



Management of Second Impact Syndrome in the Acute Care and Inpatient Rehabilitation Settings

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Introduction

- Approximately 1.6 to 3.8 million sports-related concussions occur annually
- Symptoms from this mild traumatic brain injury (TBI) usually resolve within a few weeks
- In serious cases, sports-related structural brain injury (SRSBI), defined as a moderate to severe TBI, may occur
- Second impact syndrome (SIS) is a rare and poorly understood category of SRSBI
- SIS is characterized by diffuse cerebral edema following a second head injury before symptoms from an initial concussion resolve
- SIS is associated with increased morbidity and mortality with survivors often developing significant disability and requiring extensive rehabilitation

Pathophysiology

- Following head trauma, a flux of neurotransmitter release, catecholamine surge, and blood brain barrier dysregulation occurs
- The brain's auto-regulatory mechanisms compensate for these metabolic derangements, but place the brain in a vulnerable state for further injury
- A second, often less intense insult can progress to cerebral edema, brain herniation, and death within minutes

Case Description

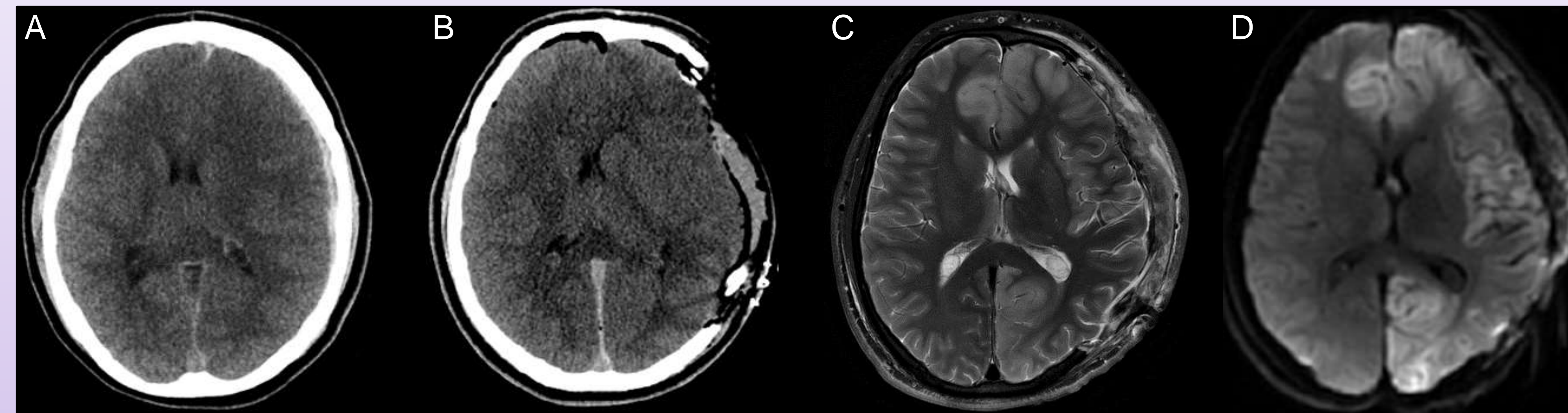
Initial Injury

- A 17-year-old athlete, cleared to resume game play after sustaining an initial head injury weeks prior, experienced a second head collision
- He developed headaches, balance impairment, loss of consciousness and seizure activity

Acute Care Management

- Computed tomography of the head (CTH) revealed a left (L) subdural hematoma (SDH) with 10mm midline shift (MLS) and he underwent a left decompressive hemicraniectomy (DHC)
- Physiatry evaluated the patient on postoperative day (POD) 10 and his exam was consistent with a minimally conscious state
- There was concern for paroxysmal sympathetic hyperactivity (PSH) and he was started on propranolol, clonidine, gabapentin, & bromocriptine

Figure 1: Pre- and early post-operative imaging following second brain injury in a 17-year-old athlete



- A) Initial post-injury non-contrast CTH demonstrating a left SDH with 10mm of left-to-right MLS
 B) Immediate post-operative non-contrast CTH showing left DHC, SDH evacuation, and reduction of MLS to 6mm
 C) POD 4 non-contrast magnetic resonance imaging (MRI, T2 sequence) showing stable post-operative findings, protrusion of brain parenchyma through craniectomy defect, and extensive confluent hyperintensities involving large portions of the left anterior cerebral artery (ACA), middle cerebral artery, and posterior cerebral artery territories in addition to right ACA territory
 D) POD 4 diffusion weighted imaging (DWI) MRI sequence again demonstrates hyperintensities in the same vascular distributions as (C) suggestive of multifocal acute infarcts related to mass effect from the initial injury

Case Description

Pre-Cranioplasty Inpatient Rehabilitation Course

- Bromocriptine was gradually discontinued on POD 28 given concern for overstimulation correlating with periodic spikes noted on his Agitation Behavior Scale (ABS) scores (Figure 2)
- Atomoxetine was started given hyperactive response to dopaminergic stimulation with improvement in attention & command following
- PSH improved and propranolol and clonidine were discontinued
- Dantrolene was titrated for spasticity
- He was fitted for a custom hinged ankle-foot-orthosis for his right foot drop
- The patient was discharged for elective cranioplasty on POD 56

Post-Cranioplasty Inpatient Rehabilitation Course

- Gabapentin was discontinued given improvement in behavior and impulsivity
- Atomoxetine was increased
- Continuity Assessment Record and Evaluation (CARE) set score improved by 65 points from initial admission to final discharge (Table 1)

POD	Event	CARE Self Care	CARE Mobility	CARE Total
18	Initial IPR admission	7	6	13
51	Planned discharge for cranioplasty	20	32	52
58	IPR readmission	20	29	49
86	Discharge home	25	53	78

