

Clinical Article



# Comparison of Clinical Characteristics of Traumatic Brain Injury Patients According to the Mechanism Before and After COVID-19

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## ABSTRACT

**Objective:** This study investigated the change in the number of patients with head trauma according to the trauma mechanism among severely injured patients transferred to the emergency department of Wonju Severance Christian Hospital before and during the coronavirus disease 2019 (COVID-19) pandemic.

**Methods:** Medical records (sex, age, diagnosis, trauma mechanism, and injury severity score) of patients referred to the emergency room between January 2018 and December 2019 and January 2020 and December 2021 were retrospectively reviewed, verified, and compared.

**Results:** Between 2020 and 2021, the number of patients with traumatic brain injury decreased by 251 (32%). No significant differences were observed in sex, age, or time of accident. From 2020 to 2021, among the trauma mechanisms, the number of cases involving rolling down slightly reduced compared with those involving other mechanisms. Furthermore, cerebral contusions among intracranial lesions significantly increased during the COVID-19 pandemic.

**Conclusion:** Partial restrictions on social activities owing to COVID-19 are ongoing. Further investigation of the clinical characteristics of trauma patients over a longer period is required.

**Keywords:** Trauma; Head injuries; COVID 19

## INTRODUCTION

Since the identification of several patients with pneumonia in Wuhan City, China, in December 2019, coronavirus disease 2019 (COVID-19) has spread globally, causing extensive social and cultural changes.<sup>3)</sup> After the first COVID-19 case was confirmed in Korea on January 20, 2020, a comprehensive survey of travelers from Wuhan, China, was initiated.<sup>5,6)</sup> On January 30, 2020, the World Health Organization (WHO) declared the COVID-19 outbreak a public health emergency of international concern; on February 20, the first death was reported in Korea. Consequently, the stage of infectious disease crisis was elevated to serious, and residential treatment centers for social isolation were established. Subsequently,

**Conflict of Interest**

The authors have no financial conflicts of interest.

additional countermeasures, including social distancing, using digital access codes, and wearing a mask, were undertaken.<sup>8)</sup> On November 7, the social distancing level was elevated from 3 to 5 m, and from December 23, gatherings of five or more people were banned in metropolitan areas. Subsequently, all foreigners entering Korea were mandated to provide negative polymerase chain reaction confirmation. As of July 31, 2021, the WHO announced that 197 million confirmed cases and over 4.2 million deaths had been reported globally. Since the confirmation of a reduction in transmission on November 1, 2021, efforts have been made towards social stabilization and a gradual return to normal life following the COVID-19 pandemic. The regional trauma center, designated as the first trauma center in the middle districts in 2012, admits at least 500 patients with severe injuries annually. The center is responsible for emergency medical care in the central region of the country, encompassing Gangwon-do, Eastern Gyeonggi-do, Northern Chungcheong-do, and Northern Gyeongsang-do, and particularly provides medical airlift services. Since the emergence of COVID-19, many studies on the use of medical resources, changes in trauma mechanisms, and quantitative and qualitative changes in inpatients worldwide have been conducted and continue to be conducted. This study compared clinical changes between patients with traumatic brain injury admitted to the trauma center from January 2020 to December 2021 (during the COVID-19 pandemic) and those admitted from January 2018 to December 2019 (pre-COVID-19 pandemic). Patients were included from mid-regions, including the entire Gangwon-do. Furthermore, the results obtained were compared with those from other domestic and overseas districts to analyze the differences and causes.

## MATERIALS AND METHODS

### Patient characteristics

This study included 5,073 patients transported to the regional trauma center for whom critical pathway activation was applied between January 1, 2018 and December 31, 2021. Their medical records were retrospectively analyzed to determine sex, age, diagnosis, trauma mechanism, date and time of injury and admission, injury severity score (ISS), and diurnal variation. Patients confirmed dead on arrival, those with incomplete medical records, and those with immediate transfers according to the patients' wish were excluded. **TABLE 1** shows the demographic characteristics of the patients admitted during the pre-COVID-19 and COVID-19 periods. This retrospective study was approved by the Institutional Review Board of Wonju Severance Christian Hospital (CR323064).

