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Three Main Mechanisms Characterize Medial Collateral Ligament Injuries in Professional Male Soccer—Blow to the Knee, Contact to the Leg or Foot, and Sliding: Video Analysis of 37 Consecutive Injuries

Team performance[10] and club finances[7,11] suffer when athletes are injured. In soccer, knee injuries contribute the most to injury burden.[6] Medial collateral ligament (MCL) injuries are the most common traumatic knee injury.[22] A critical step in the sequence of injury prevention is establishing the causes of injury,[1,32] including studying what may predispose an athlete to injury (eg, risk factors) and how injuries happen.[1] Despite the high prevalence of MCL injuries in soccer, it is unclear how MCL injuries occur.

OBJECTIVE: To describe the mechanisms, situational patterns, and biomechanics (kinematics) of medial collateral ligament (MCL) injuries in professional male soccer players.

DESIGN: Case series.

METHODS: Fifty-seven consecutive MCL injuries across 2 seasons of professional soccer matches were identified. We obtained and reviewed 37 of 57 (65%) injury videos to establish the injury mechanism, situational pattern, and knee flexion angle. We used detailed biomechanical analysis to assess the indirect and noncontact injuries. Injury layoff times, timing of injuries during the match, and location of the injuries on the pitch were also reported.

RESULTS: Twenty-three (62%) injuries were direct contact, 9 (24%) were indirect contact, and 5 (14%) were noncontact. Three main sprain mechanisms were noted: (1) direct contact/blow to the knee (n = 16), (2) contact to the leg or foot (lever like) (n = 7), and (3) sliding (n = 9). Seventy-three percent of MCL injuries occurred during 2 main situations: (1) pressing/tackling (n = 14, 38%) and (2) being tackled (n = 13, 35%). For indirect and noncontact injuries, knee valgus loading (100% of cases), hip abduction (73% of cases), and external foot rotation (92% of cases) were prominent injury kinematics, often with lateral trunk tilt (median, 10°; 64% of cases) and rotation (64% of cases). Knee flexion angles were higher for indirect and noncontact injuries (median, 100°) than for direct-contact injuries (median, 22°; *P*<.01).

CONCLUSION: Nearly two thirds of MCL injuries occurred after direct contact; 1 in every 4 MCL injuries occurred after indirect contact. Three sprain mechanisms characterized MCL injuries: (1) blow to the knee, (2) contact to the leg or foot (lever like), and (3) sliding. *J Orthop Sports Phys Ther 2021;51(12):611-618. Epub 16 Nov 2021. doi:10.2519/jospt.2021.10529*

KEY WORDS: *biomechanics, injury mechanisms, injury prevention, knee injuries, soccer*

Mechanisms (contact versus noncontact sprain-type mechanisms), playing situations, and biomechanics are important injury characteristics to study.[1] Current understanding of MCL injury mechanisms, playing situations, and kinematics during soccer is based on recall, which is prone to bias.[15] Video analysis, despite not being the gold standard method of investigating the biomechanics of injuries,[5,13] is a valid tool[16] for studying the context (eg, mechanisms and playing situations) of injuries. Anterior cruciate ligament (ACL) injuries are well studied using video analysis[4,14,17,33]; MCL injuries are not.

We aimed to use video analysis to study the mechanisms, playing situations, and biomechanics (kinematics) of MCL injuries in professional male soccer players during matches. In studying how MCL injuries occur, we aim to support clinicians in diagnosing injuries and designing interventions to reduce injury incidence.

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METHODS

Identifying Injury Cases

We performed a systematic search of online database resources across 2 seasons (2017-2018 and 2018-2019) of the top 5 first-division European leagues (Bundesliga, FA Premier League, La Liga, Ligue 1, Serie A) to identify MCL injuries that occurred during matches. Each season schedule and team roster were extracted from online databases (www.legaseriea.it; www.legab.it) and team websites. We searched www.Transfermarkt.de for injury history details for each player.[4] This methodology has been recently validated[19] and adopted[4] for identifying injuries in professional soccer, and in recent studies on return to play after various severe pathologies in professional soccer.[8,20,27] We supplemented the search by examining additional data sources for injuries that may have been missed, including national (eg, www.gazzetta.it; www.corrieredellosport.it) and local media.

