[Primary Care]

Concussions Involving 7 or More Days Out in the National Football League

Ira R. Casson, MD,* David C. Viano, Dr med, PhD,^{†‡}
John W. Powell, PhD,[§] and Elliot J. Pellman, MD^{||}

Background: Positions, signs, symptoms, and medical management of National Football League players with concussions involving 7 or more days out (7+) from play were compared for two 6-year study periods (2002-2007 vs 1996-2001).

Hypothesis: More players were held out 7+ days in the 2002-2007 period without significant difference in concussion signs and symptoms.

Study Design: Cohort.

Methods: From 1996 through 2007, National Football League team physicians reported concussion signs and symptoms, medical action taken, and follow-up management.

Results: During the 2002-2007 period, 143 (16.7%) and 33 (3.86%) concussed players were out 7+ days and 21+ days, respectively, compared with 73 (8.2%) and 7 (0.79%) in the 1996-2001 period, a significant difference ($z = 5.39$, $P < .01$). The positions with the highest fraction of 7+ days out were the quarterback (24.5% vs 16.1%), linebacker (19.7% vs 4.6%), and wide receiver (19.5% vs 8.2%) in the later versus earlier period. The player positions with the highest odds for being out 7+ days were quarterback (odds ratio = 1.80 vs 4.02), linebacker (odds ratio = 1.28 vs 0.65), and wide receiver (odds ratio = 1.25 vs 1.15). The highest incidence of 7+ days out occurred after passing plays (32.2% vs 37.0%), followed by kick-offs (18.9% vs 21.9%). The majority of players with 7+ days out were removed from the game on the day of injury (74.8% vs 72.6%); a smaller fraction were returned to play on the day of injury in the later 6 years (3.5% vs 6.8%).

Conclusions: The positions with the highest odds for being out 7+ days with concussion were quarterbacks, linebackers, and wide receivers. In the more recent 6-year period, more players were managed conservatively by being held out 7+ days, even though the signs and symptoms of their concussions were similar to those in the earlier period.

Keywords: concussion; traumatic brain concussion; concussion surveillance; epidemiology; sport concussion; postconcussion syndrome; concussion guidelines

In an earlier article,¹² the clinical and epidemiologic characteristics were discussed for National Football League (NFL) players who did not return to play for 7 or more (7+) days following concussion during the 1996-2001 seasons. In the years since then, there has been heightened awareness of sports-related concussion among the general public, the sports world, and the medical community. An explosion in the numbers of medical and scientific articles and studies devoted to the topic has been accompanied by increased scrutiny of the lay media. Numerous educational symposia on issues surrounding treatment

of sports concussion have been conducted for the benefit of physicians, athletic trainers, athletes, and coaches. Advances in helmet design have improved the impact performance of football headgear in laboratory testing.¹⁴ A number of NFL rule changes have been aimed at lessening the risk of concussion.⁶ Neuropsychological testing has been mandated by the league, and computerized neuropsychological testing has replaced the pencil-and-paper method.^{8,9}

This study compares and contrasts the clinical and epidemiologic characteristics of NFL players who did not return

From the *Department of Neurology, Long Island Jewish Medical Center, New Hyde Park, New York, and Department of Neurology, Albert Einstein College of Medicine, Bronx, New York, [†]ProBiomechanics LLC, Bloomfield Hills, Michigan, [§]Departments of Kinesiology and Radiology, Michigan State University, East Lansing, Michigan, ^{||}ProHEALTH Care Associates, LLP, Lake Success, New York, and Departments of Medicine and Orthopaedics, Mount Sinai School of Medicine, New York, New York
*Address correspondence to David C. Viano, Dr med, PhD, ProBiomechanics LLC, 265 Warrington Road, Bloomfield Hills, MI 48304 (e-mail: dviano@comcast.net).

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to play for 7+ days after concussion during two 6-year periods: 2002-2007 and 1996-2001. The analysis may help delineate the effects of game rules, medical management, and equipment safety on the most severe concussions in the NFL. Finally, this study evaluates the epidemiology of concussion in the NFL during the more recent 6 years (2002-2007), complements other studies on NFL concussions,^{5,10} and compares the data with earlier experience in the NFL.^{10,12,13}

MATERIALS AND METHODS

At the NFL level, team physicians examined all players and made all management decisions. Using the same standardized form over the 2 study periods, team physicians also reported signs and symptoms on initial and follow-up examinations of players who sustained concussions.

