

## Frequency of Post-Concussion Syndrome in Korean Patients with Minor Head Injury

Ji Young Lee, M.D.<sup>1</sup>, Young Hoon Yoon, M.D.<sup>1</sup>, Roger J. Lewis<sup>2,3,4</sup>, Juliana Tolles<sup>2,3,4</sup>

<sup>1</sup>Department of Emergency Medicine, Korea University, Guro Hospital, Seoul, Korea

<sup>2</sup>Department of Emergency Medicine, Harbor-UCLA Medical Center, Torrance, California

<sup>3</sup>Los Angeles Biomedical Research Institute, Torrance, California

<sup>4</sup>David Geffen School of Medicine, University of California, Los Angeles

**Purpose:** To determine the incidence of post-concussion syndrome (PCS) in Korean patients after minor traumatic brain injury.

**Methods:** We conducted an observational cohort study of a convenience sample of patients presenting to the emergency department of a major academic Korean hospital. Patients who visited the Emergency Department for head trauma were screened. A researcher questioned the subject regarding his or her symptoms. Subjects were contacted by phone approximately 2 weeks after their Emergency Department visit and questioned about subsequent symptoms and subsequent visits for medical care.

**Results:** Only 8% of subjects reported any post-concussion symptoms. Only 0.4% had three or more symptoms which might have met criteria for PCS. The median peak onset of symptoms was 3 days after injury.

**Conclusion:** The incidence of PCS in Korean patients is much lower than that documented for patients in the United States or other western countries. On the other hand, this study results could give an idea that mild trauma could also cause the PCS. Further study is needed to replicate this finding and investigate possible explanations for this difference. [ J Trauma Inj 2017; 30: 41-46 ]

**Key Words:** Brain injuries, Traumatic, Post-concussion syndrome

### I. Introduction

The phenomenon of persistent post-concussion symptoms after mild traumatic brain injury (TBI) has received increasing interest and scrutiny over the past decade in the United States. Post-concussion syndrome (PCS) is variably defined as a constellation of physical symptoms and cognitive disturbances experienced by patients after TBI. Two diagnostic definitions of PCS which have been commonly used for research purposes are the ICD-10 diagnostic criteria

(1) and DSM IV criteria(2) (Table 1, 2). Each requires that the patient experience at least three of eight possible symptoms, such as headache, changes in mood, sleep, or concentration. Depending on how PCS is defined and the severity of TBI in the population studied, the incidence of PCS after mild TBI in the United States has been reported to range from 25–50%.<sup>(3–7)</sup> Investigations in other countries, such as one conducted in Greece, have documented somewhat lower rates, around 10%.<sup>(8)</sup> There has also been some controversy regarding the syndrome, with some inves-

\* Address for Correspondence : **Juliana Tolles**

Health Sciences Assistant Clinical Professor,

Harbor UCLA Medical Center Box #21, 1000 West Carson Street, Torrance, CA 90509, USA

Tel : 310-222-3503, Fax : 310-782-1763, E-mail : jtolles@emedharbor.edu

**Submitted** : May 15, 2017 **Revised** : May 15, 2017 **Accepted** : May 15, 2017

**Table 1.** ICD 10 criteria for post-concussion syndrome

---

---

A. History of head trauma with loss of consciousness preceding symptom onset by a maximum of 4 wk.
B. Symptoms in 3 or more of the following symptom categories:
• headache, dizziness, malaise, fatigue, noise intolerance;
• irritability, depression, anxiety, emotional lability;
• subjective concentration, memory, or intellectual difficulties without neuropsychological evidence of marked impairment;
• insomnia;
• reduced alcohol tolerance; and
• preoccupation with above symptoms and fear of brain damage with hypochondriacal concern and adoption of sick role.

---

---

**Table 2.** DSM IV criteria for post-concussion syndrome

---

---

A. A history of head trauma that has caused considerable cerebral concussion.*
B. Evidence from neuropsychological testing or quantified cognitive assessment of difficulty in attention (concentrating, shifting focus of attention, performing simultaneous cognitive tasks) or memory (learning or recall of information).
C. Three (or more) of the following occur shortly after the trauma and last at least 3 mo:
• becoming fatigued easily;
• disordered sleep;
• headache;
• vertigo or dizziness;
• irritability or aggression on little or no provocation;
• anxiety, depression, or affective instability;
• changes in personality (eg, social or sexual inappropriateness); or
• apathy or lack of spontaneity.
D. The symptoms in criteria B and C have their onset following head trauma or else represent a substantial worsening of pre-existing symptoms.
E. The disturbance causes considerable impairment in social or occupational functioning and represents a considerable decline from a previous level of functioning. In school-aged children, the impairment might manifest as a substantial worsening in school or academic performance dating from the trauma.
F. The symptoms do not meet criteria for dementia due to head trauma and are not better accounted for by another mental disorder (eg, amnesic disorder due to head trauma, personality change due to head trauma).