Injuries were included only when the research team could corroborate the nature of the injury with official team media reports. Only isolated MCL injuries were included. Injuries with associated meniscus and/or ACL injuries were excluded.

Match videos were obtained from an online digital platform (https://wyscout.com). Videos were then processed on a digital cloud (https://paninidigitalcloud.com) and downloaded to a personal computer. Match video processing was completed using a cloud tool (Digital Soccer Project Srl, Brescia, Italy). Each video was cut to approximately 12 to 15 seconds prior to and 3 to 5 seconds after the estimated injury frame to accurately evaluate the injury mechanisms and situational patterns.

Video Evaluation

All videos were independently evaluated by 3 reviewers (M.B., F.T., and F.D.V.), according to 2 predetermined checklists (see the supplemental file). All reviewers had experience in sports medicine and orthopaedic rehabilitation practice. Each video was downloaded to a personal computer and opened with online software (Kinovea; https://www.kinovea.org/) prior to analysis.

Prior to independent assessment of all videos, the reviewers met for a 1-day comprehensive consensus training session to discuss the playing situations, actions, and injury mechanisms. Following independent analysis, the reviewers convened for a 1-day meeting to achieve consensus on all items and to perform the biomechanical/kinematic analysis (described below). Disagreements were resolved via consensus.[4,25,33] Prior to the meeting, the intraclass correlation coefficient between the reviewers for the injury frame was 0.99.

Defining an MCL Injury

The injury situation (defensive or offensive) was defined and classified based on ball possession and specific playing situation. Then, a series of views were used to determine the injury mechanism and situational pattern. Injury mechanism was defined according to both contact mechanism and estimated sprain-type mechanism. Classification of contact mechanism was based on previous research on ACL injuries, with minor modification.[3] We used the term *situational pattern* based on our previous research,[4] which is a term that describes the playing situation leading to MCL injuries. The patterns can be divided into defensive and offensive situations. This is the situation and not simply the action: we consider the action as interacting with the environment (eg, pressing pattern or tackling) (see the supplemental file).

We defined 3 injury contact mechanisms: (1) noncontact, defined as an injury occurring without any contact (at the knee or any other level); (2) indirect contact, defined as an injury resulting from an external force applied to the player, but not directly to the injured knee/lower leg or to the medial aspect of the foot; and (3) direct contact, defined as an external force directly applied to the injured knee/lower leg or the medial aspect of the foot (ie, lever-like mechanisms).[4,23]

Injuries of the MCL are largely thought to be the result of a direct application of a valgus stress/knee abduction moment (KAM).[18,28] High KAMs can occur with force applied directly and laterally to the knee joint, displacing the knee medially and resulting in a KAM. A similar action and KAM can be applied by displacing the tibia lateral to the knee joint in an open-chain situation, with force applied to the medial side of the tibia or foot (eg, the lever-like mechanism described below). We also considered MCL injury mechanisms according to sprain type, the definitions of which were developed during the consensus meetings. Three sprain-type mechanisms were defined: (1) external blow to the knee, (2) contact to the leg or foot (lever like), and (3) sliding (see the supplemental file).

Biomechanical Analysis (Kinematics)

Kinematic analysis was performed, as per previous research on ACL injuries,[4] during the second consensus meeting day (online). Knee flexion angles were reported for all injuries. More complete biomechanical/kinematic analysis was performed only for noncontact and indirect-contact injuries when sufficient quality of a frontal and/or sagittal view was available. Kinematic analysis was performed to estimate intersegmental relationships and joint angles according to frontal and sagittal plane alignment at injury only. When more than 1 view was available, composite videos were created by manual synchronization using visual cues.[25]

Sagittal plane angles and trunk tilt were estimated, using custom-made software (Screen Editor; GPEM Srl, Genova, Italy), to the nearest 5°. The remaining frontal and coronal plane estimated joint positions were categorized according to appearance. Additional information on the details of the biomechanical analysis and the items evaluated can be found in the supplemental file.

