter-rater agreement for the neurocognitive assessment based on the video analysis.

Design: Case series

Setting: Soccer matches

Patients or Other participants: Professional male soccer players

Main Outcome Measures: Neurocognitive errors in inhibitory control were operationalized as 1) motor response inhibition was scored when a player demonstrated poor decision making and approached the opponent with high speed which reduced the ability to stop or change the intended action; 2) an attentional error was scored in case the player shifted the selective attention away from the relevant task to irrelevant stimuli. Three independent reviewers evaluated each video.

Results: A total of 47 actual ACL injury videos were analyzed. Out of 47 non-contact ACL injuries, 26 were related to a pressing type injury and in 19 (73%) there was a deceiving action made by the opponent suggestive for poor inhibitory control of the defender. For the remaining

21 non-contact ACL injuries, 16 (76%) could be attributed to attentional errors. The agreement between the three raters was very good for all items, except for item poor decision making which showed fair to good agreement (0.71). Inter-rater reliability was excellent (ICC = 0.98-1.00).

Conclusion: The current student found that errors in motor response inhibitory control and attentional inhibition are common during non-contact ACL injury events in professional male soccer players. The inter-rater agreement to detect neurocognitive errors in general is very good.

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Key points

- The most common non-contact ACL injury was related to pressing during there was a deceiving action made by the opponent suggestive for poor inhibitory control of the defender
- Attentional errors may cause temporal spatial unawareness of the direction of the player's movements, potentially compromising motor control and leading to ACL injury
- Soccer players should delay the response until sufficient kinematic cues emerge from the opponent in relation to the contextual information to reduce the risk to sustain an ACL injury

INTRODUCTION

An anterior cruciate ligament (ACL) rupture is a devastating injury for a professional soccer player resulting is significant time loss[1] and reduced career length.[2] Unfortunately, despite access to injury prevention programs, the rate of ACL injuries in professional soccer remains high.[3] Understanding the situations and mechanisms which lead to ACL injuries is crucial to design effective injury prevention programs to reduce the high incidence. Two studies using video analysis of ACL injuries in male and female professional soccer revealed that 44% and 54% respectively, were non-contact in nature.[4,5] The main focus of these studies was the ACL injury mechanism based on a biomechanics perspective. Bahr and Krosshaug[6] proposed that studies on injury mechanism should not only include information about the biomechanical characteristics but also the behavior of the athlete and the opponent(s).

Stuelcken et al.[7] suggested a potential relationship between decision making and temporo-spatial constraints of ACL injuries in netball. Similar for soccer, the players are immersed in a rapidly changing, unpredictable, and externally paced environment. The challenge for the player is to get to particular locations on the pitch at specific times whilst making fast action decisions, such as staying close to an opponent, in response to moment-to-moment changes.[8] Thus, the mechanism of non-contact ACL injuries in soccer, especially for defensive injuries, may in part be explained by a high neurocognitive load.[9–11] Core neurocognitive functions control complex, goal-directed thought and behavior, and it involves multiple domains, such as inhibitory control, working memory and cognitive flexibility.[12]

In line with current research that entail the effect of decision making or selective attention paradigms on ACL injury risk biomechanics [13–15] the main focus of this study was to study inhibitory control. Inhibitory control involves the ability to control attention, behavior, thoughts and/or emotions in order to cancel strong internal predispositions or external temptation, and instead act in a more appropriate way.[12] Two key cognitive processes that have been described under the rubric of inhibitory control are: (1) motor response Inhibition and (2) attentional inhibition.[16] Motor response inhibition refers to the ability to stop unwanted and incorrect motor actions.[12] Motor response inhibitory control blocks behaviors and stops inappropriate automatic reactions, changing one response for a better, more thought-out response adapted to the situation. For example, imagine a soccer player receives the ball from a teammate. Based on visual scanning of the pitch, the player decides to pass the ball to a teammate running towards an open space, but right at the moment of initiation to play the ball, the player recognizes that a defender anticipated the decision and closed the passing lane right in time. Successful inhibitory control is demonstrated if the player is able to cancel the execution of his passing action, to avoid interception of the ball by the opponent.[17]