**TABLE 1.** Demographics characteristic

Characteristic	2018–2019	2020–2021	p-value
Total patients (n=5,073)	2,662	2,411	
Severe brain injury (n=1,634)	971	663	<0.001
Sex			0.830
Male	713 (73.4)	490 (73.9)	
Female	258 (26.6)	173 (26.1)	
Age, average	58.3±20.4	59.6±18.7	0.171
ISS, average	18.7±9.8	20.1±10.5	0.006

Values are expressed as numbers (%) or mean ± standard deviation.  
ISS: injury severity score.

### Statistical analyses

Summary statistics are reported as the median and interquartile range or mean  $\pm$  standard deviation where appropriate. Categorical variables are expressed as numbers and percentages. The Wilcoxon-rank sum test and unpaired *t*-test were used to compare the median values of continuous variables and for normally distributed continuous data, respectively. The  $\chi^2$  test was used to compare the frequencies of categorical variables between groups.  $p < 0.05$  was considered to be statistically significant. SPSS version 20.0 (IBM Corp., Armonk, NY, USA) and Stata version 14.2 (StataCorp., College Station, TX, USA) were used for statistical analysis.

## RESULTS

From 2018 to 2019 (pre-COVID-19 period) and from 2020 to 2021, 971 and 663 patients were admitted with traumatic brain injury, respectively, indicating a statistically significant reduction in the number of inpatients. Regarding sex distribution, 713 (2018–2019) and 490 (2020–2021) patients with traumatic brain injury were men, accounting for 73.4% and 73.9% of the patients, respectively, with no statistically significant differences between the sexes. During the two periods, the mean age of the patients was 58.3 (2018–2019) and 59.6 (2020–2021) years, which was not statistically significant. The mean ISS was  $18.7 \pm 9.8$  (2018–2019) and  $20.1 \pm 10.5$  (2020–2021), with the ISS being significantly higher for patients admitted from 2020–2021 ( $p = 0.006$ ). Based on trauma mechanism analysis, 166 (17.1%) and 112 (16.9%) cases of car accidents were recorded from 2018–2019 and 2020–2021, respectively, and the difference was not statistically significant. There were 119 (12.3%), 50 (5.1%), and 149 (15.3%) cases of motorcycle, bicycle, and pedestrian accidents, respectively, from 2018 to 2019, while there were 84 (12.7%), 42 (6.3%), and 105 (16.0%) cases, respectively, from 2020 to 2021. The difference was not statistically significant. From 2018–2019, 211 (21.7%), 201 (20.7%), and 71 (7.3%) cases of traumatic brain injury were caused by falling down, rolling down, and crush injuries, respectively. From 2020–2021, 160 (24.1%), 112 (16.9%), and 47 (7.1%) cases were caused by falling down, rolling down, and crush injuries, respectively. No significant difference was observed between the periods. The time of trauma occurrence was established based on general activity time (day: from 8 AM to 8 PM and night: from 8 PM to 8 AM), and the difference in the frequency of the two time periods was analyzed. From 2018–2019, 746 (76.8%) and 71 (7.3%) cases occurred during day- and night-time, respectively. From 2020–2021, 529 (79.8%) and 134 (20.2%) cases occurred during day- and night-time, respectively. The number of injuries during the daytime was higher; however, no significant difference was observed. The typical diagnosis of a head injury includes epidural hematoma (EDH), subdural hematoma (SDH), subarachnoid hematoma (SAH), cerebral contusion, and intracranial hemorrhage (ICH), and their incidence was investigated to compare the differences between the two periods.<sup>7)</sup> For EDH, 163 (16.8%) cases were reported from 2018–2019, while 107 (16.1%) cases were reported from 2020–2021, showing no significant difference. There were 581 (59.8%) and 399 (60.2%) cases of SDH from 2018–2019 and 2020–2021, respectively, and the two periods showed similar incidences. SDH had the highest incidence among all patients with head trauma. Additionally, 435 (44.8%) and 278 (41.9%) cases of SAH were reported in the two periods, respectively, showing similar incidences. Contusion was reported in 207 (21.3%) cases from 2018–2019 and 224 (33.8%) cases from 2020–2021. The incidence of contusion was significantly higher during the COVID-19 pandemic period than in the pre-COVID-19 period. In terms of ICH, 40 (4.1%) and 15 (2.3%) cases were reported from 2018–2019 and 2020–2021, respectively, showing similar incidences. **TABLE 2** shows the trauma characteristics and **TABLE 3** shows final diagnosis of the patients.