Match and Field Distribution

Injuries according to match minute, minutes played, and location on the pitch were gathered through online review and analysis of injury videos. The location of the injury on the pitch was determined according to previously published methodology.[4] Player location at the time of injury was gathered according to the field lines. The soccer pitch was divided into 11 zones.[4] The field zone dimensions in square meters were calculated using the official FIFA soccer field size (105 × 70 m).

Statistical Analysis

We calculated mean ± SD or median (range or interquartile range [IQR]) values, as appropriate, for continuous variables. Discrete variables were presented as absolute numbers and percentages of the total observations. Statistical tests were performed to contrast differences in contact and/or sprain-type mechanism for layoff times, knee flexion angles, and times of injury, according to match minute or minutes played. The Kolmogorov-Smirnov test was used for data normality assumption, and the data were not normally distributed. We tested for differences in these variables across injury classes (direct contact versus indirect contact and noncontact) using nonparametric Mann-Whitney rank-sum tests. Likewise, differences across MCL sprain mechanisms (external blow versus lever like versus sliding) were assessed with Kruskal-Wallis tests. An alpha of less than .05 denoted statistical significance. Additional analysis using a nonparametric effect size for all tests was computed,[31] with eta-square interpreted as small, 0.01; medium, 0.06; and large, 0.14. Excel 2016 (Microsoft Corporation, Redmond, WA) and SPSS Statistics (Version 24.0; IBM Corporation, Armonk, NY) were used for analysis.

RESULTS

Fifty-seven MCL injuries were tracked and included. The mean ± SD age of the injured players was 26.1 ± 4.1 years. Injuries across leagues are detailed in the supplemental file. There were 26 (46%) injuries to the right knee and 31 (54%) injuries to the left knee. Of these injuries, 28 were to the kicking leg (49%) and 29 (51%) to the nonkicking leg. A detailed study flow chart is shown in **FIGURE 1**.

Injury Mechanism Analysis

Video footage was available and identifiable for injury mechanism and situational pattern analysis in 37 cases (65%). One video had 5 camera views, 1 had 4, 15 had 3, 12 had 2, and 8 had 1 camera view. Twenty-three (62%) injuries were classified as direct contact, 9 (24%) as indirect contact, and 5 (14%) as noncontact. See **TABLE 1** for more details on injury mechanism.

Three main MCL-specific sprain-type mechanisms were identified: (1) external blow to the knee (n = 16), (2) contact to the leg or foot (lever like) (n = 7), and (3) sliding (n = 9).

External blow to the knee was the most common mechanism (n = 16, 43%) and involved a direct blow to either the front or lateral aspect of the knee. In 6 cases, this external blow came from a player (opposing or on the same team) falling on the outside of the injured player's knee (**FIGURE 2**). "Lever-like" mechanisms (n = 7, 19%) also involved contact to the injured leg, either via a tackle or contact with the ball distal and medial to the knee joint (**FIGURE 2**). The sliding mechanism, the second most common mechanism (n = 9, 24%), and principal indirect and noncontact mechanisms involved a gradual opening in hip abduction of the injured limb as the foot transitioned away from the body or the body away from the standing limb (**FIGURE 2**). The other injuries involved a closed chain–type impact with the ground (eg, landing [n = 4]) and a combination of external blow and lever-like mechanism (n = 1).

Situational Patterns

Seventy-three percent of MCL injuries occurred during 2 main situational patterns: (1) pressing/tackling (n = 14, 38%) and (2) being tackled (n = 13, 35%). The other 10 injuries (27%) involved landing from a jump, kicking the ball, or an accidental collision with direct force application to the injured leg (**TABLE 2**).

