

# Technical Considerations and outcome of repair in Hatchet Combat Injury to Cerebral Venous Sinuses

Fahmida Arab Mallah<sup>1</sup>, Muhammad Khalid<sup>2</sup>, Syed Amir Shah<sup>3</sup>, Abdul Razaq Mari<sup>4</sup>, Hamid Akbar Shaikh<sup>5</sup>, Muzamil Dilbar<sup>6</sup>, Shams Raza Brohi<sup>7</sup>

## Author's Affiliation

<sup>1</sup>Senior Registrar, Peoples University of Medical and Health Sciences, Shaheed Benazir Abad, Nawabshah

<sup>2</sup>Chief Resident Neuro Surgeon,

<sup>3</sup>Senior Registrar neurosurgery, SZABMU-Pakistan Institute of Medical Sciences, Islamabad

<sup>4,5</sup>Assistant Professor, Neurosurgery Peoples University of Medical and Health Sciences, Shaheed Benazir Abad, Nawabshah

<sup>6</sup>Senior Women Medical Officer, Neurosurgery, Peoples Medical College Hospital, Shaheed Benazirabad, Nawabshah

<sup>7</sup>Professor and Chairman, Neurosurgery, Peoples University of Medical and Health Sciences, Shaheed Benazir Abad, Nawabshah

## Author's Contribution

<sup>1</sup>Conceived the topic and review the study & Discussion

<sup>2,3</sup> Interpretation, collected the data, data analysis.

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## Address of Correspondence

Dr Muhammad Khalid  
drkhalid86@yahoo.com

## ABSTRACT

**Objective:** To assess and manage Hatchet combat injuries to cerebral venous sinuses with a variety of surgical methods.

**Study Design:** Descriptive case series study

**Place and Duration of study:** Neurosurgery Department Peoples University of Medical and Health Sciences Nawabshah and Neurosurgery department PIMS Islamabad, from 1st Aug 2014 to July 2016.

**Methodology:** All the patients were assessed clinically and radiologically and prepared for operation with an adequate amount of blood. Injury to venous sinus injury assessed and management varied from tamponade to interposition graft depending on the site and category of cerebral venous sinus injury.

**Results:** 15 patients of hatchet dural venous sinus injury, managed surgically which includes 3 (20%) females and 12 (80%) males with mean age of 35 years and mean GCS of 9 -12. There were 08 (53.33%) cases involving superior sagittal sinus, 02 (13.33%) transverse sinus, 02 (13.33%), sigmoid sinus 02 (13.33%); and combine sigmoid and transverse sinus injury in 01 (6.66%) patient. Out of 15 patients, bleeding was controlled by sinus compression in 08 (53.33%) patient, ligation in 03 (20%), dural grafting in 03 (20%) and repair with saphenous venous graft in 01 (6.66%) patient. There was 01 (6.66%) death in the first week of trauma, 02 (13.33%) patients had got CSF leak. Hemiplegia persisted in 02 (13.33%) patients and 01 (6.66%) patient had got complete Aphasia.

**Conclusion:** Hatchet combat injuries to venous sinus should be managed carefully with adequate exposure of the sinuses and securing hemostasis with simple compression, ligation, dural grafting or saphenous vein interposition graft.

**Keywords:** Technical considerations, cerebral venous sinus repair, hatchet combat, cerebral venous sinus injury.

## Introduction

Cerebral venous sinuses are different from extracranial veins being fixed to cranium, valveless and have no muscular tissue. They have three-sided lumen. Injury to Dural venous sinuses may be encountered in penetrating and non-penetrating head trauma or can result from accidental disruption during a craniotomy. Lacerations of the dural sinuses are common in wartime accounts about 14-20%. Significant dural sinus injury occurred in 1.5–5% of all severe head injured patients and injury to superior sagittal sinus (SSS) accounts for 70–80% of these.<sup>3,4,10</sup> Cushing's review of 219 military head injuries from World War I contained 14 cases of injury to one or more dural sinus with a subsequent mortality of 79%.<sup>1,2,3,4</sup> Hatchet combat injuries are 1 to 5 % of head injury patients<sup>5,6</sup>, most of these conflicts are due to tribe and family affairs, and a shortage of water distribution to crops especially during winter and autumn. It can be divided into Impalement (when object remains stuck inside the skull or brain) or non-impalement. Impalement object should be removed in Operation Theater under all aseptic measures and precautions with layer by layer removal without twisting and turning of stuck object because it can result in further damage to surrounding vital tissues of brain. That is a dangerous act that can result in on spot death because of massive blood loss from sinus.