Attentional inhibition refers to the ability to resist interference from stimuli in the external environment. In soccer, the unpredictable and constantly evolving sports environment presents players with a myriad of stimuli (e.g. visual, auditory).[18] However, attentional capacity is limited, and a player must differentiate between stimuli relevant to the task and those that can be neglected.[19] However, divided attention has been shown to impact lower extremity mechanics during changes of direction and landing unfavorably resulting in greater risk for ACL injury.[20] Any deficit or delay in sensory or attentional processing may lead to potential coordination errors and result in high risk knee movements.[21] Although the influence of neurocognition on ACL injury risk has been demonstrated in cross sectional studies[9], there is a need to improve our understanding of how neurocognitive factors contribute to the actual ACL injury mechanism.[22] Thus, the primary aim of this study was to describe the possible neurocognitive errors involved in non-contact ACL injury mechanisms. We hypothesized that errors in motor response inhibition and attention inhibition contribute to actual non-contact ACL injuries in professional soccer players. In addition, we hypothesized high inter-rater agreement for the neurocognitive assessment based on the video analysis on actual ACL injuries. Integrating neurocognition to the existing biomechanical and neuromuscular approach could enhance our understanding of the complexity of ACL injury mechanisms.

METHODS

This was a secondary analysis of a previously published video analysis study of ACL injuries in professional male soccer.[4] All non-contact ACL injuries from this study cohort (n=57) 4 were included for the current study. Of these 57 injury videos, 47 were considered of sufficient quality for inclusion to identify possible neurocognitive errors. A detailed study flow chart is presented in Figure 1. Each video was downloaded to a personal computer and assessed with Kinovea (version 08.15; www.kinovea.org). The video analysis methods used in the current study has been published previously[4,5] and is very similar to others.[23,24] Boden et al.[25] reported high reproducibility of ICC of 0.95 for the assessment of lower extremity kinematics based on video analysis with a frame rate of 30Hz. In sum, we feel that that high-quality 3D video analysis offers a promising advancement in our understanding of actual ACL injury mechanism.

In the first step, the reviewers documented all sequences independently to estimate the time of initial contact (IC) between the foot and the ground as well as the assumed moment of the ACL tear, referred to as the injury frame (IF). Based on previous findings we considered the estimation of the injury frame IF to be within 40 ms from initial contact (IC) but each reviewer gave an estimation of the IC and estimated IF.[4,23] The videos were independently evaluated by four different reviewers (XXX, XXX, XXX, XXX) all experienced in sports medicine and orthopedic rehabilitation practice (PT/PhD, PhD, MD). A series of views were used to determine the injury mechanism and situational pattern. The category of injury mechanism used was a: non-contact, defined as an injury occurring without any contact (at the knee or any other level) prior to or at IF.[4] The situational patterns describe the situation leading to the injury. These can be divided in defensive and offensive situations. The analyses were done independently, with the reviewer blinded to the results of the other reviewers. The reviewers could move the video sequence in normal speed or slow motion back and forth, frame by frame, using the keyboard arrows.

Every ACL injury video was cut to approximately 12-15 seconds prior to, and 3-5 seconds post the estimated IF to accurately evaluate the playing situation that preceded the injury.

For the second step, all videos were analyzed independently once more by the reviewers again using a checklist to determine whether neurocognitive errors were present or not. Prior to independent assessment of all videos, the reviewers met for a 2-day comprehensive consensus training session to discuss the neurocognitive error patterns regarding related to non-contact ACL injury. In the event of disagreement between reviewers, a group discussion was used to reach consensus.[4,24]

For the neurocognitive analysis we were interested in inhibitory control: motor response inhibition and attentional inhibition.[12,16] Motor response inhibition was defined as the ability to stop unwanted and incorrect motor actions.[12] There is however a delay between the presentation of a stimulus and generating an appropriate motor response.[12] Based on previous studies, we operationalized that a soccer player has a time frame of approximately 450-1200 ms to change the motor action (usually in response to a deceiving action).[26–28] A key feature in team ball sports is that players hide information or provide misleading cues (deceptive action) about their current intentions regarding their own future actions.[29] Two commonly used types of deceptive actions are; a disguised action, is performed by a football player, who tries to hide cues for as long as possible, for example playing ball to right or left side of the field.[29] An example of misleading cues are fakes of the head, where a player passes to the right side, while simultaneously looking to the left side. To score this, an item on the checklist was added to determine whether a deceiving action occurred prior to injury. In that case, the delta between onset of deceiving action and IC was calculated. Good motor response inhibition includes early selection in which goal-relevant information is actively monitored to optimally bias attention, perception, and action systems to facilitate response inhibition.[30] Hence an error in motor response inhibition was scored when a player demonstrated poor decision making and approached the opponent with high speed which reduced the ability to stop or change the intended action. Top level male soccer players typically cover 10-13 km during a game[31] perform about 1200 discrete bouts of activity changing every 4-6 seconds[32], 150–250 brief, intense actions[33], and 200-400 meters of sprinting (distance covered over 7 m.s-1). They also perform numerous high intensity accelerations and decelerations (8-times as many accelerations as reported sprints per match).[34]

Selective attention was defined as a player focusing on a particular situation on the field for a certain period of time.[12] An error in attentional inhibition was scored in case the player shifted the selective attention away from the relevant task to irrelevant stimuli to which the player had no direct influence like 1) the ball, 2) playing situation and 3) other. A relevant stimulus can aid in correct performance. A high-level player has the ability to block out irrelevant cues and pay selective attention to the cues that are deemed relevant. Any irrelevant cues can be termed as distraction and this relates to a loss in attentional focus which can lead to poor performance.

