

Severe craniocerebral injury after e-scooter accidents in winter

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ABSTRACT

The increasing popularity of electric scooters in Poland is associated with the growing number of e-scooter-related accidents, which often involve head traumas. Although the most common types of injuries are abrasions and cuts to the skin, they sometimes include severe brain injuries. Most e-scooter accidents occur in the warm months. In winter, when there are unfavorable

conditions for using this means of transport, e-scooter-related accidents are rare. Described in the text are 2 cases of severe cases of skull and brain injuries which required neurosurgical intervention. In both cases, the riders were under the influence of alcohol and did not use helmets, which had a measurable influence on the profile and the extent of injuries.

Keywords: electric scooters; road accidents; head injury; ICH.

INTRODUCTION

Recent years have seen significant changes in urban micromobility due to the increasing popularity of electric scooters [1]. Their appeal is associated with their low impact on environment, low price, convenience of moving around the city and saving time [2]. Various companies have created software enabling quick and convenient short-term rental of scooters via a smartphone. In addition, e-scooters are becoming an alternative to a car when traveling around the city or commuting to work [3]. In Poland, platforms for renting these vehicles were launched in 2018, originally only in large cities, but now such services are available also in smaller cities [4].

However, the increase in the number of users has resulted in a significant upsurge in injuries sustained in accidents involving these vehicles [1, 5]. Besides the limbs, the area of the body that is the most commonly injured is the head [6, 7]. The most prevalent head injuries include traumatic brain injuries (TBI), soft tissue damage, skull and teeth fractures, as well as intracerebral hemorrhages (ICH) [8, 9]. Particularly noteworthy, due to the gravity of consequences, are the rare incidents of severe skull and brain injuries sustained in scooter accidents. We present 2 cases of severe cranial and brain injuries selected from the patients of the Department of Neurosurgery and Neurotraumatology of the Heliodor Świącicki Clinical Hospital in Poznań from the years 2018–2022 are presented.

CASE REPORTS

Case 1

A 33-year-old patient was urgently admitted to the Clinical Department of Neurosurgery in January, after an e-scooter accident under the influence of alcohol. Physical examination revealed massive facial soft tissue edema and spectacle

hematomas. In the initial inquiry of the bone injuries, pathological mobility of the jaw and malocclusion – difficult abduction of the mandible – were palpable. A non-contrast computed tomography (CT) was performed (Fig. 1), which revealed a heterogeneous, hyperdense epidural hematoma (32 x 60 x 60 mm) with isolated air bubbles in the left frontal region. By exerting a mass effect, the hematoma displaced the ventricular system by 3 mm to the right. Numerous fractures in the braincase and facial skeleton were detected (Fig. 2): comminuted bilateral fracture of the frontal squama, fractures of the orbital walls, bilateral linear fractures of the greater wing of the sphenoid wall (on the right side the fracture gap also extended to the temporal bone), fractures of the walls of the maxillary sinuses, linear fracture of the body of maxilla, and comminuted fracture of the nasal bone. Post-traumatic bilateral rupture of the frontozygomatic suture was also observed. The maxillary, sphenoid, ethmoid and partly frontal sinuses, as well as the nasal cavity, were filled with bloody content and air bubbles. The injury also resulted in massive hematomas in the subcutaneous tissue in the area of the forehead and eyelids, as well as cutaneous emphysema of both cheeks. The subarachnoid space adjacent to the hematoma was narrowed. The patient was qualified for urgent surgical treatment. On the day of admission, an epidural hematoma was evacuated using left frontal craniotomy. In the control CT of the head, 24 h after the craniotomy, no signs of an epidural hematoma could be found. Areas of hemorrhagic contusion appeared in the antero-basal parts of the frontal lobes. After 2 days, repositioning and osteosynthesis Le Fort III of craniofacial fractures, as well as nasal repositioning were performed. One week later, in a control CT scan of the facial skeleton, tile-like overlapping of bone fragments of the lateral wall of the nose was found and another reposition was performed. After 14 days of hospitalization, once the surgical wounds had healed and the sutures had been removed, the patient was released from the hospital in generally good condition.

