

Acute hemispheric swelling associated with thin subdural hematomas: pathophysiology of repetitive head injury in sports

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Summary

Introduction. The most common head injury in sports is concussion, and repeated concussions occurring within a short period occasionally can be fatal. Acute subdural hematoma is the most common severe head injury and can be associated with severe neurologic disability and death in sports. We investigated severe brain damage resulting from repetitive head injury in sports, and evaluated the pathophysiology of sports-related repetitive injury.

Methods. We reviewed the literature containing detailed descriptions of repetitive severe sports-related head injury. In total, 18 cases were analyzed with regard to age, gender, type of sports, symptoms before second injury, and pathology of brain CT scans.

Results. The majority of cases involved young males aged 16 to 23 years old, who sustained a second head injury before symptoms from the first head injury had resolved. Ten of 15 cases did not suffer loss of consciousness at insult. Eight cases were confirmed on brain CT scans after the second injury, and all 8 cases revealed brain swelling associated with a thin subdural hematoma.

Conclusions. Second impact syndrome is thought to occur because of loss of autoregulation of cerebral blood flow, leading to vascular engorgement, increased intracranial pressure, and eventual herniation. Our investigation suggests that the existence of subdural hematoma is a major cause of brain swelling following sports-related, repetitive head injury.

Keywords: Hemispheric swelling; thin subdural hematoma; repetitive head injury; sports.

Introduction

The most common head injury in sports is concussion. Furthermore, repeated concussions occurring within a short period occasionally lead to a fatal outcome. Once athletes have suffered a concussion, they may be 4 to 6 times more likely to suffer a second head injury than someone who has never had one [7].

Subdural hematoma is the most common cause of death or severe disability in the sports-related head injury patient [11]. It has been reported that subdural hematoma can result from repeated minor head trauma

[17]. In this study, we focused on the acute phase of repetitive injuries in an attempt to clarify the pathophysiology of repetitive severe sports-related head injury.

Materials and methods

We reviewed the published papers on repetitive severe sports-related head injury [1, 2, 5, 6, 10, 11, 14, 16]. In total, 18 cases, including our own 4 cases, were analyzed with regard to age, gender, type of sport, symptoms before receiving second injury, and computed tomography (CT) findings, if available.

Results

All 18 cases were male adolescents or young adults and they returned to play before the symptoms from their first injury had resolved. At the initial insult, 10 of 15 cases did not lose consciousness. After the second injury, we could confirm CT findings in 8 cases, and all 8 cases revealed subdural hematoma (Table 1).

Case reports

The first case was a 22-year-old man, who was an American college football player with an unremarkable medical history. He received a strong tackle in the first game. He did not lose consciousness but suffered partial amnesia during the game. The player stated that he was suffering from a headache and nausea, but continued to participate in the game. At 14 days after the first game, his headache still persisted.

In the second game, the player received a hard helmet-to-helmet hit that knocked him to the ground. He came off the field of play complaining of headache

Table 1. Summary of repetitive severe sports-related head injury cases (cases with CT scan imaging available after second injury)

Ref.	Age/sex	Sport	1st injury	Ongoing symptoms	Delay to 2nd injury	2nd injury	Pathology	GOS
16	19/M	AF	LOC-	headache	4 days	deep coma	ASDH	D
9	17/M	AF	LOC-	headache	7 days	deep coma	ASDH	D
11	18/M	AF	LOC-	headache	2 hours	headache nausea	ASDH	GR
5	22/M	Boxing	LOC-	headache vertigo	2 months	headache vomiting	ASDH	GR
*	22/M	AF	LOC-	headache	2 weeks	collapsed	ASDH	GR
*	23/M	Boxing	LOC-	headache	2 weeks	collapsed	ASDH	GR
*	20/M	Karate	LOC+	headache	4 days	headache	ASDH	GR
*	22/M	Skiing	LOC+	headache	2 days	headache	ASDH	GR

* = Our cases.

AF American Football, ASDH acute subdural hematoma, D dead, GOS Glasgow Outcome Scale, GR Good Recovery, LOC+ with loss of consciousness, LOC- without loss of consciousness, Ref references.

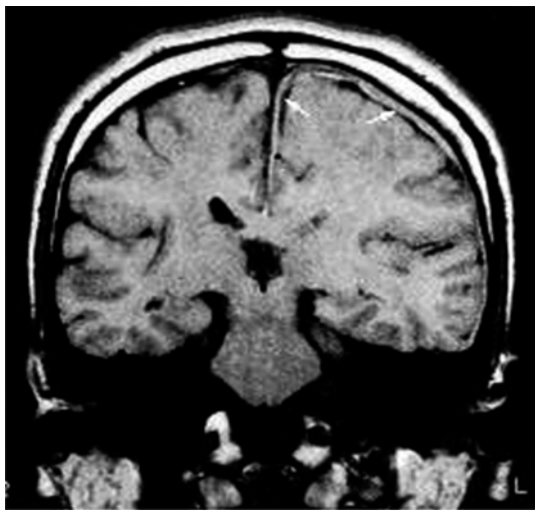


Fig. 1. MRI coronal section showing a subdural hematoma over the cerebral convexity and interhemispheric (arrows)

and vomiting, and then collapsed. He recovered consciousness immediately, and he was oriented to time, person, and place. The patient was then examined at an emergency department. Coronal magnetic resonance imaging revealed a subdural hematoma over the cerebral convexity and interhemispheric (Fig. 1).