The decision to repair versus sacrifice the sinus is dependent on the location of injury. When repair is indicated, the type and extent of the injury will largely dictate the optimal repair technique, which ranges from direct repair to segmental replacement<sup>7,8</sup>.

Management of dural venous sinus repair is quite challenging because of high mortality and morbidity associated with a large amount of blood loss, sinus thrombosis, and air embolism<sup>9,10</sup>. These complications can be avoided by vigilant measures during peri-operative period. The purpose of this study is to assess outcome of different ways of treating cerebral venous sinus injury.

## Methodology

This descriptive study was conducted in the neurosurgery department of Peoples' University of Medical and Health Sciences for Women Nawabshah over a period of two years from July 2014 to August 2016. All patients presented in ER were assessed clinically and radiology to have sign and symptoms of Hatchet injury to cerebral venous sinus. Those patients willing for surgery, having GCS above 4 were included. Venous sinus injuries

because of other causes were excluded. Plain CT scan brain with or without 3D reconstruction was done in all patients. Surgical techniques to repair the cerebral venous sinuses were tailored according to site, type and extent of venous sinus injury, all procedures were clearly enrolled on Performa.

Mode of sinus injury was further assessed on radiology depending on the severity of trauma and divided into 4 categories and managed accordingly.

- Category 1) having Linear fracture parallel to sinus with minimal cortical contusions.
- Category 2) having suture diastasis with bilateral vertex Extra Dura Hematoma {EDH}
- Category 3) had depressed fracture compressing the sinus with cortical contusions plus minimal EDH
- Category 4) having depressed fracture penetrating the sinus with cortical contusions and EDH

Generally, Category 1 and 2 are managed by simple tamponade effect with strip craniectomy over the involved sinus and dural tacking up suture with evacuation of EHD and Contusions. Category 3 are managed by Bilateral and proximal and distal exposure of involved sinus step by step removal of fracture compressing the sinus with tamponade, primary running suture, dural patch graft and ligation, again depend on involved sinus and type of laceration. Category 4 injuries are most difficult to manage because of fracture causing laceration of the specific sinus. These are managed by dural patch graft with tamponade, sinus ligation or venous sinus interposition grafting; again depending on type and size of laceration.

In hatchet combat injury incised compound wound is already over the scalp and skull so we have to tailor incision according to the extent of the injury. Under all aseptic measures, operative site was scrubbed, cleaned painted with pyodine solution, draped, local infiltrated, the wound was incised, wound toilet done. If a linear fracture or suture diastasis with venous sinus injury is encountered leave bony shelf adjacent to sinus and apply epidural taking up suture. If depressed fracture compressing the sinus, burr hole should be placed at the outer rim of depressed fracture allowing access to normal structure at periphery. If fracture transected the sinus bilateral bony exposure both proximal and distal to sinus is necessary. The fragment that lies directly over the sinus should be removed at last. If EDH, SDH or cortical contusions those are managed accordingly and evacuated.

## Results

In our study a total of 15 cases of cerebral venous sinus injury caused by hatchet combat managed by different surgical technique were enrolled. The mean age of study patients were 35±15 years ranging from 25 to 45 years. Female to male ratio was 1:4.

Male	Female	Ratio	Range	Mean
12/15(80%)	3/15(20%)	1:04	25....45	35+15

We didn't receive any patient with impalement hatchet injury because that most of the time object was removed by patients' relatives or someone else thinking to save the life their dear ones. Mode of sinus injury was further assessed on radiology depending on the severity of trauma and divided into 4 categories and managed accordingly.



Figure 1. 3D CT scan pre op showed depressed fracture on SSS.