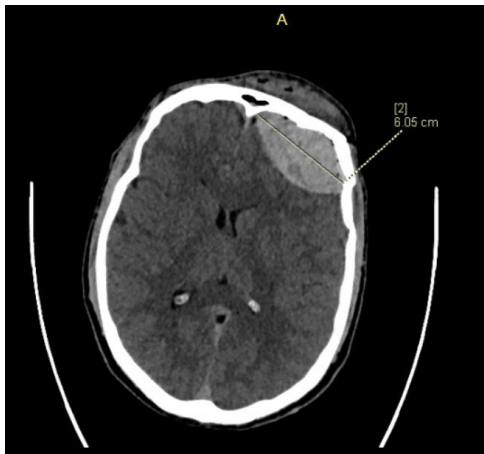


FIGURE 1. Computed tomography of the patient from case 1 – epidural hematoma (32 x 60 x 60 mm) with isolated air bubbles in the left frontal region is visible



FIGURE 2. Computed tomography 3D reconstruction of the patient from case 1 – computed tomography shows: comminuted bilateral fracture of the frontal squama, fractures of the orbital walls, bilateral linear fractures of the greater wing of the sphenoid wall (on the right side the fracture gap also extended to the temporal bone), fractures of the walls of the maxillary sinuses, linear fracture of the body of maxilla, and comminuted fracture of the nasal bone

Case 2

In March, a 19-year-old patient was urgently admitted to the Clinical Department of Anesthesiology and Intensive Care in Poznań, with a head trauma sustained from hitting the wall while driving an e-scooter. At the time of admission, the patient was in a serious condition, Glasgow Coma Scale (GCS) 6/7. A non-contrast CT scan of the head (Fig. 3) revealed a cerebral hematoma (6 x 115 x 94 mm). There were gas bubbles within it. In the cortex of both temporal lobes, ecchymomas were found. Above the hematoma, there were fractures of the parietal bone and temporal squama extending to the base of the skull through the mandibular fossa, the front side of the mastoid, the clivus of the sphenoid bone and the walls of the sphenoidal sinus. The ventricular system was moved 3 mm to the left, the right lateral ventricle was narrower. The subarachnoid space above the right cerebral hemisphere was narrowed, bloody content had appeared in the sphenoidal sinus and the nasopharynx, and a small amount of it was also visible in the right mastoid and the middle ear. Anti-swelling treatment was initiated. The follow-up CT examination revealed larger areas of contusion than the

previous one. In addition, there was blood on the right side of the tentorium cerebelli. All of the described changes caused a greater mass effect – shifting the ventricular system to the left side by about 5–6 mm. Most of the subarachnoid space below the tentorium was clamped. Due to the features of the deteriorating clinical condition, increasing intracranial compression and symptoms of herniation, the patient had to undergo an urgent of the fronto-parietal-temporal decompression craniectomy and evacuation of the subdural hematoma. The control CT examination performed 48 h after the neurosurgical intervention, showed an improvement in terms of the intracranial compartment and about 8 mm thick residual cerebral hematoma in the frontal plane with fresh blood and air bubbles adjacent to the lower parts of the right temporal lobe. Compared to the previous CT, the areas of a hemorrhagic contusion in both temporal lobes got larger. Blood was found along the cerebral falx and the tentorium cerebelli. A follow-up CT showed a collection of fluid above the brain at the level of the craniectomy, first 10–11 mm thick, then after 24 h it increased to 13 mm. Additionally, it showcased greater swelling in the areas of the temporal lobes contusion. Due to the patient’s fever and high C-reactive protein values reaching 211 mg/L, it was decided to remove the bone flap sewn into the subcutaneous tissues. Another CT exposed growth in the size of the supratentorial hypodense cerebral fluid collection on the right side to 22 mm. An L4/L5 lumbar puncture was performed, releasing 30 mL of yellow, clear cerebrospinal fluid. In the follow-up CT, the fluid collection was observed to have grown to 30 mm. Therefore, a lumbar drainage was placed into the subarachnoid space at the level of L4/L5. A decision was made to perform an early correction of the bone defect with the use of a dedicated implant. Punctures and decompression of the pseudomeningocele were suggested until the completion of the procedure. On the 27th day after the decompression craniectomy, plastic surgery of the bone defect of the right fronto-temporal skull was performed with polymethylmethacrylate cement containing gentamicin using a cranioform. On the 36th day of hospitalization, after stabilization of the clinical condition and normalization of laboratory markers of inflammation, the patient was discharged from the hospital in good condition.