The second case was a 20-year-old man, a beginner at karate. After his first competition, he suffered headache and dizziness, but did not undergo a medical examination. After an interval of 4 days, he attempted to participate in practice. He received a blow to the head and developed severe headache and vomiting. His initial CT scan revealed extensive cerebral swelling of the right hemisphere compared to the contralateral side, and a thin rim of subdural hematoma in the right temporal convexity (Fig. 2).

Discussion

Repetitive head injury in sports

Concussions are among the mildest forms of sports-related head injury. Such sports-related head injuries are very different from the typical severe traumatic brain injuries such as those sustained in traffic accidents and falls. Because sports-related brain injury tends to be repetitive, prevention is feasible. A player who has received a minor head injury is 4 to 6 times as likely to sustain a subsequent head injury [7]. Repetitive concussive injury induces acute and chronic damage to the brain. Repeated concussions that occur within a short period can occasionally lead to a fatal outcome.

Second impact syndrome

Second impact syndrome is a widely feared complication of sports-related traumatic brain injury, and is characterized by rapid cerebral edema following a second impact prior to recovery from the first. Loss of consciousness is not always present, but mortality and morbidity are extremely high. Seventeen cases were reported in the 3 years from 1992 to 1995 [1].

The pathophysiology of second impact syndrome is thought to involve a loss of autoregulation in the brain's blood supply. This leads to vascular engorgement within the cranium which can, in turn, markedly increase intracranial pressure and eventually result in herniation [2]. McCrory reviewed and analyzed the published cases of second impact syndrome, but described the term "second impact syndrome" as misleading because the etiology and pathology are not entirely clear [12, 13].

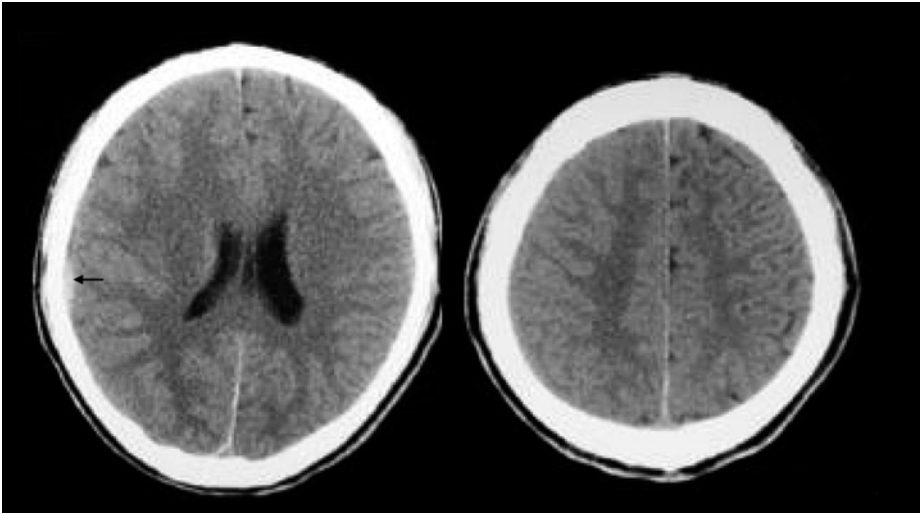


Fig. 2. CT scan showing a thin rim of acute subdural hematoma (arrow) associated with hemispheric swelling

Based on previous case reports [5, 11] and our cases, it is conceivable that the pathology of repetitive severe brain injury could be as follows. At the initial impact, the insult spreads to the bridging veins, and these veins become stretched and occasionally torn. The surface of the cortex then adheres to the dura matter. At the next impact, a thin rim of subdural hematoma compresses the bridging veins. The brain becomes swollen due to venous congestion, and fatal hemorrhage occasionally occurs. Therefore, concussion injury patients should receive close medical attention.

Management of concussion in sports

In general, a concussion can be defined as a head injury involving a traumatic alteration in mental status, commonly followed by confusion and amnesia [9]. It has been suggested that most sports-related concussions do not result in a loss of consciousness [3, 4]. Players often decide to return to play after a head injury without seeking medical attention. Kawamata *et al.* [8] have indicated that a decrease in incidence of concussion leads to a decrease in fatal injury. Both players and coaches need to understand the risks of multiple head injuries and how to apply return-to-play guidelines in their decision-making. For prevention of further injury, systems have been developed to determine when an athlete who has suffered a concussion can safely return to competition. Various grading schemas and guidelines exist [1, 10, 15, 18], and appropriate education and training for players and coaches

concerning the care of head injuries are needed in order to prevent potentially catastrophic events.

Conclusion

The existence of subdural hematoma is one of the major causes of brain swelling following repetitive sports-related head injury. Further studies are needed to clarify the detailed pathophysiology of repetitive severe head injury.

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