Specifically, to our study, loss of attention for the task at hand e.g. looking at the ball rather than allocating attention to landing from a jump may cause spatial unawareness and subsequently disturb neuromuscular control of the landing.

Statistical analyses

The response variables assessed were categorical and continuous variables. The analysis was done based on frequency (number) of injury events based on playing condition characteristics 1) playing position: offensive or defensive; 2) player action: pressing, heading, kicking, other; 3) deceiving action of opponent: yes, no. Frequency (number) of neurocognitive errors associated with inhibitory control: 1) motor response inhibition (number) injury events when approaching opponent with high speed; 2) attentional inhibition: number injury events when player shifted attention away from relevant task to irrelevant stimuli: ball, playing situation, other. Timing (ms) of events: 1) time of initial contact: 2) time of injury frame: 3) ime of deceiving action.

For the inter-rater agreement, Fleiss' Kappa coefficients and intraclass correlation coefficients (ICCs, using a 2-way random model) were calculated for the categorical and continuous variables respectively. For the inter-rater agreement, Fleiss' kappa coefficients and 95% confidence intervals were calculated (CI). The interpretation of Fleiss Kappa was < 0.40 poor, 0.41 –0.75 fair to good and 0.75 – 1.00 very good, with > 0.75 used as a cut off for clinically acceptable measure of inter-rater agreement.[35] Intraclass agreement coefficients (ICCs) using a 2-way random model were calculated to determine inter-rater reliability. The ICC values were interpreted as poor (<0.50), moderate (0.50-0.74), good (0.75-0.89) or excellent (0.90-1.00).[36] An a priori statistically significant level of $p<0.05$ was used. Data was analyzed in SPSS (version 26, IBM, Chicago).

RESULTS

In total 47 purely non-contact ACL injuries were included in the analysis. There were 26 (55%) injuries to the right and 21 (45%) to the left ACL, with 36 primary injuries, 6 contralateral and 5 ipsilateral re-injuries. The situational pattern of ACL injuries was classified as “pressing” in 26 cases, “regaining balance after kicking” in 7 cases, “landing from high jump” in 4 cases and “other” in 10 additional cases.

Neurocognitive factors

The two neurocognitive factors assessed were response inhibition and selective attentional errors. Out of 30 ACL injury cases in which a defensive action was made, 26 were related to a pressing action. Out of those 26 cases, in 19 cases (73%) there was a deceiving action made by the opponent that led to the ACL injury for the defender suggestive of poor motor response inhibition. A common non-contact ACL injury pattern attributed to an error in motor response inhibition is presented in Figure 2. For 21 ACL injuries, an attentional inhibitory error was present in 16 (76%) cases, and this was related to an attentional error on the ball in 20 cases. In Figure 3, an example of an error in attentional inhibition is presented.

The average estimated time from IC to IF was 46 ± 15.4 ms. The average time from the deceiving action to IC was 256 ms (40-560 ms) of which in 15 cases this interval was less than 300 ms (Figure 4).

The Fleiss Kappa measure of agreement between the three raters was very good for all items, except for item poor decision making which showed fair to good agreement (0.71, 95% CI: 0.55-0.88). The other Kappa values were as follows: player situation before injury (1.000 (95% CI 0.83 - 1.16)), player action before injury (0.95 (95% CI 0.85 - 1.05)), deceiving action opponent (1.00 (95% CI 0.83 - 1.16)) and external distraction (0.79 (95% CI 0.63 - 0.96)). Inter-rater reliabilities were excellent. The ICC Chronbach's Alpha for initial contact was 1.00, for injury frame was 0.99, and for deceiving action was 1.00.

DISCUSSION

The main finding of this study suggests that neurocognitive errors may contribute to the events leading up to the actual ACL injury. Out of 47 non-contact ACL injuries, 26 were related to a pressing type injury and in 19 (73%) there was a deceiving action made by the opponent suggestive for poor inhibitory control of the defender. Twenty-one ACL injuries occurred during offensive (91%) or defensive actions (9%). In these cases, 15 players (76%) allocated their attention away from the playing situation suggestive of attentional inhibition. All neurocognitive errors were identified by the three raters with very good agreement. The findings of our study showed that errors in motor response inhibitory control and attentional inhibition are commonly observed during non-contact ACL injury events in professional male soccer players.

