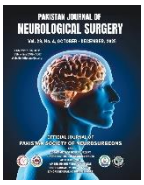

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Original Research

Surgical Outcome of Brain Contusions Treated by Decompressive Craniotomy With or Without Lobectomy

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ABSTRACT

Objective: To compare the surgical outcomes of decompressive craniotomy with or without lobectomy for patients presenting with brain contusions in a tertiary care trauma center."

Material & methods: This randomized clinical trial was carried out in the Neurosurgery department, Allied Hospital, Faisalabad, for 1 year. Patients admitted with severe TBI were enrolled and underwent decompressive craniotomy (DC) with lax duraplasty, or decompressive craniotomy with lobectomy (DCWL) or contusionectomy and lax duraplasty. The primary outcome was assessed at 3 months and 6 months using the Glasgow Outcome Scale Extended (GOS-E). All the data was recorded in a proforma and later on analyzed in SPSS version 26.

Results: The mean GCS score at presentation in DC was 5.8±0.755 and in DCWL was 5.64±0.74. At the 3rd month, 44% patients had GOS-E at vegetative state, 30% had GOS-E at lower severe disability, and 26% had GOS-E at upper severe disability in the DC group. But in the DCWL group, 2% patients had GOS-E at vegetative state, 22% were at lower severe disability 16% were at upper severe disability, 30% had GOS-E at upper moderate disability, and 30% were at lower moderate disability ($P<0.05$). At the 6th month, 26% patients had GOS-E at dead state, 34% were at upper severe disability, and 40% were at lower moderate disability in the DC group. But in the DCWL group, 38% had GOS-E at upper moderate disability, 32% were at lower good recovery, and 30% were at upper good recovery ($p<0.05$).

Conclusion: The surgical outcome of brain contusions treated by DCWL was better compared to DC without lobectomy.

Keywords: Surgical outcome, brain contusions, Decompressive craniotomy, lobectomy, Glasgow outcome scale extended, GOS-E.

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INTRODUCTION

Traumatic brain injuries (TBI) are a major threat to public health and economic stability around the

world. More than five million people worldwide die annually from trauma-related causes, reports the World Health Organization. Nine percent of all deaths worldwide can be attributed to this.[1] Million of people sustain nonfatal injuries from trauma every year that leave them permanently disabled. Brain injuries are among the most serious and have the highest risk of being fatal or leaving the victim severely disabled.[2]

There are between 64 to 74 million cases of TBI per year. However, it is difficult to evaluate how severe TBI and its effects actually are due to issues in data collection, especially in nations with low and moderate incomes.[3] A higher risk of death and poorer outcome after TBI have both been linked to intracranial hypertension in several large cohort studies of people who have experienced TBI. Therefore, it is critical to treat a TBI as soon as possible, especially if the patient has had brain swelling and high intracranial pressure.[4]

In situations of brain swelling and acute traumatic subdural hematoma, as well as for non-traumatic lesions, DC is often used to give space for a swollen brain by quickly reducing the pressure inside the skull (intracranial pressure).[5] To treat it, first the patient's vitals must be stabilized, and then normal blood flow must be restored to prevent further damage.[6]

As a common surgical procedure, DC is used to relieve high intracranial pressure brought on by TBI. Despite its life-saving purpose, the craniotomy itself is harmful to the patient's brain.[7] After the neurosurgery is finished, the patient will need to have a second cranial reconstruction.[7] Some individuals with severe TBI now have access to a relatively new type of surgery called lobectomy. In a craniectomy, a surgeon cuts away damaged or diseased bone from the skull. Lobes of the brain may be surgically removed in a process called a lobectomy, which also necessitates a craniotomy. When intracranial pressure or herniation during surgery becomes uncontrollable, lobectomy is performed to more radically and aggressively modify and extend the skull's fixed volume. A more extreme and forceful strategy is employed to achieve this. Oncel et al, analyzed data from 2007 and found that lobectomy is an effective method of treating brain cancer, whether it be a frontal lobectomy, a temporal lobectomy, or a combination/other lobectomy.[8] About 75% patients (6 out of 8) had a good recovery (GOS score of 4 or 5), 12.5% of patients (1 out of 8) had a terrible recovery (GOS score of 2 or 3), and 12.5% of patients went away, as reported by Jiang and colleagues (1 of 8 patients). Every single patient who made it through surgery showed an improvement in their Glasgow Coma Scale score.[9]

PATIENTS AND METHODS

Study Design and Place

This Randomized controlled trial was conducted at the Department of Neurosurgery, Allied Hospital, Faisalabad, for 12 months. Sample size was calculated using the WHO sample size calculator as 100 patients (50 in each group), by using 80% power of the study, 5% significance level, and percentage of good outcome, i.e. 28% without lobectomy and 42% with lobectomy.[10]

Inclusion Criteria

Patients with severe TBI with a GCS <8, admitted with unilateral temporal or frontal cerebral contusions more than 20 cm3 CT Scan in volume after head trauma..