Operational Definitions

A reportable concussion is a traumatically induced alteration in brain function that is manifested by

Alteration of awareness or consciousness—including, but not limited to, being dinged, dazed, stunned, woozy, foggy, amnesic, or (less common) being rendered unconscious, or (even more rare) experiencing seizure

Signs and symptoms commonly associated with postconcussion syndrome—including persistent headaches, vertigo, light-headedness, loss of balance, unsteadiness, syncope, near syncope, cognitive dysfunction, memory disturbance, hearing loss, tinnitus, blurred vision, diplopia, visual loss, personality change, drowsiness, lethargy, fatigue, and inability to perform usual daily activities.¹⁰

This definition is an extension of earlier ones.^{1,2,7}

Signs and Symptoms

The signs and symptoms of concussion were grouped into 6 categories: general symptoms, somatic complaints, cranial nerve findings, cognitive abnormalities, memory problems, and unconsciousness. A large and inclusive list was selected to capture all possible clinical signs and symptoms with mild traumatic brain injury (MTBI) in professional football players. The rationale for the various signs and symptoms has been described.¹⁰

Return to Play

The following definitions apply to the return to play. NFL team physicians clear a player for return to play after he is asymptomatic and has a normal neurologic examination.^{3,4,11}

Return immediately. The player returns after the team physician's evaluation demonstrates that he is asymptomatic and has a normal neurologic examination. Depending on the game, the period of rest may be minutes or possibly an hour or so before he gets back on the field.

Rest and return. The team physician evaluates the player and determines that he should have some protracted time before returning. Ultimately, the player is cleared to return to play on the day of the injury.

Removed from play. The player is not allowed to return to the game or practice session in which he was injured.

Hospitalized. The player is admitted to the hospital for evaluation, including brain imaging.

Days Out

The definition of *days out* is the time between the date of concussion and the date that the player is permitted to return to full and unlimited participation.¹¹ *Full and unlimited participation* means that the player must be able to perform all the activities of the session at the same intensity as his teammates.

Statistics

Descriptive statistics were used to characterize those players who were out < 7 days and those who were out 7+ days from play during the 6 years of surveillance. Chi-square and *t* tests were used to compare the signs and symptoms, medical action, management, and time loss to the team between the 2 groups of players (< 7 vs 7+). Combinations of, and the presence of, signs and symptoms that may predict 7+ days out were explored in multiple ways.

RESULTS

The cases involving 7+ days out were investigated and compared between two 6-year periods—specifically, the 2002-2007 and 1996-2001 seasons (Table 1). In the later period, 143 players were out 7+ days (16.7% ± 2.5%), compared with 73 in the earlier period (8.2% ± 1.8%), a significant difference ($z = 5.39$, $P < 0.01$). Thirty-three concussed players were out 21+ days (3.86%), compared with only 7 players in the earlier period (0.79%).

In the later study period, 14.1% of all concussions involved 7+ days out (Table 2). The positions with the highest percentages of 7+ days out were quarterback (24.5% vs 16.1%), linebacker (19.8% vs 4.6%), and wide receiver (19.5% vs 8.2%), compared with the earlier period. The player positions with the highest odds ratio for being out 7+ days were linebacker (1.28 vs 0.65), quarterback (1.80 vs 4.02), and wide receiver (1.25 vs 1.15).

The highest incidence of 7+ days out occurred after passing plays (32.2% vs 37.0%), followed by kickoffs (18.9% vs 21.9%), and was similar for the 2 study periods (Table 3). The highest frequencies of 7+ days out by all concussions in that activity occurred after a fumble (50%), interception (20%), and point after a touchdown (20%). There were essentially no players out 7+ days in these categories during the 1996-2001 period. The data demonstrate an increasing proportion of 7+ days out for all categories of play.