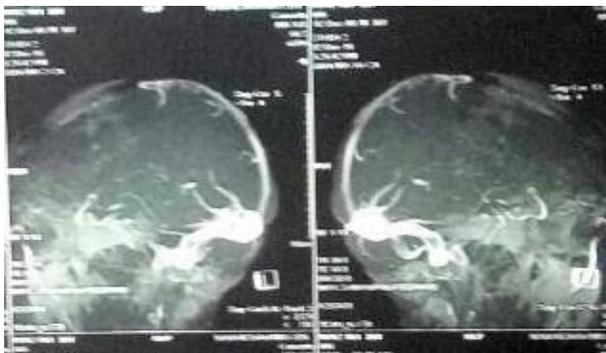


Figure 2. Post op MRV of same patient , Sinus is patent after Sepanous vein grafting

Type of skull fracture	Linear fracture parallel to SSS	Coronal suture diastases	Depressed fracture	Depressed with Penetration
Associated pathology	Cortical contusion	Contusion, EDH	Cortical contusion	Bilateral vertex EDH
Number of patients	2	4	6	3

We further simplified our technique by keeping in mind the size of laceration, type and site of specific sinus, technique and amount of blood loss in each technique. In our study 8 patients diagnosed intraoperatively to have small laceration a slit-like vertical laceration, those were managing successfully by sinus compression or tamponade technique, majority 80% were anterior 3<sup>rd</sup>. of SSS cases.10% of sigmoid and 10% transverse sinus injury managed by tamponade technique.

There was about 200-300ml blood loss during this technique, which was managed by blood transfusion. Six patients had large laceration on anterior wall of sinus which were managed by ligation in 2 cases of anterior 3<sup>rd</sup>. of SSS and 1 case of Transverse sinus laceration, there was about 400ml of blood loss, while 2 cases of SSS middle 3<sup>rd</sup>. and 1 case of transverse sinus laceration managed by sinus repair with dural patch graft rolled from convexity dura and periosteum patch graft. Maximum blood loss was 400-600ml.

Most difficult to manage are largest lacerations that involve dorsal and lateral wall of sinus especially posterior to coronal sinus,1 case had largest laceration on middle and posterior thirdx of SSS it was repaired with saphenous venous interposition grafting. Maximum blood loss was about 1000ml.

Postoperatively patients were kept in ICU, prophylactic intravenous Antibiotics and anticonvulsants were given. Measures were taken to control raised intracranial pressure and brain edema. GCS of the patient on arrival was compared with GCS on Discharge. There was a significant improvement, 8 patient presents with GCS 14, and discharge with 15. 5 patient presents with GCS 9 discharged with 15, 2 patient presented with GCS 6 discharged in GCS 9.

GCS on admission: 6	Number of patients: 2
GCS on admission: 9	Number of patients:5
GCS on admission: 14	Number of patients:8
GCS on discharge: 9	Number of patients :2
GCS on discharge:14	Number of patients:3
GCS on discharge15	Number of patients:10

Wound infection and CSF leak was in 13.33% of cases and neurologic deficit in the form of hemiplegia and complete aphasia in 20%. There was 1 death during 1 week of surgery.

## Discussion

Injury to cerebral venous sinuses accounts about 14-20% in Wartime. (3,4), and 1.5–5% of all head injuries<sup>11,12</sup> and Superior sagittal sinus (SSS) 70–80% of these<sup>13</sup>. Hemorrhage can arise from the sinus roof, lateral walls, venous lakes, arachnoid granulations, emissary veins, or cortical vein tributaries. Superficial locations, SSS, Transverse sinus, sigmoid sinuses are more commonly encountered. There is no study reported in literature on hatchet injury to vertebral venous sinuses.

There are three sites of cerebral venous sinuses that require repair to maintain patency: 1, Posterior and middle 3<sup>rd</sup> of SSS 2, Torcular herophili 3, Dominant transverse sinus. All other sites may be ligated with minimal risk. (in our setup we avoid unnecessary ligation of even anterior 3<sup>rd</sup> of sinus to restore to normal anatomical circulation<sup>14,15</sup>).

