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Traumatic Cranial Dural Venous Sinus Injury

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Abstract

Purpose: The study's objective is to elucidate and discuss the causes of traumatic dural venous sinus injury and make comparisons between these causes. The aim is also to assess the susceptibility of dural sinuses to injury in descending orders. Additionally, the research examines the relationship between types of fracture and the challenges in controlling bleeding in patients with traumatic dural venous sinus injury. Furthermore, the study analyzes the factors that influence the morbidity and mortality rate among patients with traumatic dural venous sinus injury.

Methodology: Between January 2021 and October 2022, a prospective study was carried out, involving 22 patients diagnosed with dural venous sinus injury. The study encompassed both surgically and conservatively treated patients. For each participant, demographic information, such as age, sex, causative trauma, preoperative GCS, preoperative deficit, image findings, name, and part of the injured sinus, as well as the presence and absence of a fracture and its relation to the sinus were recorded. The intraoperative method employed to control bleeding and the amount of blood transfusion were also documented, along with postoperative GCS and postoperative complications. The Glasgow Coma Scale (GCS) score was utilized to assess the neurological outcome.

Findings: The most frequently injured dural venous sinus was the superior sagittal sinus, accounting for 77.3% of cases (8).Among patients with a linear skull fracture crossing the venous sinus, 83.3% had bleeding that could be easily controlled by placing Gelfoam over the injured sinus . However, in patients with a skull fracture parallel to the sinus over the venous sinus and those with depressed fractures (with/without penetration), we encountered greater difficulty in controlling bleeding (14). Only 16.7% and 10% of these cases, respectively, were easily controlled by placing Gelfoam over the injured sinus, necessitating additional techniques to control bleeding in the remaining patients. Out of the total patients, 20 were managed surgically, while two were managed conservatively due to a Glasgow Coma Scale (GCS) score of 3 and signs of brain death.

Unique Contributions to Theory, Policy and Practice: The superior sagittal sinus was identified as the most commonly injured sinus. Road traffic accidents (RTAs) accounted for the most frequent cause of dural sinus injury, representing 40.9% of cases. Bleeding control proved more challenging when dealing with linear fractures parallel to the sinus or depressed (and/or penetrating) fractures over the sinus, compared to linear fractures crossing the sinus. The most significant factor influencing the mortality rate was the Glasgow Coma Scale (GCS) score on admission. Mortality and morbidity rates were highest in cases involving injury to the posterior part of the superior sagittal sinus, sigmoid sinuses, and combined injury to the anterior and middle parts of the superior sagittal sinus. Furthermore, the mortality rate was notably higher among military-injured patients than civilian-injured patients

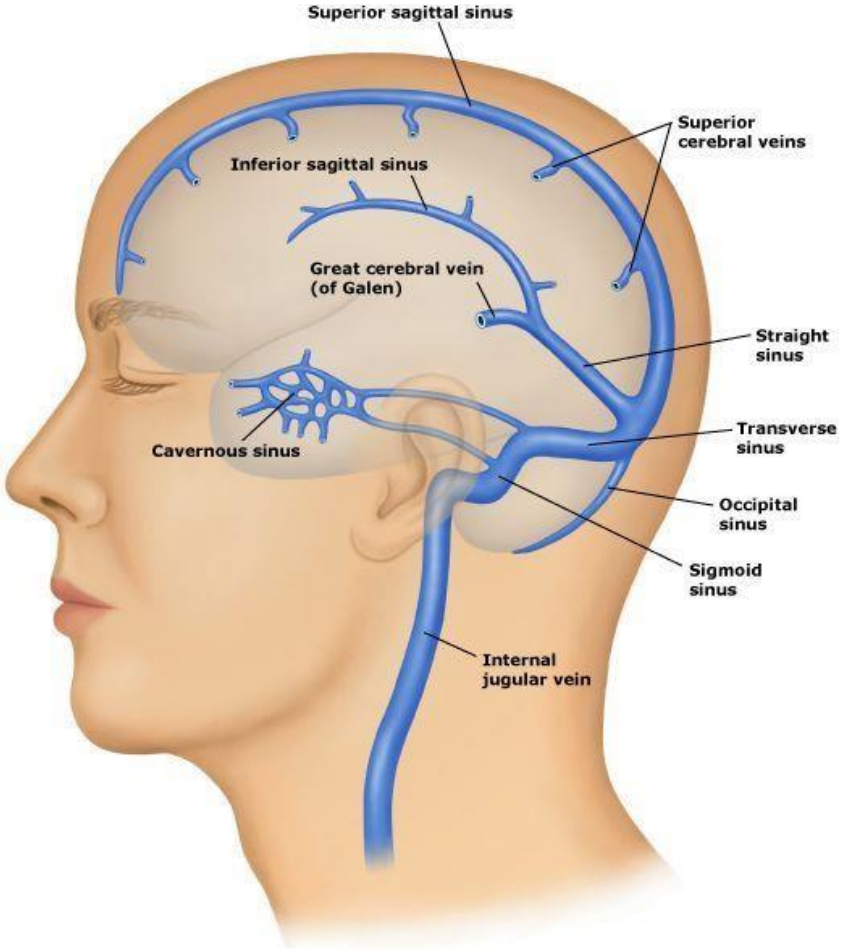
Keywords: *Dural venous sinuses, traumatic brain injury.*