FIGURE 3. Computed tomography of the patient from case 2 – cerebral hematoma (6 x 115 x 94 mm) is visible

DISCUSSION

Head injuries occurring in patients after accidents on e-scooters are a serious threat to life. An analysis of 5705 casualties of e-scooter-related accidents from 34 studies showed that severe cases of brain injuries are rare (frequency of TBI incidents amounts to 2.5%, ICH to 1.9% and brain concussions to 3.2%); however, they are responsible for the most severe consequences and can lead to death [1, 10]. The severity of condition is indicated by the GCS score of case 2, which occurs in about 2% of patients after scooter accidents [11]. Head injuries are the main cause of hospitalization in patients, who were casualties of accidents on e-scooters, the diagnosis of which is based on a CT scan that was also carried out in the described cases. During their hospitalization, patients from cases 1 and 2 were treated at the Clinical Department of Anesthesiology and Intensive Care, which is the case for approx. 1–25% of patients in similar condition [12]. Approximately 5–30% also require urgent surgery, just like the patient from case 1. Similar craniocerebral injuries, including subdural hematoma and skull base fractures described above in case 2, have been presented in the description of a fatal accident of a 33-year-old man on an e-scooter [10], which indicates the severity of the injuries suffered by the patient in case 2 and the possibility of complications of these accidents leading to death. The basic factors reducing the risk of a head injury in e-scooter-related accidents are helmets; however, research shows that they are used by less than 5% of riders [13]. In the aforementioned cases, the patients were not wearing helmets, which undoubtedly contributed to the extent of their injuries.

Analyses of accident statistics involving e-scooters indicate that most commonly they occur in the evening hours during summer weekends [3, 14]. The accidents presented above took place in the winter months, when such events are much less frequent [12]. This is due to a drop in the number of e-scooter riders (reaching 80%) due to unfavourable weather conditions e.g. snowfall and frost [15]. Little is known about the influence of winter conditions on the severity of e-scooter accident-related injuries, but frost and reduced grip can possibly lead to the increased risk of highly-dangerous traumas. They are usually related to returning from social events in the late evening hours, and the victims are mainly young men [14, 16, 17], which is also confirmed by the aforementioned cases (men aged 33 and 19, respectively). In both cases, the men were under the influence of alcohol; intoxication also raises the probability of an accident, as well as the severity of its consequences [3, 9, 18]. Research indicates that patients under the influence of psychoactive substances are more predisposed to head injuries and have a higher risk of hospitalization, including surgical intervention [9, 12], which is also demonstrated by the cases discussed in this paper. The type of accident also has a significant impact on the profile and severity of injuries. The most severe injuries are caused by a collision with another, larger motor vehicle (e.g. a passenger car, bus, and tram) [4]. Severe complications can also be caused by hitting various objects and elements of road infrastructure (e.g. curbs, hydrants, and

road safety barriers) [19]. In the described case 2, the patient hit the wall while riding an e-scooter. Statistically, the lowest risk of serious and life-threatening injuries are spontaneous falls resulting, for example, from a temporary loss of balance [20]. In addition to head injuries, users of e-scooters are often exposed to injuries in the upper and lower limbs [17]. These were also noticeable in the cases described in this study, although they were mild and of little clinical significance, not requiring additional treatment.

CONCLUSIONS

The described cases indicate the possible serious consequences of accidents on an e-scooter. It is essential to introduce systemic and legal solutions aimed at reducing the number of accidents involving e-scooters and mitigating their effects. It seems particularly important to introduce the obligation to use a helmet, which plays a key role in protecting against head injuries. In addition, campaigns should be carried out to raise public awareness of the proper and safe use of e-scooters and the potential risk of an accident. This also applies to the use of a vehicle under the influence of psychoactive substances, the principle of zero alcohol or 0.0 per mille [9] recommended in the literature is fully supported by these authors. In addition to legal and educational activities, it is also important to adapt the urban environment to e-scooters. This can be implemented by designing paths on which scooters could move and eliminating elements dangerous for riders, such as high curbs or protruding fragments of barriers. Educating and making e-scooter riders aware of the impact of weather conditions on safety are also important. The influence of weather conditions on the typical injury profile has not been well described in the literature; however, it deserves further detailed research.

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