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Table 1. NFL players out 7+ days with single and repeat concussions: 1996-2001 vs 2002-2007.^a

	1996-2001 Concussions								2002-2007 Concussions							
Days Lost	Single	First	Second	Third	Fourth	Fifth-Seventh	Total	Single	First	Second	Third	Fourth	Fifth-Seventh	Total		
0	262	98	90	32	8	7	497	197	77	65	10	2	1	352		
1	50	18	14	1	2		85	55	8	12	9			84		
2	81	21	20	8	2	2	134	85	25	21	8	3	1	143		
3	34	8	11				53	33	12	12	2			59		
4	9	4	4	1			18	16	6	5	2	1		30		
5	5				1		6	15	4	3	2			24		
6	11	3	3	2	1	1	21	10	3	4	2			19		
<7	452	152	142	44	14	10	814	411	135	122	35	6	2	711		
7	8						8	12	3	4		1		20		
8	7	1	2				10	15		1				16		
9	8	6	10	3	1		28	12	6	5	1	1		25		
10	3		1				4	8	1	5	1			15		
11	2						2	7		3	1			11		
12				1			1			1				1		
13	1		2	2			5	1	1	1				3		
14							0	2						2		
15	1					1	2	3	1			1	1	6		
16	2						2	1	1	1		1		4		
17	1						1	2		1				3		

(continued)

Table 1. (continued)

Days Lost	1996-2001 Concussions							2002-2007 Concussions						
	Single	First	Second	Third	Fourth	Fifth-Seventh	Total	Single	First	Second	Third	Fourth	Fifth-Seventh	Total
18			2				2	2						2
19							0	1						1
20		1					1				1			1
21-28			1		1		2	5	3	1	1			10
29-56	2			2			4	4	1	4	1	1		11
61-207				1			1	5	1	4	2			12
7+	35	8	18	9	2	1	73	80	18	31	8	5	1	143
MTBI	487	160	160	53	16	11	887	491	153	153	43	11	3	854
7+, %	7.2	5.0	11.3	17.0	12.5	9.1	8.2	16.3	11.8	20.3	18.6	45.5	33.3	16.7

^aNFL, National Football League; 7+, 7 or more days; MTBI, mild traumatic brain injury.

Table 2. Incidence of concussions involving < 7 and 7+ days out by NFL player position: 1996-2001 and 2002-2007.^a

	1996-2001						2002-2007					
	Days Lost			OR	CI		Days Lost			OR	CI	
	< 7	7+	7+, %				< 7	7+	7+, %			
Offense												
Wide receiver	101	9	8.2	1.15	0.54-2.48		66	16	19.5	1.25	0.68-2.29	
Running back	77	1	1.3	0.38	0.16-0.92		81	12	12.9	0.73	0.41-1.31	
Quarterback	52	10	16.1	4.02	1.50-10.82		37	12	24.5	1.80	0.83-3.90	
Offensive line	72	4	5.3	0.72	0.29-1.77		56	10	15.2	0.88	0.45-1.73	
Tight end	44	2	4.3	0.63	0.20-1.97		54	9	14.3	0.83	0.41-1.64	
Subtotal	346	26	7.0	0.92	0.55-1.53		294	59	16.7	1.00	0.69-1.43	
Defense												
Secondary	143	14	8.9	1.33	0.69-2.57		132	28	17.5	1.07	0.67-1.69	
Defensive line	74	4	5.1	0.71	0.29-1.74		47	11	19.0	1.19	0.58-2.42	
Linebacker	62	3	4.6	0.65	0.25-1.71		73	18	19.8	1.28	0.71-2.28	
Subtotal	279	21	7.0	0.93	0.55-1.59		252	57	18.4	1.21	0.83-1.76	
Special team												
Kick unit	123	12	8.9	1.31	0.65-2.65		90	15	14.3	0.82	0.47-1.41	
Return unit	30	4	11.8	1.97	0.53-7.34		49	8	14.0	0.81	0.40-1.67	
Carrier	21	1	4.5	0.66	0.13-3.33		16	2	11.1	0.66	0.19-2.31	
Punter	7	1	12.5	2.16	0.15-31.50		4	0	0.0			
Kicker, kickoff	0	0					2	1	33.3	3.26	0.16-67.2	
Kicker, field goal attempt	1	0	0.0	0.00			3	1	25.0	1.81	0.13-25.12	
Kicker, point after touchdown	1	0	0.0	0.00			1	0	0.0			
Holder	1	0	0.0	0.00			0	0				
Undesignated	11	0	0.0	0.00			0	0				
Subtotal	195	18	8.5	1.24	0.69-2.24		165	27	14.1	0.77	0.49-1.21	
Unknown	2	0	0.0	0.00			0	0				
Total	822	65	7.3				711	143	16.7			

^aNFL, National Football League; 7+, 7 or more days.