If largest laceration or complete sinus transection that lies behind the coronal suture, greater saphenous vein must be harvested from upper thigh, graft is reversed, temporary shunt is placed around the graft and continuously irrigated with heparinized fluid, incorporated with multiple interrupted end to end non absorbable suture leaving a small dorsal region to remove the shunt and tie the final stitches

The most common site of dural venous sinus injury is the anterior and middle one-third of the superior sagittal sinus. Meier et al.<sup>16</sup>, Meierowsky Kapp<sup>17</sup> and Gielchinsky, and Kapp et al<sup>18</sup>., reported that this same location has been noted in 66%, 57%, 74%, and 82% of the patients respectively. While in our study it was 55.33 to 6.66. Location of sinus injury is very important in terms of perioperative mortality and morbidity Meier et al.<sup>6</sup> reported that 17% of the patients with sinus

injury in the anterior one-third of the superior sagittal sinus result in death, whereas 50% of the cases with injury at the middle one-third and all patients with injury to the posterior part of the superior sagittal sinus died.

While in our study none of patient with SSS injury repaired died,

Kapp et al developed an internal shunt for use during sinus reconstruction.<sup>3,4</sup> This was made of a pediatric endotracheal tube with a pediatric tracheostomy cuff placed at each end. Sindhu and Alvernia avoided the balloon shunt and Fogarty balloon catheter due to risk of injury to the sinus endothelium, advocating, instead, for direct packing of the lumen with hemostatic material.<sup>2</sup> Both emphasize the need for sinus thrombectomy of the proximal and distal ends of the sinus repair to ensure patency.

Elevating depressed skull fractures overlying the superior sagittal sinus is considered hazardous. LeFeuvre et al.<sup>19</sup> and Miller and Jennett<sup>20</sup> reported that the incidences of severe hemorrhagic complications in patients undergoing operative treatment for depressed skull fractures over a venous sinus are 23% and 20%. Miller and Jennett<sup>21,22</sup> also reported an incidence of 11.5% in cases with simultaneous penetration of a venous sinus. In such cases, conservative management is strongly emphasized because of the potential mortality resulting from uncontrollable bleeding

While in our study mortality was not directly related to massive bleeding during elevation of depressed fracture over venous sinus and its repair, it was due to associated chest trauma plus pneumonia during first week of trauma. In a study by Behera et al.,<sup>23,24,25</sup> thrombocytopenia occurred in 85% and defibrination occurred in 69% of cases with dural sinus injury. Hence, coagulation studies should be performed during the perioperative period, in our study one of patient that got massive transfusion more than 6 pint of whole blood, we prophylactically transfused FFPs and platelets so there was no

Our study	Meier et al.	Miller and Jennett	Meier et al. Meierowsky, Kapp and Gielchinsky, and Kapp et al Kim et al.
0%Death in Ant 3 <sup>rd</sup> SSS 6.66% Death in middle 3 <sup>rd</sup> SSS	17% death in ant 3 <sup>rd</sup> SSS. 50% Death in middle and post 3 <sup>rd</sup> of SSS	overall mortality 11-20%	
Injury to SSS ant:# 3 <sup>rd</sup> to middle 3 <sup>rd</sup> 53.33 to 6.66			<b>66%, 57%, 74%, and 82% ,75%</b>
Wound infection, CSF leak+ wound infection 13.33% Neurodefecit.20%	0%	0%	0%

thrombocytopenia nor defibrination observed. Postoperatively patient was kept in ICU, prophylactic antibiotics and anticonvulsants were given, discharge on a full recovery and follow up for 3 months post-surgery. Because of emergency surgery, we didn't do sinus venography and CT angiography.

In our study the most common complication observed was 01 deaths (6.66%) in the first week of trauma, 02 (13.33%) had got CSF leak and wound infection, hemiplegia persisted in 02 (13.33%) patients and 01 (6.66%) patient had got complete aphasia. Patients having initial GCS of greater than 6 got considerable improvement irrespective to extent and site of sinus involved in hatchet injury.

We have relatively better outcome and results, because in our study type of injury is focal, while above-mentioned studied it was diffuse type of injury associated with brain stem and polytrauma patients,

They have included all patients presented in ER with GCS 3 also but in our study patients, GCS was more than 4.

It's not a logical comparison so our study is the unique because both nationally and internationally hardly any research conducted on hatchet injury to cerebral venous sinuses, the reason may be the cultural aspect.

## Conclusion

Hatchet combat injuries to venous sinus should be managed carefully with adequate exposure of the sinuses and securing hemostasis with simple compression, ligation, dural grafting or saphenous vein interposition graft depends upon size and site of sinus injury with proper precautions to avoid air embolism, thrombosis, hemorrhage and venous infarction.

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