Introduction:

Cranial dural venous sinuses are venous channels situated between the two layers of the cranial dura mater (Endostea layer and meningeal layer). They can be described as trapped epidural veins and differ from other veins as they run alone and are not parallel to arteries (16, 18). These sinuses lack valves, enabling bidirectional blood flow in intracranial veins. The incidence of cranial dural venous sinus injury varies, with reported rates ranging from one to four percent in civilian settings and four to twelve percent in wartime situations (1, 2, and 3). The significance of these injuries lies in their association with high mortality and morbidity due to severe bleeding during surgical operations. Interestingly, this type of injury is preoperatively suspected in only about half of the patients. Bleeding from the sinus roof, lateral sinus walls, venous lakes, arachnoid granulations, emissary veins, or cortical vein tributaries could be the origin of such bleeding. Superficial dural venous sinuses like the superior sagittal sinus, transverse sinus, and sigmoid sinuses are more susceptible to injury. Repair to maintain patency is typically required at three main locations of cranial dural venous sinuses:

1. Posterior and middle third of the superior sagittal sinus.
2. Torcular Herophili
3. Dominant transverse sinus (often the right transverse sinus)

Fig 1 showing dural venous sinuses sagittal view



All other sites can be ligated with minimal risk but should only be performed when all other measures have failed (4, 5). Cushing's review of 219 military head injuries during World War I included 14 patients with dural sinus injuries (6).

Patients and Methods

Clinical data

Between January 2021 and October 2022, a prospective review was undertaken for all patients diagnosed with dural venous sinus injury. For each patient, the following information was gathered: preoperative Glasgow Coma Scale (GCS) score, image findings, name, and part of the injured sinus, presence or absence of a fracture, and the relation of the fracture to the sinus. Additionally, the intraoperative method used for controlling bleeding, postoperative GCS score, and postoperative complications were recorded. The Glasgow Coma Scale (GCS) score was used as a parameter to assess the neurological status of the patients.

Imaging studies

On admission, all patients underwent computed tomography (CT) scans. The skull fracture pattern observed in the initial CT scans was classified based on the relation of the injured sinus, including

categories like crossing the sinus, parallel to the sinus, depressed and overlying the sinus, and depressed and penetrating the sinus (23). This classification allowed for a detailed assessment of the skull fracture pattern in relation to the injured dural venous sinus.

Hemorrhage control

From the operation reports, important details such as the amount of blood loss, the method of hemorrhage control, and the quantity of transfused blood were carefully noted.

For patients with a fracture line extending to the sinus area and with a depressed fracture over the sinus area, those planned for surgery were prepared with an additional unit of blood and fresh frozen plasma. During the operations, bleeding control was categorized as either 'Easy' or 'Difficult'. 'Easy' bleeding control referred to situations where sinus bleeding could be stopped by applying simple digital pressure using Gelfoam. On the other hand, 'Difficult' bleeding control indicated cases where sinus bleeding persisted despite attempts of simple digital pressure.