Table 3. Team activity at the time of concussion and days out (< 7 vs 7+): 1996-2001 and 2002-2007.^a

	0	1	2	3	4	5	6	7+	Total	< 7, %	7+, %	7+, % (vs all)
1996-2001												
Passing	168	27	42	26	10	3	4	27	307	34.4	37.0	8.8
Interception	5	0	0	1	0	0	0	0	6	0.7	0.0	0.0
Run, inside	88	15	22	5	1	1	3	13	148	16.6	17.8	8.8
Run, outside	75	11	26	8	1	1	6	8	136	15.7	11.0	5.9
Fumble	3	0	0	0	0	0	0	0	3	0.4	0.0	0.0
Punt	40	9	15	6	1	0	1	5	77	8.8	6.8	6.5
Field goal	1	1	0	0	0	0	0	0	2	0.2	0.0	0.0
Point after touchdown	1	0	0	0	0	0	0	0	1	0.1	0.0	0.0
Kickoff	71	12	19	5	2	1	3	16	129	13.9	21.9	12.4
Other	28	5	5	2	3	0	2	1	46	5.5	1.4	2.2
Unknown	17	5	5	0	0	0	2	3	32	3.6	4.1	9.4
Total	497	85	134	53	18	6	21	73	887	100	100	8.2
2002-2007												
Passing	123	29	57	27	12	4	8	46	306	36.6	32.2	15.0
Interception	7	2	1	1	0	0	1	3	15	1.7	2.1	20.0
Run, inside	49	10	18	2	8	2	5	17	111	13.2	11.9	15.3
Run, outside	42	13	10	8	5	5	2	15	100	12.0	10.5	15.0
Fumble	0	0	1	0	0	1	0	2	4	0.3	1.4	50.0
Punt	25	9	8	3	0	0	1	8	54	6.5	5.6	14.8
Field goal	0	0	0	0	0	0	0	0	0	0.0	0.0	
Point after touchdown	2	1	0	0	0	1	0	1	5	0.6	0.7	20.0
Kickoff	67	9	32	11	1	8	1	27	156	18.1	18.9	17.3
Other	26	6	12	6	1	3	1	16	71	7.7	11.2	22.5
Unknown	12	4	4	1	3	0	0	8	32	3.4	5.6	25.0
Total	353	83	143	59	30	24	19	143	854	100	100	16.7

^a7+, 7 or more days.

The players experiencing 7+ days out had more signs and symptoms on initial evaluation compared with those whose MTBIs resulted in fewer days out (Table 4). For those who were out for 7+ days, the symptoms and signs with the highest incidence upon initial evaluation were headaches (69.9%), dizziness (45.5%), problems with information processing (42.7%), and problems with immediate recall (30.8%). The difference in the percentage of players out 7+ days with headaches, immediate recall difficulties, and information-processing problems was statistically significant ($P < .05$).

The data show that a higher fraction of players who were out for 7+ days had the following initial signs and symptoms in the later period: nausea, dizziness, blurred vision, and problems with information processing (Table 5).

The number of players who were out 7+ days and did not return to play on the day of injury (84.6% vs 86.4%) was similar between the 2 study periods (Table 6). The number of players who were out 7+ days and did return to play on the day of injury (3.5% vs 6.8%) was significantly lower in the later study period.

Headaches and cranial nerve problems—mostly dizziness—were the most common initial signs and symptoms of concussion (Table 7). These resolved during the first few days following injury in the majority of the players who ended up out 7+ days. Headaches were the symptom that lingered the longest, albeit in a small number of players. When cognitive and/or memory problems occurred in the initial examinations, they resolved quickly in most players who were out 7+ days.

DISCUSSION

The major difference in the data between the two 6-year periods is the significantly greater number of players who were out for 7+ and 21+ days in the period from 2002 through 2007. There are 3 possible explanations for this change, and they are not mutually exclusive: First, the severity of concussions may have increased during the second 6-year period; second, the changes in the neuropsychological testing program during the second 6-year period may have resulted in the detection of a greater number of abnormalities in clinically unrecognized cognitive and/or memory functions; and third, team physicians and athletic trainers, with the cooperation of the players and coaches, may have adopted a more conservative, cautious approach to the treatment of concussions during the second 6-year period.