Biomechanics (Kinematics)

Direct-contact injuries occurred at lower knee flexion angles (median, 22°; IQR,

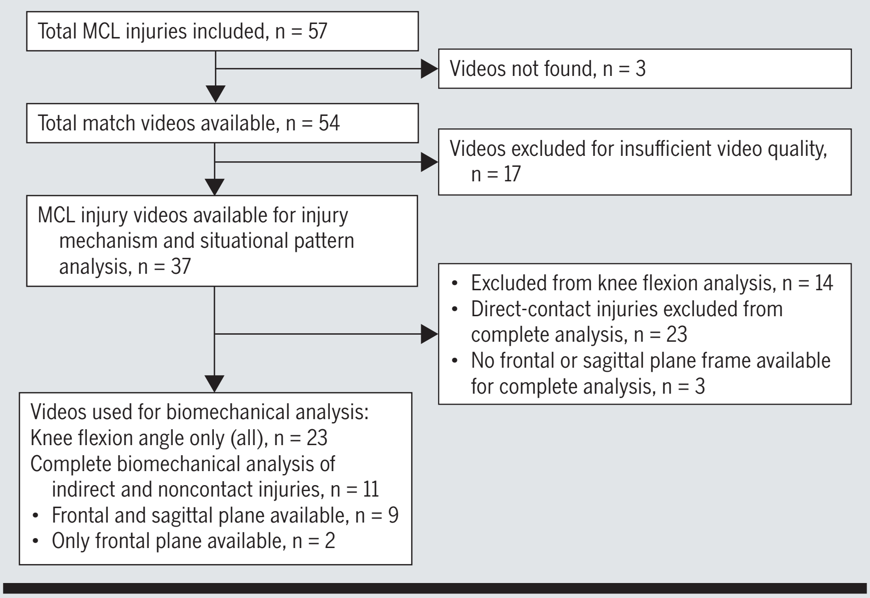

FIGURE 1. Detailed study flow chart. Abbreviation: MCL, medial collateral ligament.

36°) than indirect and noncontact injuries (median, 100°; IQR, 65°) (P<.001, η^2 = 0.33). Knee flexion angles differed across the sprain-type mechanisms (P<.001, η^2 = 0.46): sliding (median, 110°; IQR, 35°) had higher knee flexion angles than the external blow (median, 27°; IQR, 29°) and lever-like (median, 22°; IQR, 38°) mechanisms (P<.01).

Of the 14 indirect and noncontact injuries included for complete biomechanical analysis, 9 involved sliding. In the sagittal plane, in the injury frame, players generally had an upright trunk (median, 23°), a relatively flexed hip (median, 42°) and knee (median, 100°), and a neutral ankle (median, 0°). In the frontal plane, the trunk was generally tilted (median, 10°; 64% of cases) and rotated to the injured leg (64% of cases). The hip was generally abducted (73% of cases), with the knee always in valgus (100% of cases) and the foot nearly always in external rotation (92% of cases). See **TABLE 3** for more details.

Layoff Times

The median layoff time in our study for all injuries (n = 36) was 41 days (IQR, 33.5 days). There was no difference in layoff times between direct (n = 23; median, 38 days; IQR, 41.5 days) and indirect and noncontact injuries (n = 13; median, 52 days; IQR, 33 days) (P = .98). Layoff times for external blow (n = 16; median, 37.5 days; IQR, 37 days), lever-like (n = 7; median, 61 days; IQR, 46 days), and sliding (n = 8; median, 29 days; IQR, 23 days) mechanisms were statistically similar (P = .14), but with a medium to large effect-size difference (η^2 = 0.07). Layoff times for injuries without available match video (n = 17) were similar to those with available match video (median, 28 days; IQR, 28 days; P = .056), but with a medium to large effect-size difference (η^2 = 0.10).