---

---

\* The manifestations of concussion include loss of consciousness, posttraumatic amnesia, and, less commonly, posttraumatic onset of seizures. The specific method of defining this criterion needs to be established by further research.

tigations reporting similar incidence of the symptoms in patients who have had no traumatic brain injury. (7) Relatively little is documented about the incidence of PCS internationally, particularly in East Asia. We therefore conducted a prospective observational study to document the incidence of PCS in patients with mild TBI who presented for treatment to the emergency department of a major Korean teaching hospital.

## II. Methods

### 1. Study Design

This was a prospective observational cohort study which employed convenience sampling. It was approved

by the Institutional Review Board of Guro University Hospital (No. KUGH15240).

### 2. Study Setting and Population

Patients who visited the Emergency Department of Korea University Guro Hospital for treatment of head trauma between the dates of November 01, 2015 and March 31<sup>st</sup>, 2016 were screened. Patients were excluded if they were age less than 7 years or greater than 65 years, had no clear history of trauma as the primary event (eg, primary seizure or syncope), had abnormal CT findings, had unstable vital signs associated with major trauma, or were unable (Glasgow Coma Scale <14) or unwilling to consent, or if this was not the ini-

tial visit for evaluation of the head trauma. Patients were included if they had traumatic head injury and any of the following symptoms: headache, dizziness, difficulty concentrating, sleep disorder, fatigue, depression, emotional changes, anxiety, grogginess, amnesia, balance problem, loss of consciousness, or nausea/vomiting.

### 3. Study Protocol

Potential subjects were identified by the primary treating physician. The research team then determined eligibility enrollment and obtained informed consent. A researcher questioned the subject regarding his or her symptoms according to a standardized questionnaire and recorded the answers. Subjects were contacted by phone approximately 2 weeks after their Emergency Department visit and questioned about subsequent symptoms and subsequent visits for medical care. If the subjects did not respond to the first call, a second attempt was made to reach the subject. If there was no response to the second request, the subject was considered as a non-responder.

### 4. Outcome Measures

Outcome measures were subjects' self-reported experience of the following: headache, dizziness, difficulty concentrating, sleep disturbances, fatigue, depression or emotional disturbance, amnesia, balance difficulties, loss of consciousness, nausea/vomiting in the two weeks following the initial visit for head trauma. The timing, in days, of peak symptom severity was recorded. The severity of symptoms was rated by the subjects on a 5 point scale. Lastly, subjects were asked to report whether they were readmitted to a medical facility for the same condition that prompted their initial visit.

### 5. Data Analysis

For categorical outcomes a proportion was calculated. For outcome variables, a median value and range were calculated. The R software for statistical computing was used for all variables.

## III. Results

### 1. Patient Characteristics

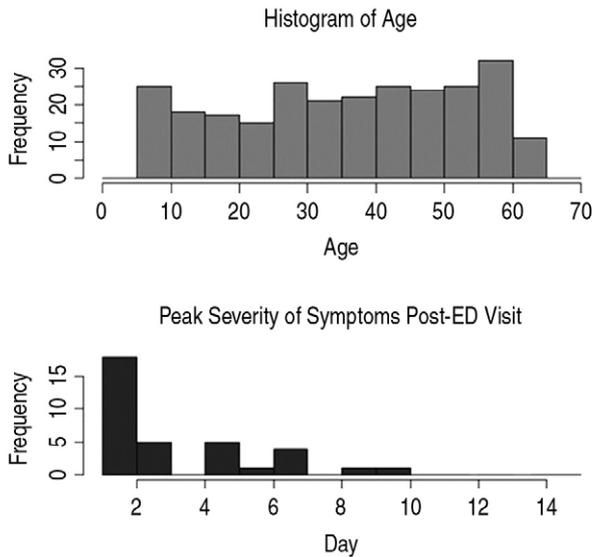
A total of 234 subjects were recruited. One subject was subsequently lost to follow-up. One recruited subject was outside the predetermined age range for the study and thus her data was omitted from the final analysis. Subject age and gender demographics are detailed in Table 3. Subjects' ages ranged from 7 to 65 years, with a relatively uniform distribution across this range (Fig. 1). The most common mechanism of injury was a fall, but subjects with a variety of different injury mechanisms were recruited. Injuries were most frequently sustained on a street or highway, with smaller percentages sustained at a residence or at a recreational sporting activity. Means of transport to the Emergency Department varied, the most common being private vehicle. Only 10 of 233 subjects (4%) had sustained a prior concussion. One subject was wearing protective headgear at the time of injury (Table 3). Symptoms upon presentation