Increased severity of concussions could be manifested in a number of ways. An increased incidence of the signs and symptoms of concussion—taken individually or in sum—is one possible indicator. Signs and symptoms can be evaluated at the initial examination and at follow-up until the concussed player is asymptomatic with normal neurologic function. The data presented in an earlier article⁵ indicated that only photophobia occurred at an increased incidence during the later 6-year period (Table 5). This increase does not explain the increase in the number of players who were out for 7+ days during that time. Despite the equivalent incidences of

all other signs and symptoms upon initial examination in the entire group of concussed players during the 2 study periods, significant differences were noted when the incidences of initial signs and symptoms were compared between players out < 7 days and players out 7+ days during the 2002-2007 period. All the general symptoms except syncope and seizures occurred more frequently in players out 7+ days ($P < 0.05$). Anxiety, fatigue, loss of appetite, photophobia, blurred vision, cognitive problems except orientation to person, and all memory problems also occurred more frequently in players out 7+ days ($P < 0.05$). Thus, a greater number of the initial clinical signs/symptoms of MTBI were associated with being held out for 7+ days during the 2002-2007 period than during the 1996-2001 period.

Evaluating the incidence of signs and symptoms at the various follow-up examinations can help determine if concussions were more severe, as manifested by the persistence of signs and symptoms in the days following concussion. Analysis of the incidence of signs and symptoms present at the third follow-up evaluation does not reveal any large increase during the second 6-year period to account for the significantly increased number of players who were out for 7+ days during that time (Table 7). The fourth follow-up examination occurred at a median time of 5 days following concussion, with 75% of fourth follow-ups occurring before day 7. The second study period (2002-2007) showed only a small increase in the presence of symptoms at the fourth examination. There were small nonstatistically significant increases in headache, cranial nerve symptoms, somatic signs/symptoms, and cognition/memory (Table 7). The data on memory and cognitive function are based on clinical history and examination performed by the team physicians and/or consulting physicians and not on the results of formal neuropsychological testing. Again, these small changes do not likely explain the large increase in players out for more than 7 days in the second study period.

Similarities Between the 2002-2007 Cohort and the 1996-2001 Cohort

The groups out 7+ days during the two 6-year periods are similar in many ways. During both periods, quarterbacks, linebackers, and wide receivers had a higher incidence of being held out for 7+ days when compared with other players. These position players are often involved in high-speed collisions, and they may sustain more-severe MTBIs than those of other players. These position players continued to have a higher chance of being held out for 7+ days during the more recent period despite the fact that the overall incidence of reported MTBI in these players actually decreased during 2002-2007.⁵

During both 6-year periods, the chances of a player being held out for 7+ days after MTBI were highest for passing plays, followed by running plays and kickoff plays. Kickoff plays are often associated with high-speed head collisions; because kickoffs occur much less often per game than do passing plays,

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Table 4. Initial signs and symptoms of concussion by days out: 2002-2007.^{1, a}

	Days Out													
	0	1	2	3	4	5	6	7+	Total	< 7, %	7+, %	7+, % (vs all)		
2002-2007														
Total ^b	353	83	143	59	30	24	19	143	854	711	143	16.7		
General symptoms	196	51	100	40	21	17	14	114	553	61.7	79.7	20.6		
Headaches	167	48	93	34	20	13	13	100	488	54.6	69.9	20.5		
Nausea	17	11	13	6	3	2	4	25	81	7.9	17.5	30.9		
Vomiting	1	1	1	0	0	0	1	4	8	0.6	2.8	50.0		
Neck pain	37	6	19	10	1	6	3	24	106	11.5	16.8	22.6		
Back pain	2	0	0	0	0	0	0	3	5	0.3	2.1	60.0		
Syncope	12	1	1	2	1	1	0	6	24	2.5	4.2	25.0		
Seizures	0	0	0	0	0	0	0	2	2	0.0	1.4	100.0		
Somatic complaints	35	15	34	21	15	10	6	59	195	19.1	41.3	30.3		
Irritability	7	4	9	4	2	1	2	9	38	4.1	6.3	23.7		
Anxiety	2	3	2	7	2	2	2	11	31	2.8	7.7	35.5		
Depression	2	0	1	1	2	0	1	1	8	1.0	0.7	12.5		
Personality change	6	6	10	6	1	5	4	14	52	5.3	9.8	26.9		
Fatigue	21	5	14	6	9	7	4	34	100	9.3	23.8	34.0		
Sleep disturbance	1	0	1	3	0	1	0	1	7	0.8	0.7	14.3		
Loss of libido	0	0	0	0	0	0	0	0	0	0.0	0.0			
Loss of appetite	0	1	0	0	0	0	0	4	5	0.1	2.8	80.0		
Cranial nerve symptoms	192	47	78	33	13	12	14	86	475	54.7	60.1	18.1		
Dizziness	130	31	61	31	7	7	9	65	341	38.8	45.5	19.1		
Vertigo	13	3	8	4	1	0	1	8	38	4.2	5.6	21.1		
Tinnitus	7	0	1	2	0	1	1	6	18	1.7	4.2	33.3		