Exclusion Criteria

The patients with penetrating injury, brainstem injury, multiple trauma, hemodynamic instability, history of prior neurologic disease or disability, coagulopathy, coup counter coup, or if the patient improves with conservative management, and GCS improves.

Ethical Approval

Before initiating the research work, permission was

taken from the Ethical Review Committee (ERC letter no. 48-ERC/ 2020-21/ PHRC/ FMU/ 74).

Data Collection

All the patients were enrolled by applying a convenience sampling technique, and informed consent was taken. All of the patients' personal data, including demographic data, time of injury, time between injury and operation, pre-op Glasgow Coma Scale (GCS) score, post-op GCS score, and pupillary reaction, were recorded. Then, patients underwent decompressive craniotomies under general anesthesia by a single surgical team. Then, patients will be randomly divided into two groups by using a random number table. In group A, decompressive craniotomies were done with lax duraplasty alone. In group B, decompressive craniotomies were performed with lobectomy or contusectomy with lax duraplasty.

A question-mark-shaped incision is made in the patient's skin in order to do a standard DC. In addition to the frontal craniotomy's linear hairline incision, 10-15 cm of the temporo-parietal bone will be excised. To access the dura, a curved incision across the Sylvian fissure about a centimeter from the craniotomy window is required. Cuts made to the sides of the dura enlarge the entrance. Individuals in Group A will have a DC performed. Brain contusions will not receive any medical attention. Patients in Group B will undergo a DC in addition to lobectomy of the affected lobe or excision of the bruised brain. Lax duraplasty, using either a harvested pericranium graft or an artificial dura, fascia lata, and temporalis fascia graft, will be performed at the end of the procedure. Both sets of people will undergo this surgery. Bone flap reimplantation into abdominal subcutaneous tissue. No more than 5 centimeters of brain tissue will be removed during a bottom lobectomy, and no more than the coronal suture will be removed with a top lobectomy. When operating on the patient's dominant side of the brain, neurosurgeons often stop cutting 1 to 2 cm before the coronal suture when doing a frontal lobectomy. This is because a coronal suture is employed to seal the incision. A temporal lobectomy involves cutting out the temporal lobe's anterior five cm and some surrounding mesial structures. Doing so reduces the risk of damaging the main arteries carrying blood to the heart during surgery.

After the procedure, patients were shifted to post-procedural wards and were discharged from there. All the patients were followed up in OPD for 3 and 6 months. On each visit, patients were examined for the Glasgow outcome scale, and findings were recorded as either positive (patient made a full recovery with just mild impairments) or negative (patient did not make a full recovery and has major impairments) (severe disability, persistent vegetative state, and death).

SPSS version 26 will be used to analyze the data. Both groups were compared for GOS-E was done by using a chi-square test (p-value≤ 0.05 was kept as significant.

Definitions

Traumatic Brain Injury (TBI)

Patients of head injury leading to changes in CT brain reported by a consultant radiologist will be labeled as TBI.

Brain Contusion

Often "fluffy" inhomogeneous high-density areas within brain parenchyma, usually adjacent to bony prominences (frontal and occipital poles, sphenoid wing). Typically, less well-defined than primary ICH.

GCS (Glasgow Coma Scale)

The Conscious level of the patient presenting in the emergency with a history of head trauma will be assessed using this scale.

GOS-E	Definition
Vegetative state	Unable to obey the command
Lower severe disability	Dependent on others for care
Upper severe disability	Independent at home
Lower moderate disability	Independent at home and outside the home, but with some physical or mental disability
Upper moderate disability	Independent at home and outside the home, but with some physical or mental disability, with less disruption than the lower moderate disability
Lower good recovery	Able to resume normal activities with some injury-related problems
Upper good recovery	No problem

Goose Score							
1 Dead	2 Vegetative State	3 Lower Severe Disability	4 Upper Severe Disability	5 Lower Moderate Disability	6 Upper Moderate Disability	7 Lower Good Recovery	8 Upper Good Recovery

Glasgow Outcome Scale Extended (GOS-E)

Primary outcome will be based on the Glasgow Outcome Scale Extended (GOS-E), assessed after 3 months & 6 months.

