The First Reported Case of Second Impact Syndrome: A Reexamination of Dr Fekete’s Case Report from 1968

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Abstract

Background In the December 28, 1968 edition of the Canadian Medical Association Journal, Dr John Fekete described a 16-year-old hockey player with fatal cerebral edema following a brain impact while actively symptomatic of a concussion incurred 4 days ago. This case has been described as a “possible” case of second impact syndrome, an entity that was named in 1984 and purportedly first described by Schneider in 1973.

Method An audit of material in the public register of Dr Fekete’s case was undertaken. Information sources included the newspaper report of the death, transcripts from a coroner’s inquest held 12 days later, including the autopsy report, genealogical data available online, and available internet resources.

Results There was clear documentation of concussive symptomatology following an initial head injury and evidence of a medical assessment, thus fulfilling the “definite” clinical criteria for second impact syndrome as proposed. After 4 days of ongoing concussive symptomatology, a dramatic, rapid neurological deterioration took place following an apparently unremarkable body contact and fall on the ice while playing hockey. His primary brain pathology included cerebral edema.

Conclusion Cerebral edema may follow primary or secondary head injury, the latter comprising second impact syndrome. Dr Fekete’s case, as described in the December 28, 1968 edition of the Canadian Medical Association Journal, should be recognized as the first description of this condition.

Keywords ► second impact syndrome
► brain concussion
► child
impact. The original article itself provided limited clinical information surrounding the nature of the initial injury, as it was reported primarily from a neuropathological perspective.

In the face of current medical literature, two questions persist about this report: first, was this a case of second impact syndrome? and second, if it was, should it not be correctly recognized as the inaugural report of this syndrome?

**Methods**

An audit of material in the public register of Dr Fekete’s case was undertaken to resolve these issues. Information sources included the newspaper report of the death, transcripts from a coroner’s inquest held 12 days later (including the autopsy report), genealogical data available online, and available internet resources.

**Results**

A coroner’s inquest was held 12 days after the death on the basis that “there may have been more than one accident involved” (in his death).

A witness testified that she had seen the deceased skating backward quickly without a helmet at a public skate when he fell suddenly on the ice, striking his occiput, 4 days before he died. He did not move on the ice for 4 to 5 minutes and required two-person assistance to leave the ice surface. His mother reported that he said he “felt alright” but that he had a bump on his head when she came to see him in the rink manager’s room. He stayed off the ice subsequently and requested to go home later that night. Once home, he reported a headache that had been unresponsive to three 325 mg acetylsalicylic acid (ASA) tablets and requested additional analgesics.

A classmate reported him telling her, “I’ve got a slight concussion, you know,” and of an ongoing headache during the day of the second injury. She further reported him borrowing approximately 9 to 21 ASA tablets (325 mg) from her locker over the week. A teacher reported the deceased requesting a medical review following the day of the second injury. She further reported that he functioned normally in her class.

On the evening of the second impact (4 days after the initial impact with apparent ongoing concussive symptomatology), the scheduled opponent for the deceased’s hockey team did not arrive, and a call went out to assemble a pickup team. During that game (with the deceased wearing a Cooper hockey helmet, likely the SK10 model), there was a collision with a player (much bigger than he), and the deceased fell to the ice, striking his left temple (reported as approximately 8:15 p.m.).

The initial responder (with whom he had collided) found him to be immediately unresponsive, with difficulty in breathing, his jaw tightly closed, and then he started vomiting repeatedly.

The first medical responder, a local GP arrived at approximately 8:30 p.m., found him “badly hurt” and unresponsive. He was transferred to the local hospital, where “his condition grew worse”—his pupils were later reported as fixed and dilated. A transfer was discussed with the regional neurosurgeon in St. John (1 hour 55 minutes away by Google maps7), and the deceased was ultimately transferred to the regional hospital in Fredericton (42 minutes away by Google maps5). The weather was clear that night with no snow and wind. He probably died during that transfer at approximately 10:00 p.m.

If there was a genetic propensity to brain swelling following trauma, a genealogical review traced the deceased’s lineage back four to five generations to primarily Irish and also Scottish immigrants to New Brunswick, Canada in the mid-1800s.

While the postmortem findings were extensively reported in Dr Fekete’s original report, the summary of the autopsy is as follows: Normal development and well-nourished male, weight at 25th percentile and height at the 10th percentile. Recent hemorrhage in left temporalis muscle and left orbit. The brain was edematous, weighing 1,600 g (+5.3 SD5) with subarachnoid hemorrhage, both cerebral and spinal; a right occipital lobe contusion 1 × 2 cm; and hemorrhage within the brainstem—cerebral peduncles and pons. The larynx and trachea showed widespread petechial hemorrhage and the lungs showed edema and congestion with large hemorrhagic areas. A remote kyphoscoliosis surgical repair was present.

**Discussion**

McCrory and Berkovic proposed diagnostic criteria for second impact syndrome, consisting of:

1. Medical review after a witnessed first impact.
2. Documentation of ongoing symptoms following the first impact up to the time of the second impact.
3. Witnessed second head impact with a subsequent rapid cerebral deterioration.
4. Neuropathological or neuroimaging evidence of cerebral swelling without significant intracranial hematoma or other cause for edema.

They have previously concluded that the above-mentioned case was a “probable” case of SIS on the basis that there was no medical review following the first impact. From the coroner’s inquest, we have indirect evidence that the deceased was aware that he had a concussion, that he was experiencing ongoing symptomatology, and that he consulted his doctor earlier in the day he died. Using the above diagnostic criteria, this description fulfills definite criteria for SIS.