(continued)

Table 4. (continued)

	Days Out												
	0	1	2	3	4	5	6	7+	Total	< 7, %	7+, %	7+, % (vs all)	
2002-2007	5	2	2	1	0	0	1	4	15	1.5	2.8	26.7	
Nystagmus													
Hearing loss	0	1	0	0	0	0	0	1	2	0.1	0.7	50.0	
Diplopia	13	1	5	0	0	0	1	4	24	2.8	2.8	16.7	
Photophobia	14	4	8	2	4	5	5	21	63	5.9	14.7	33.3	
Blurred vision	52	18	22	7	6	3	4	34	146	15.8	23.8	23.3	
Pupil response	0	0	0	0	0	0	0	1	1	0.0	0.7	100.0	
Pupil size	0	0	0	0	0	0	0	2	2	0.0	1.4	100.0	
Cognitive problems	29	15	33	22	9	7	6	49	170	17.0	34.3	28.8	
Not oriented to person	2	2	4	3	0	1	0	5	17	1.7	3.5	29.4	
Not oriented to place	2	4	4	2	0	1	0	12	25	1.8	8.4	48.0	
Not oriented to time	1	8	9	6	2	3	1	20	50	4.2	14.0	40.0	
Immediate recall	27	14	28	19	9	6	6	44	153	15.3	30.8	28.8	
Memory problems	71	27	51	30	18	12	7	89	305	30.4	62.2	29.2	
Attention problems	23	6	23	11	8	0	5	39	115	10.7	27.3	33.9	
Information-processing problems	35	14	30	19	9	4	5	61	177	16.3	42.7	34.5	
Anterograde amnesia delayed	11	6	11	9	5	4	2	30	78	6.8	21.0	38.5	
Retrograde amnesia delayed	23	15	21	15	3	7	2	39	125	12.1	27.3	31.2	
Unconscious > 1 min	10	1	7	4	0	1	1	7	31	3.4	4.9	22.6	
All loss of consciousness	12	1	12	5	0	1	2	23	56	4.6	16.1	41.1	

^a7+, 7 or more days.^bSymptom category totals are the number of players with any of the subtypes of signs and symptoms within the category.

Table 5. Initial signs and symptoms with concussion for NFL players out 7+ days: 1996-2001 and 2002-2007.^a

	1996-2001					2002-2007				
	7+	MTBI	< 7, %	7+, %	7+, % (vs all)	7+	MTBI	< 7, %	7+, %	7+, % (vs all)
Total ^b	73	887	814	73	8.1	143	854	711	143	16.7
General symptoms	55	571	63.3	75.3	9.6	114	553	61.7	79.7	20.6
Headaches	51	508	56.1	69.9	10.0	100	488	54.6	69.9	20.5
Nausea	6	78	8.8	8.2	7.7	25	81	7.9	17.5	30.9
Vomiting	0	15	1.8	0.0	0.0	4	8	0.6	2.8	50.0
Neck pain	14	115	12.4	19.2	12.2	24	106	11.5	16.8	22.6
Back pain	0	3	0.4	0.0	0.0	3	5	0.3	2.1	60.0
Syncope	1	14	1.6	1.4	7.1	6	24	2.5	4.2	25.0
Seizures	0	1	0.1	0.0	0.0	2	2	0.0	1.4	100.0
Somatic complaints	29	178	18.3	40.3	16.3	59	195	19.1	41.3	30.3
Irritability	1	26	3.1	1.4	3.8	9	38	4.1	6.3	23.7
Anxiety	7	47	4.9	9.6	14.9	11	31	2.8	7.7	35.5
Depression	1	3	0.2	1.4	33.3	1	8	1.0	0.7	12.5
Personality change	7	45	4.7	9.6	15.6	14	52	5.3	9.8	26.9
Fatigue	20	81	7.5	27.4	24.7	34	100	9.3	23.8	34.0
Sleep disturbance	3	6	0.4	4.1	50.0	1	7	0.8	0.7	14.3
Loss of libido	0	0	0.0	0.0	0.0	0	0	0.0	0.0	
Loss of appetite	0	2	0.2	0.0	0.0	4	5	0.1	2.8	80.0
Cranial nerve symptoms	50	474	52.0	69.4	10.5	86	475	54.7	60.1	18.1
Dizziness	38	374	41.3	52.1	10.2	65	341	38.8	45.5	19.1
Vertigo	5	33	3.4	6.8	15.2	8	38	4.2	5.6	21.1
Tinnitus	4	23	2.3	5.5	17.4	6	18	1.7	4.2	33.3