Favorable Outcome

From lower moderate disability to upper good recovery.

Unfavorable Outcome

Dead, vegetative, lower, and upper severe disability.

RESULTS

Age Distribution of Patients

In DC, 26% of the patients were <20, 46% were between 20-50, and 28% were >50, but in DCWL, 38% of the patients were <20, 24% were between 20-50, and 28% were >50.

Gender Distribution

In DC, males were 28% and females were 72% but in DCWL, males were 78% and females were 22%.

Cause of Trauma

DC, 62% of the patients had their trauma cause was RTA, 30% had their trauma cause was assault, and 8% had their trauma cause was a fall, but in DCWL, 36% of the patients had their trauma cause was RTA, 18% had their trauma cause was assault, and 46% had their trauma cause was a fall.

Pupil Reaction at Presentation

In DC, 26% of the patient's pupil reaction was normal, 48%of the patient's pupil reaction was ipsilateral and 26% of the patient's pupil reaction were non-reactive but in DCWL, 24% of the patient's pupil reaction was normal, 36% of the patient's pupil reaction was ipsilateral and 40% of the patient's pupil reaction were non-reactive.

Side of Lobectomy

DC, 40% of the patients' lobectomy sides were right, and 60% of the patients' lobectomy sides were left, but in DCWL, 48% of the patients' lobectomy sides were right, and 52% of the patients' lobectomy sides were left.

Location of Hematoma Formation

In DC, 32% of the patient's hematoma formation location were frontal, 30% of the patient's hematoma formation location were temporal, 28% of the patient's hematoma formation location were parietal and 10% of the patient's hematoma formation location were occipital but in DCWL, 40% of the patient's hematoma formation location were frontal, 26% of the patient's hematoma formation location were temporal, 16% of the patient's hematoma formation location were parietal and 18% of the patient's hematoma formation location were occipital.

Table 1: *Basic demographic characteristics of patients (n = 100).*

	DC	DCWL
n	50	50
Age		
<20	13 (26.0)	19 (38.0)
20-50	23 (46.0)	17 (34.0)
>50	14 (28.0)	14 (28.0)
Gender		
Male	14 (28.0)	39 (78.0)
Female	36 (72.0)	11 (22.0)
Trauma causes		
RTA	31 (62.0)	18 (36.0)
Assault	15 (30.0)	9 (18.0)
Fall	4 (8.0)	23 (46.0)
Pupil Reaction		
Normal	13 (26.0)	12 (24.0)
Ipsilateral	24 (48.0)	18 (36.0)
Non-Reactive	13 (26.0)	20 (40.0)
Lobectomy Side		
Right	20 (40.0)	24 (48.0)
Left	30 (60.0)	26 (52.0)
Hematoma Location		
Frontal	16 (32.0)	20 (40.0)
Temporal	15 (30.0)	13 (26.0)
Parietal	14 (28.0)	8 (16.0)
Occipital	5 (10.0)	9 (18.0)
Time from injury to presentation (hours)	1.45 ± 0.44	2.15 ± 0.56
GCS at Presentation	5.8 ± 0.76	5.64 ± 0.74

1. **Time from Injury to Presentation:** The mean time from injury to presentation in DC was 1.45 ± 0.44. But the mean time from injury to presentation in DCWL was 2.15 ± 0.56.
2. **GCS at Presentation:** The mean GCS score at presentation of the patient in DC is 5.8 ± 0.76. But the mean GCS score at presentation of the patients in DCWL is 5.64 ± 0.74 (Table 1).
3. **GOS-E after 3 Months:** In DC, 44% of the patient's GOS-E at 3 months were at vegetative state, 30% of the patient's GOS-E after 3 months were at lower severe disability and 26% of the patient's GOS-E after 3 months were at upper severe disability but in DCWL, 2% of the patient's GOS-E after 3 months were at vegetative state, 22% of the patient's GOS-E after 3 months were at lower severe disability and 16% of the patient's GOS-E after 3 months were at upper severe disability,30% of the patient's GOS-E after 3 months were at upper moderate disability and 30% of the patient's GOS-E after 3 months were at lower moderate disability.
4. **GOS-E after 6 Months:** In DC, 26% of the patient's GOS-E after 6 months were at dead state, 34% of the patient's GOS-E after 6 months were at upper severe disability and 40% of the patient's GOS-E after 6 months were at lower moderate disability but in DCWL,38% of the patient's GOS-E after 6 months were at upper moderate disability,32% of the patient's GOS-E after 6 months were at lower good recovery and 30% of the patient's GOS-E after 6 months were at upper good recovery (Table 2).