**TABLE 2.** Trauma characteristics

Characteristics	2018–2019	2020–2021	p-value
Trauma mechanism			
Car accident	166 (17.1)	112 (16.9)	0.915
Motorcycle	119 (12.3)	84 (12.7)	0.803
Bicycle accident	50 (5.1)	42 (6.3)	0.307
Pedestrian accident	149 (15.3)	105 (16.0)	0.725
Fall down	211 (21.7)	160 (24.1)	0.255
Rolling down	201 (20.7)	112 (16.9)	0.055
Crush	71 (7.3)	47 (7.1)	0.864
Time	96.0±12.1		0.156
Day (08:00–20:00)	746 (76.8)	529 (79.8)	
Night (20:00–08:00)	225 (23.2)	134 (20.2)	

Values are expressed as numbers (%) or mean ± standard deviation.

**TABLE 3.** Final diagnosis

Diagnosis	2018–2019	2020–2021	p-value
Epidural hemorrhage	163 (16.8)	107 (16.1)	0.729
Subdural hemorrhage	581 (59.8)	399 (60.2)	0.889
Subarachnoid hemorrhage	435 (44.8)	278 (41.9)	0.251
Cerebral contusion	207 (21.3)	224 (33.8)	<0.001
Intracerebral hemorrhage	40 (4.1)	15 (2.3)	0.041

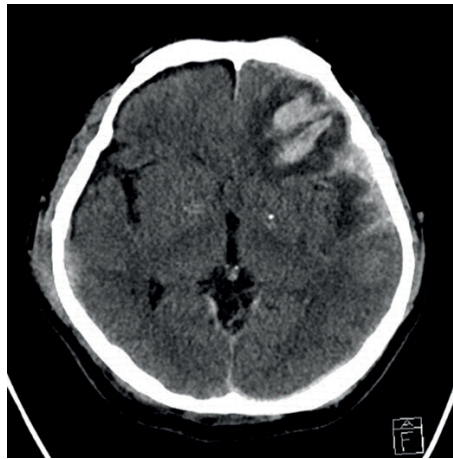
Values are expressed as numbers (%).

## DISCUSSION

This study compared the proportion of patients with traumatic brain injury admitted to the regional trauma center before and during the COVID-19 pandemic and found a decrease of approximately 32% (251 patients). Other studies have also supported these findings. Trier et al.<sup>14)</sup> conducted a retrospective comparison of patients admitted from 2018–2019 and 2020 to determine the effects of COVID-19 on aspects of hospitalization of traumatic patients at a major Danish trauma center. The proportion of patients with minor injuries increased by 24% in 2020 compared to that from 2018–2019, while the incidence rate ratio for patients with severe injuries was 0.97. During the first lockdown in 2020, trauma team activation was reduced from 49.5 to 42, similar to the findings of the present study, showing a decline in the number of inpatients. Additionally, the reduction in traffic injuries during the first lockdown in 2020, as reported in the preceding study, was similar to the findings of this study. Furthermore, the preceding study reported that fall injuries increased numerically but not statistically in 2020, and our study confirmed this finding.<sup>14)</sup> During the first lockdown, a major trauma center in London conducted a study and reported that the proportion of patients injured in falls from heights <1.5 m increased from 49% to 58%, while the proportion injured from heights >1.5 m increased from 5% to 10%.<sup>10)</sup> Studies by other authors have found similar results, which can be due to a reduction in social activities but an increase in activities such as home repairs and landscaping.<sup>2,11,13)</sup> Ahuja et al.<sup>1)</sup> analyzed the effects of COVID-19 on the clinical aspects of patients who required transfer to a tertiary spine hospital following acute spinal surgery. They hypothesized that road traffic and outdoor activities would decline and compared acute referrals from February 1, 2020 to April 30, 2020 to referrals in the same period in 2019 to investigate the qualitative or quantitative changes. The study showed a 46% decrease in referrals and a 72% decrease in high-energy traumatic presentations. Consequently, the study highlighted the importance of optimizing spinal healthcare services provided by referring hospitals and tertiary centers<sup>1)</sup> in neurosurgery. Sinha et al.<sup>12)</sup> reported on the impact of COVID-19 on patients admitted