(continued)

Table 5. (continued)

	1996-2001						2002-2007				
	7+	MTBI	< 7, %	7+, %	7+, % (vs all)	7+	MTBI	< 7, %	7+, %	7+, % (vs all)	
Nystagmus	1	9	1.0	1.4	11.1	4	15	1.5	2.8	26.7	
Hearing loss	0	0	0.0	0.0	0.0	1	2	0.1	0.7	50.0	
Diplopia	2	17	1.8	2.7	11.8	4	24	2.8	2.8	16.7	
Photophobia	9	36	3.3	12.3	25.0	21	63	5.9	14.7	33.3	
Blurred vision	16	142	15.5	21.9	11.3	34	146	15.8	23.8	23.3	
Pupil response	0	6	0.7	0.0	0.0	1	1	0.0	0.7	100.0	
Pupil size	0	1	0.1	0.0	0.0	2	2	0.0	1.4	100.0	
Cognitive problems	36	237	24.7	50.0	15.2	49	170	17.0	34.3	28.8	
Not oriented to person	6	24	2.2	8.2	25.0	5	17	1.7	3.5	29.4	
Not oriented to place	10	45	4.3	13.7	22.2	12	25	1.8	8.4	48.0	
Not oriented to time	22	69	5.8	30.1	31.9	20	50	4.2	14.0	40.0	
Immediate recall	33	217	22.6	45.2	15.2	44	153	15.3	30.8	28.8	
Memory problems	44	144	35.8	61.1	13.1	89	305	30.4	62.2	29.2	
Attention problems	18	117	12.2	24.7	15.4	39	115	10.7	27.3	33.9	
Information-processing problems	19	148	15.8	26.0	12.8	61	177	16.3	42.7	34.5	
Anterograde amnesia delayed	12	80	8.4	16.4	15.0	30	78	6.8	21.0	38.5	
Retrograde amnesia delayed	31	153	15.0	42.5	20.3	39	125	12.1	27.3	31.2	
Unconscious > 1 min	7	14	0.9	9.6	50.0	7	31	3.4	4.9	22.6	
All loss of consciousness	19	59	4.9	26.0	32.2	23	56	4.6	16.1	41.1	
Mean signs/symptoms	4.62	2.75				4.43	2.75				
Total ^c	337	2438				634	2345				

^aNFL, National Football League; 7+, 7 or more days; MTBI, mild traumatic brain injury.

^bTotals are less than the sums of their subcategories, owing to players with multiple symptoms.

^cTotals of all individual signs and symptoms.

Table 6. Action taken with NFL players experiencing concussions by days out: 1996-2001 and 2002-2007.^a

	Days Out											
	0	1	2	3	4	5	6	7+	Total	< 7, %	7+, %	7+, % (vs all)
1996-2001												
Return immediately	111	5	8	3	2	0	1	5	135	16.0	6.8	3.7
Rest and return	242	19	28	9	1	1	0	5	305	36.9	6.8	1.6
Removed from play	136	55	94	37	14	4	18	53	411	44.0	72.6	12.9
Hospitalized	1	1	2	3	1	1	2	9	20	1.4	12.3	45.0
Unknown	7	5	2	1	0	0	0	1	16	1.8	1.4	6.3
Total	497	85	134	53	18	6	21	73	887	100	100	8.2
2002-2007												
Return immediately	35	7	9	4	1	2	2	5	65	8.4	3.5	7.7
Rest and return	223	18	30	10	5	4	2	17	309	41.1	11.9	5.5
Removed from play	95	57	101	42	24	15	13	107	454	48.8	74.8	23.6
Hospitalized	0	1	3	3	0	3	2	14	26	1.7	9.8	53.8
Unknown	0	0	0	0	0	0	0	0	0	0.0	0.0	
Total	353	83	143	59	30	24	19	143	854	100	100	16.7

^aNFL, National Football League; 7+, 7 or more days.

Table 7. Signs and symptoms in the initial and follow-up examinations for players out 7+ days: 1996-2001 and 2002-2007.