Positional, Match, and Field Distribution

Data for position (n = 57), match (n = 52), and field distribution (n = 37) were available. Four of every 5 injuries occurred at the central (n = 21, 37%) or wide (n = 12, 21%) midfields or at center forward (n = 12, 21%) (see the supplemental file). Thirty injuries (58% of 52 injuries) occurred in the second half; 25 injuries occurred in the final 30 minutes and 1 in every 4 injuries occurred in the final 15 minutes of a match (**FIGURE 3**). There was no difference in average timing between direct-contact and indirect and noncon-

TABLE 1 Details of Medial Collateral Ligament Injury Mechanism Analysis According to a Predetermined Checklist (n = 37)

Variable	Result
Raining	No (n = 37)
Playing phase before injury	Defensive (n = 20), offensive (n = 15), neither (n = 1), unsure (n = 1)
Field location of injury	
Long axis of the field	Defensive third (n = 3), midfield third (n = 17), offensive third (n = 17)
Short axis of the field	Left-side corridor (n = 6), middle corridor (n = 21), right-side corridor (n = 10)
Player contact preceding injury	No (n = 26), yes (n = 11)
If contact, where?	Upper body (n = 8), injured leg (n = 1), uninjured leg (n = 2)
Player contact at IF	No (n = 11), yes (n = 26)
If contact, which type?	Direct (n = 23), indirect (n = 3)
Injury classification	Direct contact (n = 23), indirect contact (n = 9), noncontact (n = 5)
Closed or open chain	Closed chain (n = 27), open chain (n = 10)

Abbreviation: IF, injury frame.

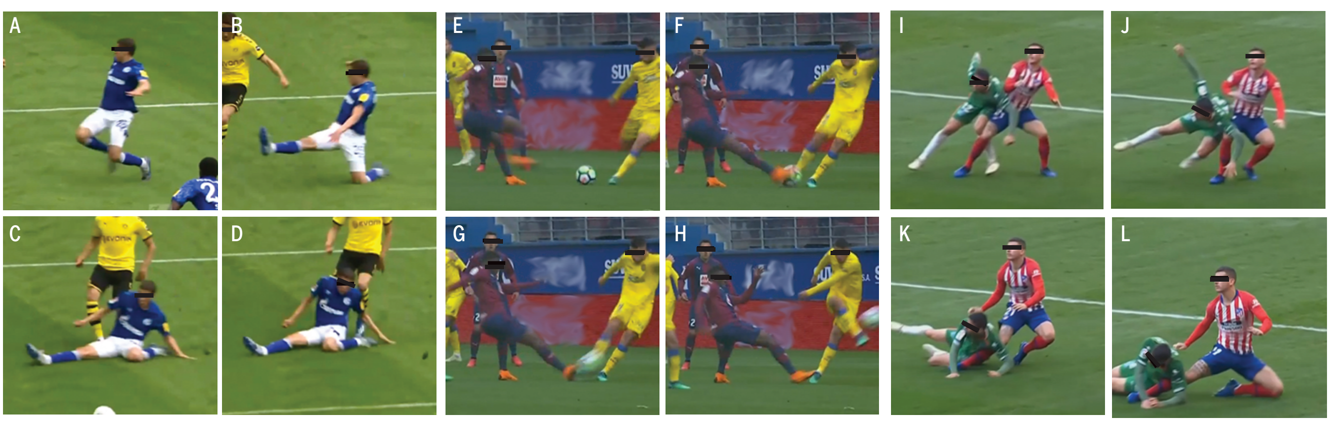

FIGURE 2. Examples of the 3 identified medial collateral ligament tear mechanisms. Sliding-type mechanism: (A and B) an attempted block tackle, with the nontackling leg on the ground; (C and D) estimated injury frames as the body passes the injured leg in contact with the ground. Lever-like mechanism: (E) the injured player presses the opposing player; (F) a block tackle and initial contact; (G) injury frame; (H) after injury. Blow-type mechanism: (I and J) the opposing player falls, making contact with the player's injured leg; (K) the opposing player falls on the outside of the player's injured leg and forces the injured player's leg into extreme valgus, causing medial collateral ligament injury; (L) the injured player falls to the pitch. Photos reproduced with permission from Federico Ferri, director of Sky Sport Italia.