**Table 3.** General characteristics in included patients

M:F	135:98
Age	36.3 ± 16.9
Location of injury, n (%)	
residence	31 (13)
street/highway	163 (70)
recreation/sport	19 (8)
school	4 (2)
other public building	7 (3)
industrial place	8 (3)
other location	1 (0.5)
Injury mechanism, n (%)	
fall	90 (39)
motor vehicle accident	68 (29)
assault	24 (10)
struck by/against	38 (16)
bicycle	6 (3)
Sports	7 (3)
Mode of transportation, n (%)	
ambulance	102 (44)
private vehicle	131 (56)
Past concussion Hx, n (%)	
no	233 (96)
yes	10 (4)
The use of helmet or protective headgear, n (%)	1 (0.4)

varied, the most common being headache, and some subjects had multiple symptoms. Ninety-seven percent of subjects were discharged to home from the

emergency department after their initial visit and three percent were admitted for further observation at a Level 1 hospital (Table 4).



**Fig. 1.** Histogram of included patients and peak severity symptoms post emergency department visit.

**Table 4.** Patient symptoms and disposition at initial ED presentation

Symptom at ED presentation	n (%)
headache	216 (93)
dizziness	18 (8)
difficulty in concentration	0 (0.0)
sleep disorder	0 (0.0)
fatigue	4 (2)
depression, emotional change, anxiety, grogginess	1 (13)
amnesia	3 (1)
balance problem	0 (0.0)
loss of consciousness	32 (14)
nausea/vomiting	24 (10)
Disposition from ED	
residence	226 (97)
level I hospital for observation	7 (3.0)

\* ED: emergency department

**Table 5.** Patient symptoms on two-week phone follow up after emergency department discharge

Symptoms after ED Discharge	n	% of patients with symptom	95% CI
Headache	1	0.4	(0.02-2.7)
Dizziness	10	4.3	(2.2-8.0)
Difficulty Concentrating	0	0	(0-2.0)
Sleep Disorder	2	0.9	(0.14-4.0)
Fatigue	0	0	(0-2.0)
Depression/Emotional Change	0	0	(0-2.0)
Amnesia	1	0.4	(0.02-2.7)
Balance Problem	0	0	(0-2.0)
No Symptoms	214	91.8	(87.4-94.9)
Miscellaneous	2	0.4	(0.02-2.7)
Loss of Consciousness	0	0	(0-2.0)
Nausea/Vomiting	10	4.3	(2.2-8.0)

\* CI: confidence interval

**Table 6.** Severity of post- concussion syndrome

Severity	n	%	95% CI
None	205	88	(83-92)
Very mild	19	8	(5.1-12.6)
Mild	8	3	(0.3-4.0)
Moderate	1	0.4	(0-2.0)
Severe	0	0	(0-2.0)
Total	233	100	

\* CI: confidence interval

## 2. Post-concussion Symptoms

On two-week phone follow-up, only 8% of subjects report experiencing any symptoms (95% CI 5.1–12.6%) (Table 5). The median day of peak symptom severity reported was 3 (0–8,0) but the distribution was heavily left-skewed. No subjects reported symptom peak after 10 days (Fig. 1). Of the 27 patients who reported symptoms, 19 patients rated them as “very mild”, 8 patients rated them as “mild” and one patient rated them as “moderate” in severity (Table 6).

## IV. Discussion

Broad consensus on the definition of concussion and PCS is lacking. However, the common element in all definitions is that concussion is the temporary functional disturbance caused by traumatic head injury.(9–11) In order to favor sensitivity in the screening of potential subjects for this study, we selected broad inclusion criteria, including some symptoms are not listed as part of the ICD10 and DSM IV definition of concussion or PCS. We found that 8% of subjects had at least one symptom on follow up and one subject met criteria for the ICD 10 definition of post-concussion syndrome (for the presence of headache, dizziness and a sleep disturbance), yielding PCS rate of 0.4% (95% CI 0.02–2.7%). This is well below the lower end of range of incidence reported in the US population. There are several possible explanations for this finding. In this study, the term “minor head injury” defined as any trauma on head area with any symptoms related to head trauma at all at the time of event occurred. It is possible that our subjects had relatively minor trauma compared to populations studied in the US, the incidence in our study population is dramatically less: 0.4% versus a lower range of 25%. However, even if that were true, 8% of subjects had at least one symptom on follow up and one subject met criteria for the ICD 10 definition of post-concussion syndrome. This finding could be interpreted as the most minor trauma we could image can also cause the post-concussion syndrome. Other possible explanations for this dramatically lower prevalence include differences in care, differences in public awareness about PCS, cultural influ-

ences on the perceived severity of symptoms or social pressure not to acknowledge symptoms.