to tertiary neurosurgical centers and referred for neurosurgical head trauma in 2021. They compared the data during 31 days of lockdown in the early days of COVID-19 (March 23 to April 22, 2020) and data for the same period between 2016 and 2019 and showed that the mean numbers of neurosurgical head injury referrals and admissions were reduced by 57.5% and 48.3%, respectively. Furthermore, they demonstrated a significant reduction in the length of hospital stay. Residents in the neurosurgery department should prioritize patients' safety and quality care and give special consideration to completing appropriate trainings.<sup>12)</sup> The first Korean study to report the effects of COVID-19 at a regional trauma center (Pusan National University) was conducted by Kim et al.<sup>9)</sup> They retrospectively compared multi-trauma patients admitted to a regional trauma center during the COVID-19 pandemic (January 20 to September 20, 2020) with those admitted during the same periods in 2016–2019. Compared to that pre-COVID-19, the mean proportion of admissions decreased by 15%, but the mechanism of injury remained unchanged. The mean length of hospital stays during COVID-19 decreased substantially from 16 (pre-COVID-19 period) to 10 days (during COVID-19). However, there was no difference in intensive care unit mortality, as the severity of inpatients during the pre-COVID-19 period and during the COVID-19 period was not significantly different. According to the conclusion of the preceding single-center study, future studies should involve multiple centers. Several studies have provided compelling explanations for the reduction in daily trauma admissions and shorter lengths of stay.<sup>9)</sup> Jean et al.<sup>4)</sup> conducted a principal study for 2 weeks from March 18, 2020, when the American College of Surgeons advised limiting social activities and added a supplemental study once the pandemic spread swiftly. The principal study consisted of 20 items, and the supplemental study was conducted to inquire about policy changes during the COVID-19 pandemic. The study included 494 respondents from 60 countries, with 55 respondents from low- to middle-income countries. During the pandemic, the operative volume decreased by at least 50%, according to 46.1% of the respondents from all countries.

In this study, patients hospitalized from 2020–2021 had a higher mean ISS. This showed that the severity was higher in these patients. Due to the spread of COVID-19 and the likelihood of contracting an infection at the tertiary hospital, the transfer of patients with comparatively low ISS (mild) was canceled by physicians, and patients chose not to be admitted. Due to the reduction in the proportion of patients with mild disease visiting the hospitals, the result of this study is different from that of other studies. Nationwide statistics should be compiled for further studies on the clinical aspects of inpatients during the pandemic period. The incidence of common head injuries such as EDH, SDH, SAH, contusion, and ICH was investigated, and the differences between the two periods were analyzed. Only in the case of contusion, 207 (21.3%) and 224 (33.8%) cases were reported from 2018–2019 and 2020–2021, respectively. This demonstrated that a higher incidence was reported during the COVID-19 period which was statistically significant. It is difficult to explain the exact reason why the incidence of contusion is higher than that of other diagnoses of head injury. Since the severity of head injuries in inpatients increased between 2020–2021, we expected an increase in multiple brain injuries observed in radiographic images of these patients. **FIGURE 1** shows the example of multiple brain injury. COVID-19 continues to cause unstable changes in the overall social and medical environment. However, it is progressively stabilizing. Based on the health countermeasures and social responses implemented by each country, it is anticipated that the COVID-19 pandemic will persist in various aspects. To gain further insights into its progression, conducting additional studies in the future will be crucial. Furthermore, active health countermeasures should be implemented in Korea for traumatic patients.



**FIGURE 1.** Radiographic example of multiple brain injuries. The patient was a 38-years-old male with pedestrian car accident. Non-contrast computed tomography shows left frontal contusional hemorrhage, bilateral acute subdural hemorrhage and diffuse subarachnoid hemorrhage.

## CONCLUSION

The number of inpatients with trauma from 2020 to 2021 was significantly lower than that from 2018 to 2019 (pre-COVID-19 period). In terms of the mean ISS, patients admitted from 2020–2021 had more severe injury than those admitted in 2018–2019 ( $p=0.006$ ). In 2020–2021, the incidence of contusion was significantly higher than that of other head injuries.

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