Motor response inhibitory errors during pressing

The current study expands our understanding outlining the contribution of neurocognitive errors for the most common non-contact ACL injury mechanism in soccer reported; pressing with a defensive action.[4] Error in motor response inhibitory control are mainly expected to occur during pressing situations. Pressing may be considered the proxy to trigger impulsive responses from the pressing defender. In support, in 19 (73%) cases a deceiving action by the opponent was a initiating factor that lead to a non-contact ACL injury. The delta between deceiving action and IC was 266 ms on average. These temporal-spatial demands suggest that neurocognitive load could be a contributing factor to ACL injuries. Elite soccer players are true masters in making deceptive movements and opponents must be able to predict the outcome of these deceptions. This means the defender must react very quickly, inhibit an already initiated response and plan and execute a new movement, all within this short time window. In a meta-analysis it has been reported that unplanned actions may result in at-risk knee biomechanics.[13] More specifically, in movement laboratory studies the median time was 500 ms for the presentation of a stimulus indicating a change of direction. Compared to planned movements, the unplanned movements resulted in higher knee abduction and tibial internal rotation moments.[13]

The complexity and temporal pressure under real world conditions as assessed in our study is arguable higher when compared to these movement laboratory studies. Temporal pressure imposed on players can push them into making inaccurate decisions at a rate double that if demand is low.[8] The results from our study indicate that temporal pressure affects perceptual–motor processes. The extreme time constraints evident in soccer, coupled with the fact that an opponent can disguise his intentions or present deceptive information, and the contextual information highlight the complexity for a player when making judgments.[37]

It is well established that expert athletes are superior to novices at utilizing advance visual information – specifically, kinematic information emanating from an opponent's motion – to inform their decisions.[38] In rugby with respect to perceptual skills, expert rugby players are more attuned to honest kinematic information that specify future running direction whilst novices are more attuned to deceptive signals.[39] However, players need not only to pay attention to the opponent as the playing situation contains more complexity. These include the use of postural cues, and pattern recognition and available contextual information.[38]

Perception of essential information from the rapidly changing playing environment is key for performance in soccer players and must then process this information correctly to select the most appropriate response. Any deficit or delay in sensory or attentional processing may contribute to an inability to correct potential errors in complex coordination, resulting in knee positions that increase the ACL injury risk.[40]

It is not well understood whether or not top-level athletes exhibit enhanced ability in both proactive and reactive inhibitory control. These two components refer to distinct temporal dynamic modes of motor response inhibition.[41] Proactive inhibition refers to a form of early selection in which task-relevant information is actively monitored to optimally bias attention, perception, and action systems to facilitate response inhibition as needed; proactive inhibition is used to strategically restrain actions in preparation for stopping (slowing down while approaching an attacker in possession of the ball). By contrast, reactive inhibition is a late correction process, triggered by external stimuli (responding to the deceiving action of the opponent). Under proactive control, the change of movement direction is pre-activated, which makes the actual change easier when it is needed.[30,41] Thus, proactive inhibition might be key to the ability to refrain from behavioral tendencies in anticipating the need to stop, such as when an athlete has to adapt to cues signaling different levels of motor cautiousness.

Attentional inhibition

Of those ACL injures related to attentional errors, 95% occurred whilst the player's attention was directed to the ball. This is similar to previous research in basketball where ACL injuries commonly occurred whilst the injured players attention was on the basketball rim, opposing player or ball.[42] This externally directed attention may have taken attention away from temporal spatial awareness of the direction of the injured players movements, potentially compromising motor control and leading to ACL injury. In support of this finding, athletes attending to a ball during the side-cut maneuver, demonstrated greater peak hip abduction and hip abduction at initial contact, greater peak knee flexion angle, and knee abduction moment.[43]

Soccer players need to determine which of the many stimuli in the complex environment requires selective or sustained attention, which allows them to ignore situations that are not important. Selective attention is defined as focusing on a particular situation on the field for a certain period of time.[12] Lacking the capability to redirect or sustain attention from one stimulus to the next may result in a loss of spatial awareness and disrupt motor control.[44] An attentional error occurs in case the player shifts the selective attention away from the task/goal. Expert soccer players show more flexible search strategies than novices depending on the nature and temporal constraints of the task and on the number of relevant information sources involved (individual or group offensive/ defensive plays).[45] Elite soccer players are better able to rapidly shift attention, coupled with gaze, to sequentially pick up information from several relevant sources.[46]

Implications for ACL injury mechanism

Sport performance is a combination of physical and perceptual-cognitive factors governing an athlete's ability to take appropriate actions to meet their goals in sport situations.[47] It is important to keep in mind two essential principles related to performance. First, human performance is constrained by the context and conditions in which it takes place (the situation) and, second, the perceptual-cognitive processes related to performance center on decision-making based on goal- directed coordination of controlled actions. This means that athletes' ability to accomplish goals and coordinate movements is shaped by the circumstances of the situation in which they perform.

