Mechanisms of Injury as a Diagnostic Predictor of Sport Related Concussion Severity in Football, Basketball, and Soccer: Results from a Regional Concussion Registry

Scott L. Zuckerman MD; Doug Totten; Kolin Rubel; Andrew W Kuhn BS; Aaron M Yengo-Kahn MD; Gary Solomon PhD; Allen K. Sills MD

Vanderbilt Sports Concussion Center

Vanderbilt Sports Concussion Center

Introduction

Through a single-institution sport-related concussion (SRC) registry, we sought to: 1) provide a descriptive analysis of mechanisms of SRC in football, basketball, and soccer, and 2) determine if mechanism of injury was associated with symptom duration.

Learning Objectives

By the conclusion of this session, participants should be able to: 1) describe the 3 mechanistic ways sports concussions occur, 2) discuss the most common mechanisms seen in football, basketball, and soccer, 3) identify what mecahnisms affect duration of symptoms after sport-related concussion.

Figure 1. Flow-chart of final cohort.
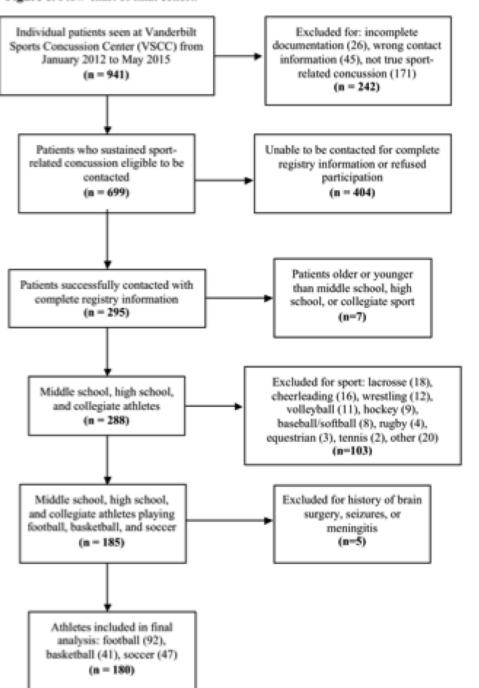
Methods

A retrospective cohort study was conducted through in-depth patient interviews. Complete data were collected for 295 patients. Mechanisms were stratified into 3 components: a contact mechanism, a player mechanism, and an awareness mechanism. For each sport, each mechanism was compared via one-way Chi-square analyses. Symptom duration data were represented with Kaplan Meier survival plots and Cox proportional hazards models to estimate the relationship between the exposure (concussion mechanism) to the time variable outcome (days of symptom duration).

Table 1. Demographics.

	Football	Basketball	Soccer	Total
Sport				
Age, mean (SD)	15.7 (2.0)	16.2 (2.0)	16.1 (2.1)	15.9 (2.0)
Male, n (%)	92 (100)	24 (59)	10 (21)	126 (70)
Caucasian, n (%)	78 (85)	29 (71)	44 (94)	151 (84)
BMI, mean (SD)	25.3 (4.6)	21.7 (3.6)	21.6 (2.9)	23.6 (4.4)
Prior Concussions, n (%)				
0	69 (75)	23 (56)	32 (68)	124 (69)
1	15 (16)	8 (20)	8 (17)	31 (17)
2	4 (4)	6 (14)	7 (15)	17 (9)
≥3	4 (4)	4 (10)	0 (0)	8 (5)
Comorbidities, n (%)				
ADD/LD	10 (11)	1 (2)	3 (6)	14 (8)
Migraine	14 (15)	8 (20)	10 (21)	32 (18)
Depression/anxiety	4 (4)	0 (0)	1 (2)	5 (3)
Psychiatric	1 (1)	1 (2)	0 (0)	2 (1)
Family history*	44 (48)	20 (49)	27 (57)	64 (36)
School, n (%)				
Middle school	17 (18)	6 (15)	8 (17)	31 (17)
High school	69 (75)	31 (75)	33 (70)	133 (74)
Collegiate	6 (7)	4 (10)	6 (13)	16 (9)
Occurred during practice	37 (40)	17 (42)	6 (13)	60 (33)
Symptom Duration (days)				
Median	23	21	21	21
IQR	11-76	11-61	11-42	11-61
Range	1-365	3-244	2-365	1-365
Did not reach asymptomatic status	3 (3)	0 (0)	1 (2)	4 (2)
Total, n (%)	92 (100)	42 (100)	47 (100)	180 (100)