Operative techniques used in our study to control profuse bleeding:

During the positioning phase, the head was elevated at a 30-degree angle, carefully avoiding excessive neck flexion or rotation to prevent jugular vein kinking and venous drainage issues. A large incision was made to ensure ample exposure of all bone fragments and surrounding calvarium. The sinus was also exposed both proximally and distally to the site of injury. The bone flap extended well beyond the edge of any fracture, necessitating craniectomy on both sides of the sinus to prevent further injury. In all patients, sinus bleeding was temporarily controlled using digital pressure on a sheet of Gelfoam® covered with cottonoid (13).

Results:

From January 2021 to October 2022, a total of twenty-two patients with a Dural venous sinus injury and severe head injuries underwent surgery at Erbil Teaching Hospital. Among these patients, 4 were female, and 18 were male. The average age at presentation for these patients was 29.05 years, with an age range spanning from 3 to 63 years.

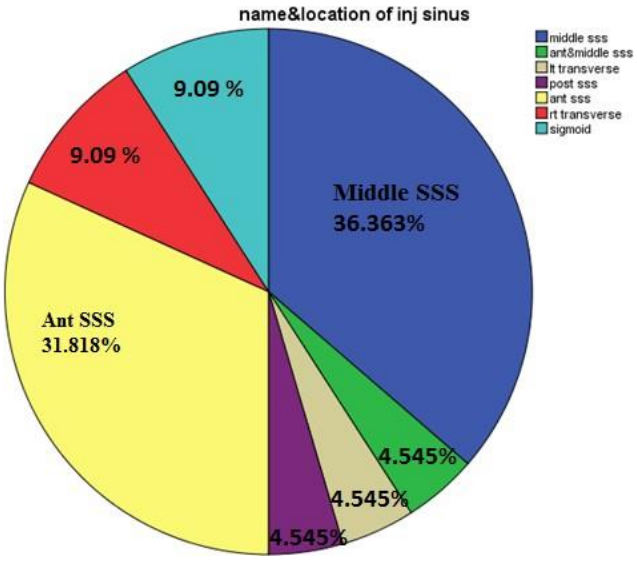


Fig 2 showing name and location of injured sinus

Name and location of injured sinus

The most frequent site of injury was the superior sagittal sinus. In 17 patients (77.27%), the superior sagittal sinus sustained injury. Among these patients, the anterior one-third of the superior sagittal sinus was injured in 7 cases (31.82%), followed by the middle one-third of the superior sagittal sinus in 8 patients (36.36%). In one patient (4.55%), there was a combined injury to the anterior and middle parts of the superior sagittal sinus, while in another patient (4.55%), the posterior one-third of the superior sagittal sinus was injured. Out of the twenty-two patients, three (13.64%) had an injury to the transverse sinus. Two of these patients had involvement of the right transverse sinus, and one patient had involvement of the left transverse sinus. Additionally, two patients (9.09%) had injuries to the sigmoid sinus, and in both cases, the injuries were on the left side.

Name of injured sinus		Number of Patients	Percentage
SSS overall		17	(77.271%)
Parts of SSS	Ant	7	(31.818%)
	Middle	8	(36.363%)
	Combined ant and middle	1	(4.545%)
	Post	1	(4.545%)
TS		3	(13.636%)
SS		2	(9.09%)

Out of the twenty-two patients, twenty underwent surgical intervention, while the remaining two patients were managed conservatively. The conservative treatment was chosen for these two

patients due to their Glasgow Coma Scale (GCS) score of 3, unstable medical condition, and signs of brain death.