Expert performance in sport is a combination of both physical and perceptual-cognitive skills that address the ability of an athlete to locate, identify, process this information, and coordinate appropriate actions (decision making).[48] The dual-system theory assumes there are two decision-making systems: system 1 and 2.[49] System 1 is intuitive, and automatically modulates the perception and memory processes, thus generating an almost immediate response. Conversely, the deliberate thought process of System 2 is slower and requires a greater amount of time and cognitive effort for decision making.[50] The two systems are complementary. Thus, in soccer intuitive responses seem to allow players to make faster decisions with less cognitive effort in an environment where time is limited and a determining factor.[46] In this context, quick and intuitive decision making takes into account the ability to optimize visual search strategies (the perceptual process), and to prioritize neurocognitive skills for information processes and subsequent decision making.

Professional soccer players are frequently immersed in situations that requires intuitive decision making often done at high speeds. These players have made such actions thousands of times throughout their career, indeed with any injury occurring from it. Usually athletes cope with sport-specific situational demands and adjust their attention to focus on the appropriate environmental cues, so they can plan movements accordingly. However, during high-speed, complex athletic maneuvers, cognitive capacities of athletes may be unable to reconcile the overabundant somatosensory information with the biomechanical demands of a rapidly changing physical environment. Unexpected joint loads during a sudden change occurring from an unplanned movement may be inconsistent with the brain's internal model of anticipated events. Such is the case for non-contact ACL injuries, due to incorrect, preprogrammed knee-stiffness–regulation strategies and subsequent movement errors as a potential consequence of neurocognitive errors.[10]

Also, high risk behavior may emerge in athletes as a result of poor inhibition. Athletes with poor motor response inhibition were found to overestimate their ability and more prone to injury.[51] Also, athletes who have 1) low perception of risk[52] , or 2) high self-efficacy and overestimate themselves are more likely to attempt high risk behavior and therefore expose themselves to greater risk of injury.[53] These studies show that ACL injury risk is not only related to biomechanical and neuromuscular factors, but is also related to neurocognitive factors. ACL injury prevention programs are based on linear relationships between presence of risk factors and the actual occurrence of the ACL injury.[54]Recently, Bittencourt et al.[55] proposed a complex system approach to enhance the understanding of injury etiology. Briefly, this approach highlights a non-linear interaction between risk factors from different dimensions (biomechanical, psychological, neurocognitive, physiological and training characteristics) as a web of determinants, and how these may result in injuries.[55]

From an ACL injury prevention standpoint, the findings from the current study may suggest that soccer players should delay their response until sufficient kinematic cues emerge from the opponent in relation to the contextual information to reduce the risk to sustain an ACL injury. However, this could affect the performance of the player if actions are delayed. To optimize the balance between reducing injury risk whilst maintaining performance, it is suggested to include neurocognitive load to injury prevention exercises.

In sum, a growing body of literature suggests that neurocognitive factors may influence an athlete's risk of ACL injury.[21,56–58] Athletes have demonstrated alterations in lower extremity biomechanics with drop landing trials that incorporated temporal constraints on decision-making compared to standard drop landing trials.[56,57] Attending to a ball while sidestep cutting has been shown to result in more trunk extension and less lateral trunk flexion toward the cutting direction.[59] It has been demonstrated that that athletes' perceptual and decision-making ability for agile maneuvers can be trained.[60] In other words, it has been shown that it is possible to develop an athlete's ability to identify kinematic cues from their opponents.[60]