TABLE 2 INJURIES ACCORDING TO SITUATIONAL PATTERN, PLAYING SITUATION, AND MECHANISMS OF INJURY (N = 37 CASES)

Situational Pattern	Playing Situation	Contact Mechanism	MCL Sprain-Type Mechanism	Closed or Open Chain
Pressing/tackling (n = 14, 38%)	Defensive, n = 14	Direct, n = 8; indirect, n = 3; noncontact, n = 3	External blow, n = 4; lever like, n = 3; sliding, n = 6; other, n = 1	Closed chain, n = 10; open chain, n = 4
Being tackled (n = 13, 35%)	Defensive, n = 2; offensive, n = 11	Direct, n = 10; indirect, n = 3	External blow, n = 8; lever like, n = 3; sliding, n = 1; other, n = 1	Closed chain, n = 8; open chain, n = 5
Other (n = 10, 27%)	Defensive, n = 4; offensive, n = 4; neither, n = 1; unsure, n = 1	Direct, n = 5; indirect, n = 3; noncontact, n = 2	External blow, n = 4; sliding, n = 2; lever like, n = 1; other, n = 3	Closed chain, n = 9; open chain, n = 1

Abbreviation: MCL, medial collateral ligament.

tact injuries for either match minutes (direct contact: median, 56 minutes; IQR, 62 minutes versus indirect/noncontact: median, 54 minutes; IQR, 46 minutes; $P = .61$, $\eta^2 = 0.007$) or minutes played (direct contact: median, 24 minutes; IQR, 62 minutes versus indirect/noncontact: median, 44 minutes; IQR, 45 minutes; $P = .17$, $\eta^2 = 0.052$). Injuries according to pitch location are presented and detailed in the supplemental file.

TABLE 3 BIOMECHANICAL VARIABLES FOR INDIRECT AND NONCONTACT INJURIES[a]

Variable	Result
Number of feet on the ground (n = 14)	Zero, n = 1; 1, n = 3; 2, n = 10
Leg loading (n = 14)	Injured leg, n = 7; both, n = 6; neither, n = 1
Horizontal speed (n = 14)	Zero, n = 2; low, n = 4; high, n = 8
Vertical speed (n = 14)	Zero, n = 5; low, n = 4; medium, n = 2; high, n = 3
MCL sprain-type mechanism (n = 14)	Sliding, n = 9; other, n = 5
Sagittal plane kinematics, deg[b]	
Knee flexion angle (n = 7)	100 (53-140)
Trunk flexion (n = 7)	23 (–20 to 38)
Hip flexion angle (n = 7)	42 (13-90)
Ankle flexion (n = 5)	0 (0-10)
Frontal plane kinematics	
Lateral trunk tilt angle, deg (n = 10)[b]	10 (0-66)
Trunk tilt orientation (n = 11)	Toward injured leg, n = 7; neutral, n = 4
Trunk rotation (n = 11)	Toward injured leg, n = 7; neutral, n = 1; toward uninjured leg, n = 3
Frontal plane hip alignment (n = 11)	Abduction, n = 8; neutral, n = 2; adduction, n = 1
Frontal plane knee alignment (n = 11)	Valgus, n = 11
Foot rotation (n = 12)	External, n = 11; neutral, n = 1
Significant increase in foot external rotation	Yes, n = 9; no, n = 3

Abbreviation: MCL, medial collateral ligament.
[a]*Total, n = 14: 9 indirect and 5 noncontact injuries.*
[b]*Values are median (range).*

DISCUSSION

Most MCL injuries in professional male soccer were due to direct-contact mechanisms. We suggest 3 main injury mechanisms: (1) external blow to the knee (direct contact), (2) blow to the leg or foot (lever like; direct contact), and (3) sliding (indirect/noncontact). Injuries of the MCL most often occurred either when the injured player was pressing/tackling or being tackled.