## V. Limitations

The study was a convenience sample of subjects presenting to a single emergency department at a major academic hospital in Korea, and thus may not be representative of the patient population as a whole. As this was a convenience sample that relied upon the treating physician to identify eligible patients, it is possible that there may be have been some systematic bias in the patients who were referred to the study. Finally, we did not question subjects about all elements included in the ICD-10 definitions of PCS. No information about subjects’ intolerance to alcohol, which is part of the ICD-10 definition, was collected. We estimated the overall prevalence with the assumption that this subject would have met criteria for PCS, because the DSM IV criteria for PCS requires that symptoms last at least 3 months, which extends beyond are follow up period. We cannot determine if subjects with symptoms met the criteria.

## VI. Conclusion

In this study, we used relatively minor head trauma definition. Our findings suggest that the incidence of PCS may be lower in Korean patients who seek care at an emergency department for mild traumatic brain injury as compared with patients in the US. This could be due to cultural influences on the way patients experience symptoms or social pressures to avoid reporting symptoms. On the other hand, this could give an idea that mild trauma could also cause the PCS. Further study, including multicenter prospective investigation using an internationally agreed-upon definition for PCS will be needed to define possible cultural influences on the incidence of PCS following minor TBI.

## REFERENCES

- 1) World Health Organization. The ICD-10 Classification of Mental and Behavioral Disorders: Clinical Descriptions and Diagnostic Guidelines. Geneva: World Health Organization, 1992.

- 2) American Psychiatric Association. American Psychiatric Association. Diagnostic and statistical manual of mental disorders: DSM-IV [Internet]. 4th ed, text rev. Washington (DC): American Psychiatric Association;1994 [cited 2010 Mar 8]. 866p. Available from: <http://www.psychiatryonline.com/DSMPDF/dsm-iv.pdf>.
- 3) Butler IJ. Postconcussion syndrome after mild traumatic brain injury in children and adolescents requires further detailed study. *JAMA Neurol* 2013; 70: 636-7.
- 4) Dischinger PC, Ryb GE, Kufera JA, and Auman KM. Early predictors of postconcussive syndrome in a population of trauma patients with mild traumatic brain injury. *J Trauma* 2009; 66: 289-96.
- 5) Sheedy J, Harvey E, Faux S, Geffen G, and Shores EA. Emergency department assessment of mild traumatic brain injury and the prediction of postconcussive symptoms: a 3-month prospective study. *J Head Trauma Rehabil* 2009; 24: 333-43.
- 6) Bazarian JJ, and Atabaki S. Predicting postconcussion syndrome after minor traumatic brain injury. *Acad Emerg Med* 2001; 8: 788-95.
- 7) Dean PJ, O'Neill D, and Sterr A. Post-concussion syndrome: prevalence after mild traumatic brain injury in comparison with a sample without head injury. *Brain Inj* 2012; 26: 14-26.
- 8) Spinou P, Sakellariopoulos G, Georgiopoulos M, Stavridi K, Apostolopoulou K, and Ellul J et al. Postconcussion syndrome after mild traumatic brain injury in Western Greece. *Brain Inj* 2010; 69: 789-94.
- 9) Giza CC, Kutcher JS, Ashwal S, Barth J, Getchius TS, and Gioia GA et al. Summary of evidence-based guideline update: evaluation and management of concussion in sports: report of the Guideline Development Subcommittee of the American Academy of Neurology. *Neurology* 2013; 11: 2250-7.
- 10) Harmon KG, Drezner J, Gammons M, Guskiewicz K, Halstead M, and Herring S et al. American Medical Society for Sports Medicine position statement: concussion in sport. *Clin J Sport Med* 2013; 23: 1-18.
- 11) McCrory P, Meeuwisse W, Aubry M, Cantu B, Dvorak J, and Echemendia R et al. Consensus statement on Concussion in Sport--the 4th International Conference on Concussion in Sport held in Zurich, November 2012. *J Sci Med Sport* 2013; 16: 178-89.
- 12) Marshall S, Bayley M, McCullagh S, Velikonja D and Berrigan L. Clinical practice guidelines for mild traumatic brain injury and persistent symptoms. *Can Fam Physician* 2012; 58: 257-67.