Limitations

In the current study, only motor response inhibition and selective attention were inferred from video analysis of non-contact ACL injuries. This is a reduction of core executive functions. Although not examined in this study, working memory may also play an important role in the injury mechanism as working memory is intricately related to inhibition. In complex situations certain players may not be able to clear the irrelevant from the relevant information. Subsequently they clutter their capacity of the working memory and as a result may potentially affect their movement control.[15] In addition, we did not use eye tracking to assure where the attention of players was directed. However, point-of-gaze does not entirely reflect the athlete's allocation of attention, as covert attention to cues in the visual periphery is not picked up by eye movement registration systems.[61] Finally, cognitive function was not assessed with questionnaires or computerized tests. Nevertheless, our results may serve as a framework for future studies to determine an association between neurocognitive function and actual ACL injuries. Previous research indicated that athletes with lower baseline cognitive function are more likely to experience non-contact knee injuries during the season compared to those with higher cognition.[56]

Conclusion

ACL injury mechanisms have been primarily viewed from a biomechanical and neuromuscular perspective. Errors in motor response inhibitory control and attention inhibition are commonly observed during non-contact ACL injury events in professional male soccer players. The inter-rater agreement to detect neurocognitive errors in general is very good.

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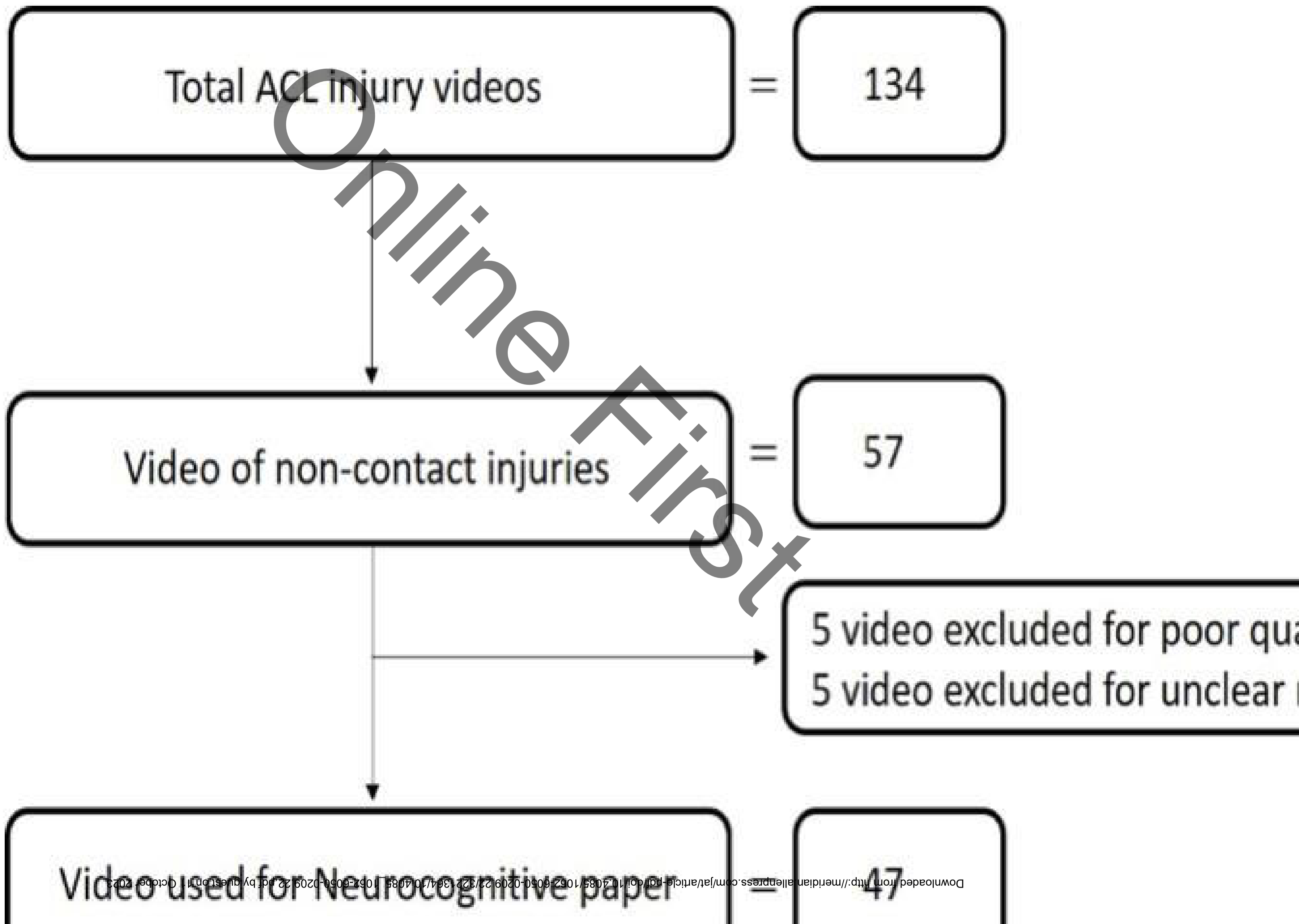
FIGURE LEGENDS

Figure 1. Detailed flowchart of the study. ACL, anterior cruciate ligament.