Injury Mechanisms and Situational Patterns

Our results support previous research: MCL injuries predominantly result from contact,[21,22] which might suggest that a high proportion of MCL injuries are unavoidable. One in every 4 injuries was due to indirect contact. There were 2 contact-type sprain mechanisms: a direct blow to the knee (more than half of injuries) and contact to the leg or foot (lever-like mechanism; 1 in 5 injuries). These actions contribute to high and rapid knee valgus loads.[18,28] The "sliding" mechanism is novel (distinct mechanism and different kinematics, described below) and explained most of the indirect and noncontact MCL injuries. Most MCL injuries occurred during 2 main playing situations: (1) pressing/tackling and (2) being tackled, as reported in previous research on MCL[21,22] and ACL[4,33] injury in soccer. We speculate that an injury prevention program focused on perturbation neuromuscular/movement training may help players avoid some MCL injuries, although future research must test our hypothesis.

Biomechanics/Kinematics

Knee flexion angle at the time of injury differed between injury mechanisms. Direct-contact injuries occurred with shallow (22°) knee flexion, while indirect and noncontact injuries (composed mostly of sliding injuries) occurred at high knee flexion angles (100°). This high knee flexion angle for indirect and noncontact injuries was accompanied by limited motion at the ankle and hip/trunk, suggesting a predominance of knee loading in the sagittal plane.[5]

All indirect and noncontact injuries occurred when the knee was in valgus.[18,28] The MCL is the primary restraint to knee valgus.[9] A lateral trunk lean was prevalent in most injuries, and may increase MCL (and ACL) loading due to a lateral shift of the center of mass, causing a KAM.[29] External tibial rotation "appearance" was highly prevalent, supporting previous research.[18,28] External tibial rotation knee injuries may be associated with additional injury to the deep MCL.[26] Both the superficial MCL and deep MCL resist valgus stress, but the deep portion also resists external tibial rotation.[12,34] Identifying injuries involving the deep MCL may guide more effective diagnosis and management of MCL injuries.[26]

Layoff Times and Positional, Match, and Field Distribution

There were no differences in layoff times with respect to injury mechanisms.[22] The layoff times in this study for the injuries with available video footage (median, 41 days) were longer than previously reported in soccer (mean, 23-24 days).[21,22] This difference is likely explained by discrepancies in injury reporting methods: UEFA injury reporting relies on direct communication with the team and uses layoff times from injury to full participation in training and availability for match selection. Our study relied on www.Transfermarkt.de and matches missed. There is typically a time delay from when the player is available to play to participation in the first match after injury. It is also possible that the MCL injuries we analyzed were more severe. Higher-grade injuries are associated with longer layoff times.[21]

Injuries were more common in the final third of the match. Other research in soccer reported a higher incidence of MCL injuries in the final 15 minutes of each half.[22] Factors such as cumulative fatigue (fatigue over the course of match play),[2,25] an increased intensity of or more risky tackling later in the match, or poor decision making (potentially due to mental fatigue) could account for this.

Nearly 4 in 5 injuries were in midfield/attacking players, with 37% of all injuries in central midfield players. High-risk positions on the pitch were the middle and attacking thirds, as well as the middle corridor. Previous research has shown a 2-fold relative increased risk of MCL injuries in outfield players versus goalkeepers (relative risk = 2.1, P = .001),[22] but ours is the first study to report between-position differences in outfield players and injuries according to pitch location. Future research should elucidate these findings in a larger cohort of players/injuries.