Relation of Fracture to injured dural sinus

Among the twenty-two patients, ten had a depressed skull fracture overlying the venous sinus, and out of these, five had a fracture penetrating the sinus based on CT findings. Six patients had a linear skull fracture parallel to the dural venous sinus, and all of them experienced massive sinus bleeding that could not be controlled by simple digital pressure using Gelfoam. On the other hand, six patients had a linear skull fracture crossing the sinus over the venous sinus. In five of these patients, massive bleeding from the injured sinus wall could be controlled by simple digital pressure using Gelfoam. However, in one patient with the same type of fracture, there was vigorous bleeding from the sinus that could not be controlled by a simple procedure. Furthermore, in one patient with a depressed skull fracture overlying the sinus, the bleeding from the injured sinus could be controlled by a simple procedure. However, in the remaining nine patients with the same type of fracture, the bleeding from the injured sinus could not be controlled by a simple procedure.

Fracture type		Easy Haemostasis	Difficult Haemostasis
linear	Crossing 6	5	1
	Parallel 6	0	6
Depressed **5**		1	4
Depressed and penetrating **5**		0	5

Table 2 showing Difficulty of Haemostasis in relation to Fracture Type

Eight patients passed away during their treatment, and all of them were in the Respiratory Care Unit (RCU). Among these eight patients, six were among those who underwent surgery, and the remaining two were managed conservatively. It's important to note that patient outcomes can vary, and medical conditions can be complex, leading to different results in each case.

Neurological status

The GCS scores at admission ranged from 3 to 15, with a mean score of 8. Among the patients, two individuals had a GCS score of 3 and exhibited signs of brain death, resulting in conservative

treatment for them.

GCS Category	13-15	8-12	3-7
Preoperative GCS	**3**	**8**	**11**
Postoperative GCS	**8**	**6**	**8**

Table 3 showing Neurological status at admission and discharge from the hospitalaccording to GCS

Discussion

The primary objective of this study is to discuss traumatic dural venous sinus injury comprehensively. The study aims to explore the various causes of such injuries, examining their relation to different types of fractures. Additionally, the study seeks to investigate the difficulty of achieving haemostasis (bleeding control) in these cases and explore the morbidity and mortality associated with traumatic dural venous sinus injuries. By addressing these aspects, the study aims to provide valuable insights into the management and outcomes of this specific type of injury. Indeed, traumatic dural sinus injury poses significant challenges in neurosurgery and requires proper and timely management. The critical aspect lies in the risk of fatal hemorrhage during the surgical operation, emphasizing the need for careful handling and intervention. According to the authors' reports, the incidence of such injuries can vary, but during times of war, it generally ranges from 4% to 12%. In contrast, in civilian life, the incidence is typically lower, ranging from 1% to 4% (1, 2, and 3). Traumatic dural sinus injuries typically occur due to moderate to severe trauma, often leading to severe hemorrhage and brain swelling from venous congestion. As a result, the mortality rate associated with this type of injury is generally high. In a study, a mortality rate of 36.6% was reported.

Historically, during World War I, Cushing reviewed 219 military head injury patients and found a mortality rate of 79% among 14 cases of dural sinus injuries (6). However, a more recent review by Meirowski of 100 patients with dural sinus injury reported a lower mortality rate of 12%. Meirowski emphasized the importance of proximal and distal control of the damaged sinus and described repair techniques involving Gelfoam, muscle strips, and silk sutures (24).

It's essential to continue research and improvements in surgical techniques to enhance outcomes and reduce the mortality rate associated with traumatic dural sinus injuries.

Location of sinus injury

In the mentioned study, the most common injured dural sinus was the superior sagittal sinus, particularly in its anterior and middle parts. The authors reported different rates of injury to these sites in previous studies, such as Meier finding 66% (25), Meirowsky 57% (24), Kapp and

Gielchinsky 74% (2), and Kapp finding 82% (3). The location of the sinus injury is crucial, as the presence of additional collaterals proximal to the injury site can significantly reduce morbidity. If adequate collaterals are present, ligations of the sinus can be performed if necessary. However, it is important to note that ligations of the sinus should only be done in life-saving situations. In one patient (case 12) in the study, ligation of the anterior part of the superior sagittal sinus was necessary. This emphasizes the importance of carefully assessing the condition and considering appropriate measures to minimize complications and improve patient outcomes.