Table 2. Mechanisms

		Football		Basketball		Soccer	
				Sport			
Contact Mechanism	Ground/equipment	15 (17)	Ground/equipment	16 (40)	Ground/equipment	10 (22)	
What player collides with during time of injury, n (%)	Head	67 (74)	Elbow	14 (35)	Head	9 (20)	
	Player non-head	8 (9)	Player non-elbow	10 (25)	Player non-head	15 (33)	
					Ball	11 (25)	
Analysis	χ²=69.267 df=2	p<0.0001*	χ²=1.399 df=2	p=0.4968	χ²=1.844 df=3	p=0.6053	
Player Mechanism	Offensive ball-carrying/catching	17 (21)	Offensive shooting/driving	9 (23)	Offensive ball-carrying	7 (16)	
Player action during time of injury, n (%)	Blocking	26 (32)	Rebounding	18 (45)	Challenging ball/loose-ball	20 (44)	
	Tackling	27 (33)	Defense/loose-ball	13 (33)	Header	18 (40)	
	Kick-off/Punt	12 (15)					
Analysis	χ²=7.659 df=3	p=0.0536	χ²=3.043 df=2	p=0.2184	χ²=6.533 df=2	p=0.0381*	
Awareness Mechanism	Aware	47 (51)	Aware	11 (27)	Aware	12 (25)	
Player aware or unaware of collision, n (%)	Unaware	45 (49)	Unaware	30 (73)	Unaware	35 (75)	
Analysis	χ²=0.043 df=1	p=0.8348	χ²=8.805 df=1	p=0.003*	χ²=11.255 df=1	p=0.0008*	

Results

The majority of athletes were male (70%) with an average age of 15.9 (±2.0) years. Football was the most represented sport (51%). The most common contact mechanisms were helmet-to-helmet contact in football (74%), ground/equipment in basketball (40%), and player to head in soccer (33%). Helmet-to-helmet contact was significantly overrepresented in football (p<0.0001). Within the player mechanism, tackling (33%) and blocking (32%) predominated in football, rebounding (45%) and defense/loose-ball (33%) were most common in basketball, and challenging a player (44%) along with the act of heading (40%) were most commonly reported in soccer. Within the awareness mechanism, basketball (p=0.003) and soccer (p=0.0008) players were more likely to be unaware of the oncoming collision. For soccer, being unaware of the oncoming collision was associated with a 2.54 (95% CI 1.14-5.69) times increased risk of not achieving asymptomatic status.

Figure 4A-C. Awareness mechanism Kaplan-Meier graphs.
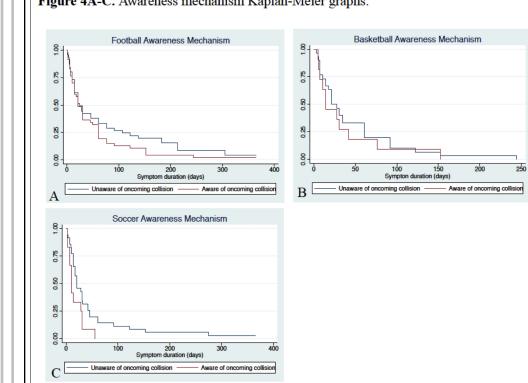
Conclusions

The current study analyzed mechanisms of SRC via a regional sports concussion outcomes registry. In middle school, high school, and collegiate athletes: (1) a helmet-to-helmet collision was most common football mechanism; (2) ground and surrounding equipment and player elbows predominated in basketball; (3) challenging a player and heading were the most common mechanisms of SRC in soccer; and (4) "awareness" of an oncoming collision in soccer was the only mechanism associated with a decreased the risk of prolonged symptom recovery.