Cerebral edema may follow a primary or a secondary head injury, the latter comprising second impact syndrome. Similar mechanisms may be involved. Within the concussion literature, the existence of second impact syndrome has been questioned, preferring the simplicity of diffuse cerebral edema following a primary head injury. These same articles reference case series of primarily children with dramatic cerebral edema developing acutely in the context of a head injury, most notably the series by Snoek and Bruce. Unfortunately, these case series either did not include adequate details as to the mechanism of injury to ensure a “minor” injury or clearly included children with severe head injury (by Glasgow coma scale). Within pediatrics, short height, witnessed falls have been
associated with death, and a subset of these have contusion with brain edema.\textsuperscript{13,14} Fortunately, these incidents are rare, estimated at less than 1 in a million children less than six per year\textsuperscript{15} and approximately 1 per 100,000 children brought to an emergency department following a playground equipment fall.\textsuperscript{16} It is known that mutations within the CACNA1A gene predispose individuals to familial hemiplegic migraine and delayed cerebral edema following minor head trauma;\textsuperscript{17,18} however, this gene abnormality is exceedingly rare within the population,\textsuperscript{19} and therefore unlikely to have accounted for these cases of diffuse cerebral edema.

Would the outcome of this case have been different if the physician who reviewed him earlier in the day was practicing using current guidelines? I suspect that the answer is “likely.” Practicing consistent with the consensus statement from the fourth International Conference on Concussion in Sport\textsuperscript{20} would have seen the physician recommend physical and cognitive rest until the acute symptoms resolved and then a graded program of exertion prior to medical clearance and return to play.

Second impact syndrome was named by Saunders and Harbaugh in the Journal of the American Medical Association in 1984.\textsuperscript{21} Reviews of this condition\textsuperscript{1,2} erroneously attributed its first description to Schneider in 1973,\textsuperscript{22} 5 years after Dr. Fekete’s report. As one of many Canadian physicians who manage individuals with concussive symptomatology, I believe that it is time that Dr. Fekete’s foundational work is recognized.

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Conflict of Interest
The author has no conflict of interest to disclose.

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References
\begin{itemize}
\item\textsuperscript{2} Cantu RC, Gean AD. Second-impact syndrome and a small subdural hematoma: an uncommon catastrophic result of repetitive head injury with a characteristic imaging appearance. J Neurotrauma 2010;27(09):1557–1564
\item\textsuperscript{3} McCrory PR, Berkovic SF. Second impact syndrome. Neurology 1998;50(03):677–683
\item\textsuperscript{4} McCrory P. Does second impact syndrome exist? Clin J Sport Med 2001;11(03):144–149
\item\textsuperscript{5} Thomas M, Haas TS, Doerer JJ, et al. Epidemiology of sudden death in young, competitive athletes due to blunt trauma. Pediatrics 2011;128(01):e1–e8
\item\textsuperscript{6} Fekete JF. Severe brain injury and death following minor hockey accidents: the effectiveness of the “safety helmets” of amateur hockey players. Can Med Assoc J 1968;99(25):1234–1239
\item\textsuperscript{7} Available at: https://www.google.ca/maps Accessed May 7, 2014
\item\textsuperscript{8} Available at: http://climate.weather.gc.ca/climate_data/hourly_data_e.html?hlyRange=1953-01-01%2C1970-01-01&StationID=6157&Prov=NB&urlExtension=_e.html&searchType=stnProv&optLimit=specDate&StartYear=1950&EndYear=2017&selRowPerPage=25&Line=1&Month=2&Day=1&StationID=6157&Prov=NB&OptLimit=specDate&StartYear=1968&EndYear=2014 Accessed September 21, 2017
\item\textsuperscript{9} Dekaban AS. Changes in brain weights during the span of human life: relation of brain weights to body heights and body weights. Ann Neurol 1978;4(04):345–356
\item\textsuperscript{11} Snoek JW, Minderhoud JM, Wilming JT. Delayed deterioration following mild head injury in children. Brain 1984;107(Pt 1):15–36
\item\textsuperscript{12} Bruce DA, Alavi A, Bilaniuk L, Dolinskas C, Obrist W, Uzzell B. Diffuse cerebral swelling following head injuries in children: the syndrome of “malignant brain edema.” J Neurosurg 1981;54(02):170–178
\item\textsuperscript{13} Chadwick DL, Chin S, Salerno C, Landsverk J, Kitchen L. Deaths from falls in children: how far is fatal? J Trauma 1991;31(10):1353–1355
\item\textsuperscript{14} Plunkett J. Fatal pediatric head injuries caused by short-distance falls. Am J Forensic Med Pathol 2001;22(01):1–12
\item\textsuperscript{16} Spivack B. Fatal pediatric head injuries caused by short-distance falls. Am J Forensic Med Pathol 2001;22(03):332–336
\item\textsuperscript{17} Kors EE, Terwindt GM, Vermeulen FL, et al. Delayed cerebral edema and fatal coma after minor head trauma: role of the CACNA1A calcium channel subunit gene and relationship with familial hemiplegic migraine. Ann Neurol 2001;49(06):753–760
\item\textsuperscript{18} Kors EE, Haan J, Giffin NJ, et al. Expanding the phenotypic spectrum of the CACNA1A gene T666M mutation: a description of 5 families with familial hemiplegic migraine. Arch Neurol 2003;60(05):684–688
\item\textsuperscript{21} Saunders RL, Harbaugh RE. The second impact in catastrophic contact-sports head trauma. JAMA 1984;252(04):538–539
\item\textsuperscript{22} Schneider RC. Head and Neck Injuries in Football. Baltimore, MD: Williams & Wilkins; 1973
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