Signs and Symptoms	Initial Exam	Follow-up Examinations									
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
1996-2001											
Headache											
Normal	16	18	21	17	16	10	12	6	3	2	0
Present	49	47	20	14	8	7	2	2	0	0	0
Cranial nerve											
Normal	19	41	34	25	17	14	12	8	3	2	0
Present	46	25	7	6	7	3	2	0	0	0	0
Somatic complaints											
Normal	38	39	29	24	21	13	12	8	3	2	0
Present	27	26	12	7	3	4	2	0	0	0	0
Cognition problems											
Normal	31	59	38	31	24	17	14	8	3	2	0
Present	34	6	3	0	0	0	0	0	0	0	0
Memory problems											
Normal	24	41	32	29	24	17	14	8	3	2	0
Present	41	24	9	2	0	0	0	0	0	0	0

(continued)

Table 7. (continued)

Signs and Symptoms	Initial Exam	Follow-up Examinations									
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
2002-2007											
Headache											
Normal	21	51	30	36	27	16	14	5	2	3	3
Present	102	72	45	23	13	11	5	4	5	1	0
Cranial nerve											
Normal	47	87	52	48	32	22	17	8	7	4	3
Present	76	36	23	11	8	5	2	1	0	0	0
Somatic complaints											
Normal	70	76	52	48	34	20	18	8	7	4	3
Present	53	47	23	11	6	7	1	1	0	0	0
Cognition problems											
Normal	80	114	70	59	39	27	19	9	7	4	3
Present	43	9	5	0	1	0	0	0	0	0	0
Memory problems											
Normal	45	91	57	50	38	22	16	8	7	4	3
Present	78	32	18	9	2	5	3	1	0	0	0

^a7+, 7 or more days.

the actual risk of sustaining an MTBI that results in being held out for 7+ days may be higher per play for kickoffs than for other types of plays.

The percentages of players who were not allowed to return to play on the day of concussion and who ended up out 7+ days were similar between the two 6-year periods. The small percentages of players who were allowed to return to play on the day of the concussion and who ended up out 7+ days were also similar during the two 6-year periods.

Repeat Concussions and Players Out 7+ Days

Players with repeat concussions were more likely to be held out for 7+ days than were those who were experiencing a first concussion during 2002-2007, as they had been during 1996-2001 (Table 1). During the 2002-2007 seasons, players held out for 7+ days had on average 4.43 initial signs and symptoms of MTBI compared to the average for all players of 2.75. This was essentially similar to the 1996-2001 seasons, where players held out 7+ days had an average of 4.62 initial signs and symptoms of MTBI compared to the average for all players of 2.75 (Table 5). Players who experienced loss of consciousness at the time of concussion were more likely to be held out for 7+ days during 2002-2007, as they had been during 1996-2001 (Table 5). The consistency of these relationships over the entire 12-year period suggests that these clinical factors are prognostic indicators for being held out for 7+ days. Players who were hospitalized or removed from play on the day of concussion were also more likely to be held out from play for 7+ days during 2002-2007, as they had been during 1996-2001 (Table 6). During 2002-2007, only 22 of 374 players who initially returned to play on the day of concussion ultimately ended up being held out for 7+ days (Table 6).

CONCLUSION

The purpose of this study was to compare and contrast the clinical picture of the cohort of NFL players who did not return to play for 7+ days during 2 consecutive 6-year periods: 1996-2001 and 2002-2007. Such comparisons can help shed light on issues surrounding the epidemiology, natural history, and treatment of NFL players whose concussions are at the more severe end of the spectrum of MTBIs in professional football.

During 2002-2007, a great deal of attention was focused on the subject of MTBI in sports. Numerous scientific and medical publications and lay press articles have concentrated on MTBI in NFL athletes. Additionally, neuropsychological

testing of players at baseline and following concussion became more widespread and in fact became mandatory before the 2007 season. During these years, the predominant mode of neuropsychological testing switched from pencil-and-paper administration to a computerized format. It is possible that, as a result of these changes, neuropsychological testing detected an increased number of players with abnormalities in cognition/memory functions in 2002-2007 than in 1996-2001.

There were no significant differences in the initial and follow-up examination findings between the 2 study periods. However, significantly more players were held out 7+ days in the second study period. These findings suggest that a more cautious and conservative approach to the treatment of concussions has increased the number of players held out for 7+ days during the 2002-2007 seasons.

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