References

1- YS Kim ,SH Jung, DH Lim, TS Kim, JH Kim, MD, JK Lee, Traumatic Dural Venous Sinus Injury. Korean J neurotrauma 2015 Oct; 11(2): 118–123.

2- Kapp JP, Gielchinsky I. Management of combat wounds of the dural venous sinuses. Surgery. 1972;71:913–917. [PubMed]

3- Kapp JP, Gielchinsky I, Deardourff SL. Operative techniques for management of lesions involving the dural venous sinuses. Surg Neurol. 1977;7:339–342. [PubMed]

4- Meier U, Gärtner F, Knopf W, Klötzer R, Wolf O. The traumatic dural sinus injury--a clinical study. Acta Neurochir (Wien) 1992; 119:91–93.

5- LeFeuvre D, Taylor A, Peter JC. Compound depressed skull fractures involving a venous sinus. Surg Neurol. 2004; 62:121–125. discussion 125-126.

6- Cushing H. A study of series of wounds involving the brain and its enveloping structures. Br J Surg. 1918;5:558–684

7- Ozer FD, Yurt A, Sucu HK, Tektas S. Depressed fractures over cranial venous sinus. J Emerg Med. 2005;29:137–9. [PubMed]

8- Bonnal J, Buduba C. Surgery of the central third of the superior sagittal sinus. Experimental study. Acta Neurochir (Wien) 1974;30:207–15. [PubMed]

9- Datta SG, Ch M. Bilateral vertex extradural hematomas: A patient report. Indian J Neurotrauma. 2008;5:109–11.

10- Behera SK, Senapati SB, Mishra SS, Das S. Management of superior sagittal sinus injury encountered in traumatic head injury patients: analysis of 15 patients. Asian J Neurosurg. 2015;10:17–20

11- Tanaka H, Tanaka H, Kobata H. Superior sagittal sinus occlusion caused by a compound depressed skull fracture: A patient treated by emergency surgery. No Shinkei Geka. 2004;32:753–8. [PubMed]

12- Huang SQ. Surgical treatment of intracranial venous sinus injury. A report of 111 patients. Zhonghua Wai Ke Za Zhi. 1989;27:166–8. 190. [PubMed]

13- Gazzeri R, Galarza M, Fiore C, Callovini G, Alfieri A. Use of tissue-glue-coated collagen sponge (TachoSil) to repair minor cerebral dural venous sinus lacerations: technical note. Neurosurgery. 2015;11 Suppl 2:32–36. discussion 36

14- Ozer FD, Yurt A, Sucu HK, Tektaş S. Depressed fractures over cranialvenous sinus. J Emerg Med. 2005;29:137–139. [PubMed]

15- http://media.axon.es/pdf/92971_2.pdf

16- The cerebral Veins .Rhotons Cranial anatomy And Surgical ApproachesNeurosurgery 51[Suppl 1]:159–205,

17- https://ucsfmed.wordpress.com/2016/10/28/zsfg-neuro-report-multiple- cranial-neuropathies-spotlight-on-the-cavernous-sinus/

18- Christine gralapp Medical Medical Illustrationshttps://entokey.com/chapter-1-neuro-ophthalmic-anatomy/

19- Christine gralapp Medical Medical Illustrations, http://muvag.info/sinus-drainage-anatomy.html

20- American Journal of Neuroradiology (http://www.ajnr.org/content/25/7/1181)

21- https://www.pinterest.com/pin/493566440390790260/?lp=true

22- http://ranzcrpart1.wikia.com/wiki/Meninges:Dura_mater_(in_general)?file= Cerebelli.jp

23- Josser E. Delgado Almandoz, MD, Hillary R. Kelly, MD, Pamela W. Schaefer, MD, Prevalence of Traumatic Dural Venous Sinus Thrombosis in High-Risk Acute Blunt Head Trauma Patients Evaluated with Multidetector CT Venography

24- Meirowsky AM. Wounds of dural sinuses. J Neurosurg. 1953;10:496–514

25-Meier U, Gärtner F, Knopf W, Klötzer R, Wolf O. The traumatic dural sinus injury--a clinical study. Acta Neurochir (Wien) 1992;119:91–93