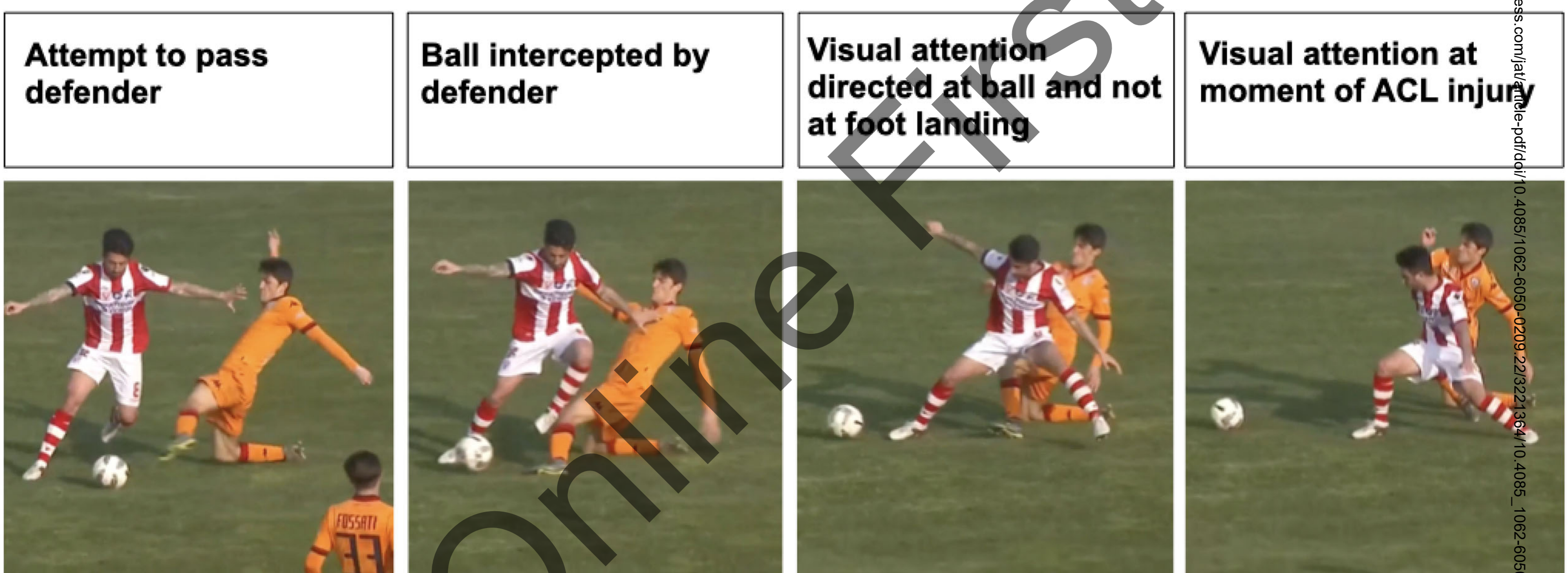
Figure 2. Example of cascade of events leading to a non-contact ACL injury attributed to motor response inhibition errors. D: deceiving action; IC: initial contact, IF: injury frame.

Figure 3. An example of an error in attentional inhibition. After the ball loss, the player focuses solely on the ball without paying sufficient attention on how to plant the left foot. The loss of spatial awareness disrupts motor control.

Figure 4. Scatterplots showing the time interval between the deceiving action and initial contact for all 19 players.


Total ACL injury videos
=
134
Video of non-contact injuries
=
57
5 video excluded for poor
5 video excluded for unclear
Video used for Neurocognitive paper
=
47

Poor Inhibitory control and decision making (Aggressive pressing)


Attempt to pass defender
Ball intercepted by defender
Visual attention directed at ball and not at foot landing
Visual attention at moment of ACL injury
FOSSATI
33