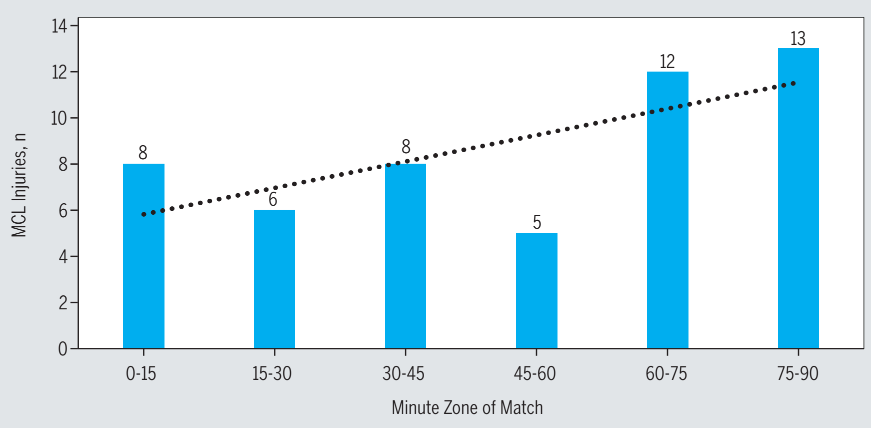

FIGURE 3. Distribution of MCL injuries throughout the match. The dotted line indicates the linear trend of injuries over the course of the match. Data are from 52 MCL injuries. Abbreviation: MCL, medial collateral ligament.

Methodological Considerations

Previous research on MCL injury mechanisms has relied on player recall or observation with questionnaires, which are both prone to recall bias.[15] We addressed this problem with video analysis. The consecutive nature of the injuries analyzed and the consistent biomechanical/kinematic analysis of 3 independent viewers (using measurement tools) are strengths. However, the methodology used to identify MCL injuries is different from the gold standard, which involves prospective studies and frequent contact with teams.[21,22] We could not distinguish between grades of MCL injury or parts of the MCL (eg, superficial MCL, deep MCL, posterior oblique ligament).

Model-based image-matching techniques are considered the gold standard method of injury analysis.[13,14] Video analysis is valid[16] and consistently adopted in similar studies.[4,14,17,33] We found a lower proportion of available videos than is ideal (65%), largely due to an inability to identify injuries during the available match footage. There were few indirect and noncontact injuries for full biomechanical analysis (n = 14), with some measures having very low numbers (eg, sagittal plane kinematic analysis, n = 5-7).

CONCLUSION

Injuries of the MCL are largely a contact-type injury. We suggest 3 MCL sprain mechanisms: (1) blow to the knee, (2) contact to the foot or leg (lever like), and (3) sliding. Injuries occurred during 2 main playing situations: pressing/tackling and being tackled. Indirect and noncontact injuries involve altered kinematics, similar to ACL injuries,[24,30] although with high knee flexion angles. Injuries of the MCL were more common later in match play and among midfield and attacking players. ◉

KEY POINTS

FINDINGS: Medial collateral ligament (MCL) injuries predominantly resulted from direct contact; 1 in 4 MCL injuries involved indirect contact. Three sprain-type mechanisms characterize MCL injuries: (1) blow to the knee, (2) lever like, and (3) sliding, occurring during 2 main playing situations: (1) pressing/tackling and (2) being tackled.

IMPLICATIONS: We provide a clearer picture of how MCL injuries happen and information to support diagnosis. Most MCL injuries involved direct contact and are likely not preventable. However, a quarter of injuries involved indirect-contact mechanisms and could theoretically be prevented with an improved ability to maintain neuromuscular control following mechanical perturbation, particularly to the upper body.

CAUTION: The methodology used to identify and analyze MCL injuries is different from the gold standard of prospective studies, which includes frequent contact with teams and model-based image-matching techniques. The number of indirect and noncontact injuries for full biomechanical analysis was small, and some measures had very low numbers.

STUDY DETAILS

AUTHOR CONTRIBUTIONS: Dr Della Villa conceived the idea of the study. Drs Della Villa and Buckthorpe designed the study. Davide Pisoni performed the player searches and obtained the videos. Dr Tosarelli and Davide Pisoni selected and edited the videos. Drs Buckthorpe, Della Villa, and Tosarelli performed the analysis of the videos. Dr Buckthorpe performed the data analysis. All authors contributed to the interpretation of the data. Dr Buckthorpe wrote the first version of the paper. All authors provided intellectual input to the revision of the manuscript and gave their approval of the final version. Drs Della Villa and Buckthorpe are accountable for the accuracy and integrity of the work.

DATA SHARING: Data are available from the corresponding author on request.

PATIENT AND PUBLIC INVOLVEMENT: No athletes, patients, or members of the public were involved in the design or conduct of the research.

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