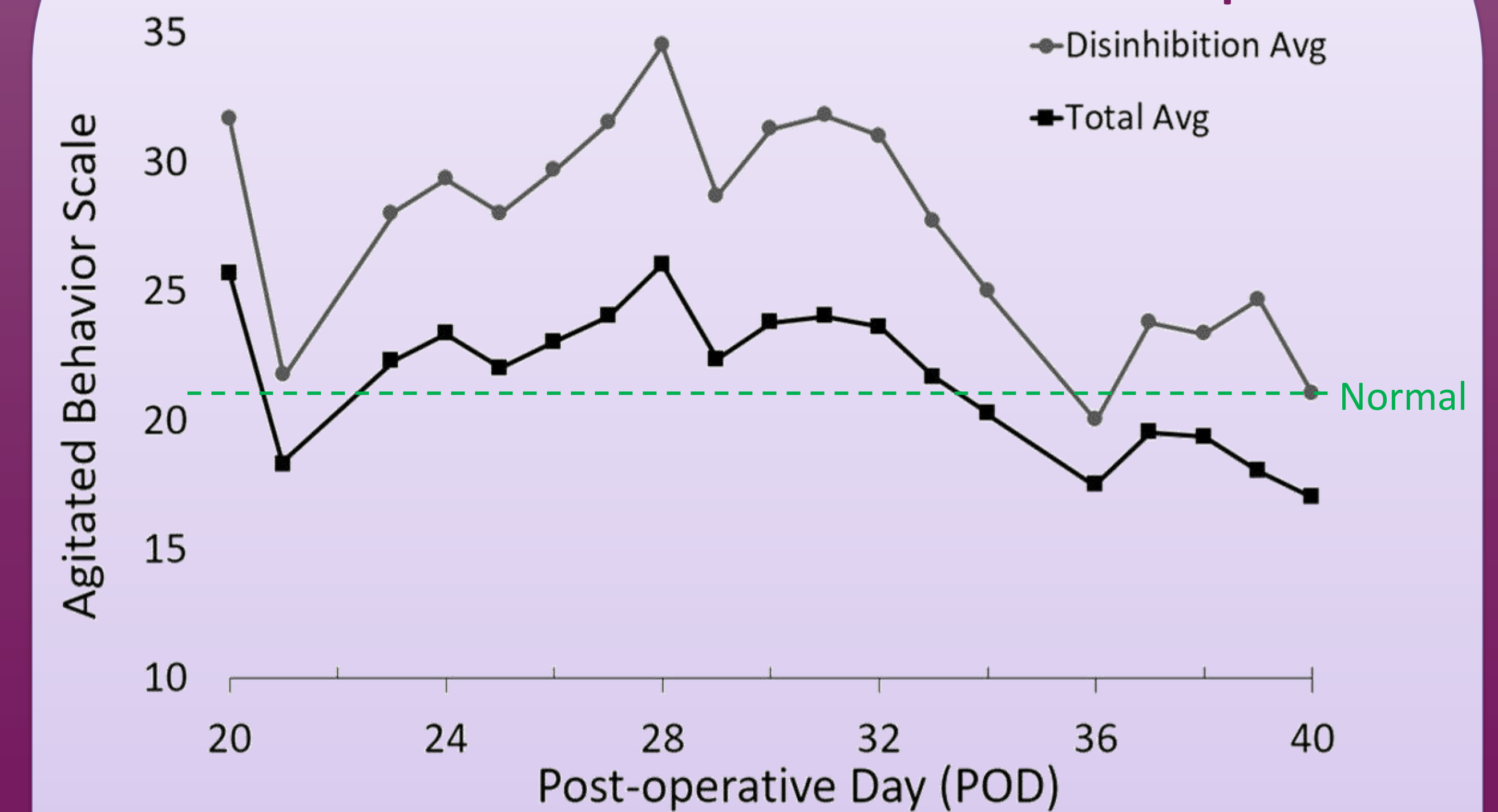
Table 1: Continuity Assessment and Record Evaluation (CARE) score progression during the patient's recovery course.

CARE is a National Quality Forum (NQF)-endorsed reporting tool for documenting patient functional trajectories in the post-acute care setting. Patients are scored on a 1-6 scale in 8 self care and 16 mobility categories for a total maximum CARE score of 144.

On initial admission, the patient required maximum to total assist & was dependent in all self-care and mobility tasks.

On final discharge, he completed self-care and mobility tasks with significantly less assistance (supervision to moderate assist levels).

Figure 2: Agitated Behavior Scale & Disinhibition subscale measures with titration of Bromocriptine



The Agitation Behavior Scale (ABS) is a 14-item tool that measures behavioral aspects of agitation during the acute phase of recovery following acquired brain injury. Each item is scored from 1-4 with a maximum total ABS score of 56. In addition to a total score, subscale scores for disinhibition, aggression and lability can be calculated.

On POD 20 and 24, the patient's dose of bromocriptine was increased to improve cognitive domains. He made functional gains, but there was concern for overstimulation, as supported by increased ABS scores, specifically in disinhibition. Bromocriptine was decreased on POD 28 and discontinued on POD 32 with a gradual decline in ABS and disinhibition subscale scores.

Discussion

- Athlete safety has improved with updates in protective equipment and return to play guidelines
- Still, athletes may be cleared to resume gameplay prematurely with devastating consequences such as second impact syndrome
- Acute neurosurgical and critical care interventions are crucial to reduce mortality
- As demonstrated here, significant functional recovery is possible under the close monitoring and management of a physiatrist specializing in brain injury medicine with a multidisciplinary rehabilitation team

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