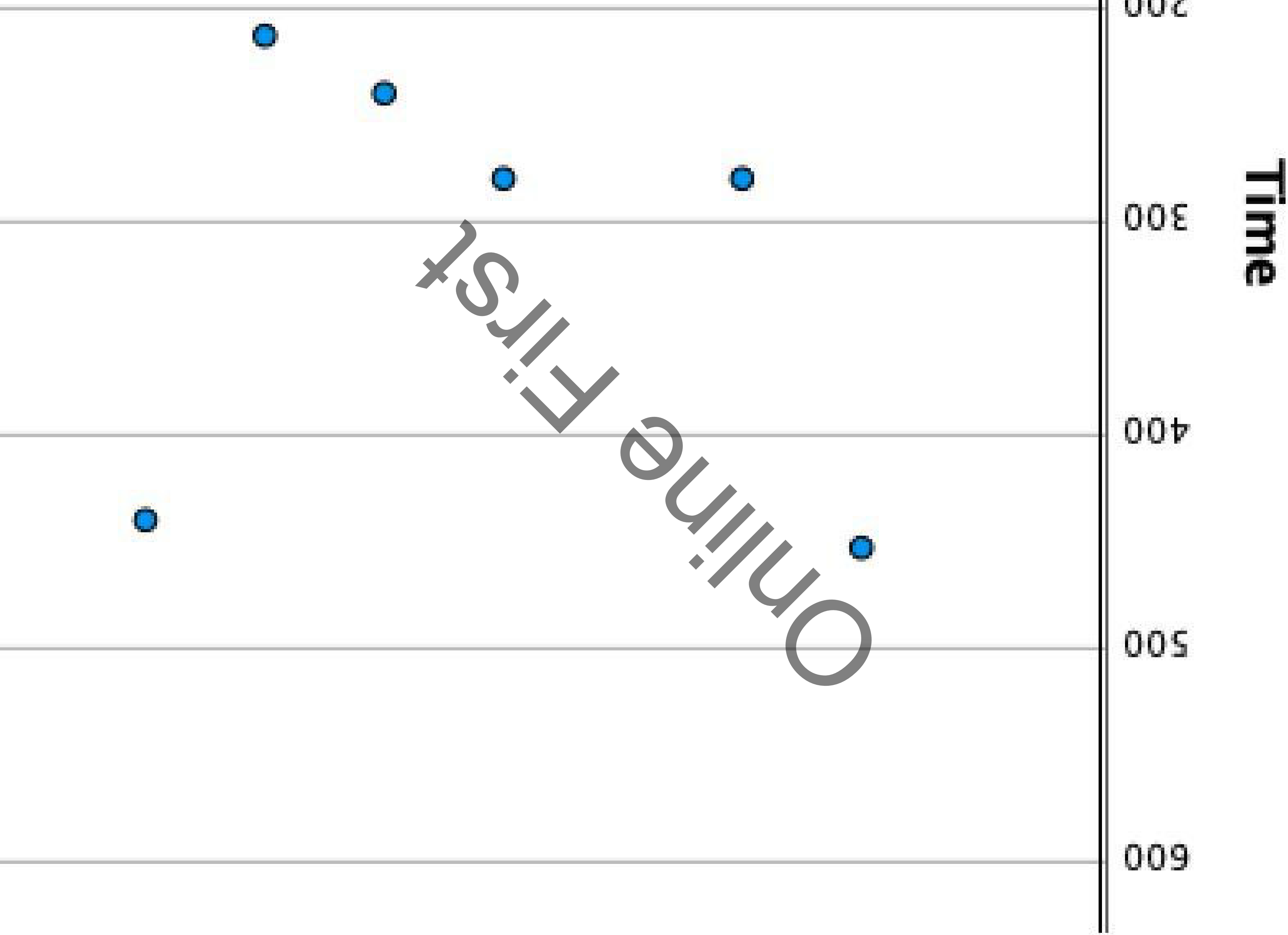

Time
200
300
400
500
600

Table 1. Details of injury mechanism, situational pattern classification according to a predetermined checklist.

	All non-contact ACL injuries (n=47)	Non-contact ACL injuries with possible error in motor response inhibition	Non-contact ACL injuries error with possible error in attentional inhibition
Playing phase n (%)	Defensive n=30 (64%); offensive n=17 (36%)	Defensive n=26 (100%)	Offensive n=17 (81%); Defensive n=4 (19%)
Poor decision making in relation to the context?	Yes n=43 (91%) No n=4 (30%)	Yes n=24 (92%); No n=2 (8%)	Yes n= 2 (9%); No n=19 (91%)
Deceiving action by the opponent prior to injury?	Yes n=20 (43%) No n=27 (57%)	Yes n=19 (73%); No n=7 (27%)	Yes n=1 (5%); No n=20 (95%)
Did the player shift his attention away from the playing situation before the injury?	Yes n=20 (42%) No n=26 (55%)	Yes n=4 (15%); No n=22 (85%)	Yes n=16 (76%); No n=5 (24%)
If yes where to what was the attention drawn?		Ball n=4 (100%)	Ball n=15 (94%); Other n=1 (6%)