DISCUSSION

According to our study, the mean time from injury to presentation of the patients in DC is 1.45 with 0.44 SD, but the mean time from injury to presentation of the patients in DCWL is 2.15 with 0.56 SD. The mean GCS score at presentation of the patient in DC is 5.8 with 0.755 SD, but the mean GCS score at presentation of the patients in DCWL is 5.64 with 0.74 SD. In DC, 26% of the patients' pupil reaction was normal, 48%of the patients' pupil reaction was ipsilateral, and 26% of the patients' pupil reaction was non-reactive, but in DCWL, 24% of the patients' pupil reaction was normal, 36% of the patients' pupil reaction was ipsilateral, and 40% of the patient's pupil reactions were non-reactive. In DC, 40% of the patients' lobectomy sides were right and 60% of the patients' lobectomy sides were left, but in DCWL, 48% of the patients' lobectomy sides were right and 52% of the patients' lobectomy sides were left.

Table 2: *Comparison of GOS-E in both groups during follow-up of patients (n = 100).*

GOS-Eat		DC	DCWL	p-value
n		50	50	
	Dead	Nil	Nil	
	Vegetative state	22 (44.0)	1 (2.0)	
	Lower severe disability	15 (30.0)	11 (22.0)	
3rd	Upper severe disability	13 (26.0)	8 (16.0)	<0.05
month	Lower moderate disability	Nil	15 (30.0)	
	Upper moderate Disability	Nil	15 (30.0)	
	Lower good recovery	Nil	Nil	
	Upper good recovery	Nil	Nil	
	Dead	13 (26.0)	Nil	
	Vegetative state	Nil	Nil	
	Lower severe disability	Nil	Nil	
6th	Upper severe disability	17 (34.0)	Nil	<0.05
month	Lower moderate disability	20 (40.0)	Nil	
	Upper moderate Disability	Nil	19 (38.0)	
	Lower good recovery	Nil	16 (32.0)	
	Upper good recovery	Nil	15 (30.0)	

In DC, 32% of the patient's hematoma formation location were frontal, 30% of the patient's hematoma formation location were temporal, 28% of the patient's hematoma formation location were parietal and 10% of the patient's hematoma formation location were occipital but in DCWL, 40% of the patient's hematoma formation location were frontal, 26% of the patient's hematoma formation location were temporal, 16% of the patient's hematoma formation location were parietal and 18% of the patient's hematoma formation location were occipital.

In DC, 44% of the patient's GOS-E after 3 months were at vegetative state, 30% of the patient's GOS-E after 3 months were at lower severe disability and 26% of the patient's GOS-E after 3 months were at upper severe disability but in DCWL,2% of the patient's GOS-E after 3 months were at vegetative state, 22% of the patient's GOS-E after 3 months were at lower severe disability and 16% of the patient's GOS-E after 3 months were at upper severe disability,30% of the patient's GOS-E after 3 months were at upper moderate disability and 30% of the patient's GOS-E after 3 months were at lower moderate disability.

In DC, 26% of the patient's GOS-E after 6 months were at dead state, 34% of the patient's GOS-E after 6 months were at upper severe disability and 40% of the patient's GOS-E after 6 months were at lower moderate disability but in DCWL,38% of the patient's GOS-E after 6 months were at upper moderate disability,32% of the patient's GOS-E after 6 months were at lower good recovery and 30% of the patient's GOS-E after 6 months were at upper good recovery.

In our study, patients with comparable intracranial insults, age distribution, and baseline GCS nevertheless demonstrated different outcomes after undergoing DC versus DCWL. This variation can be attributed primarily to the surgical

strategy itself. DCWL provides a more aggressive form of decompression by removing swollen, non-viable, or contused brain tissue, thereby achieving superior intracranial pressure control and preventing delayed deterioration from progressive swelling or secondary haemorrhage. In contrast, patients treated with DC alone were more prone to unfavourable outcomes, including vegetative state and mortality at 6 months, likely due to persistent mass effect from residual contusions.

In addition, certain patient-related factors may have contributed to outcome differences despite comparable injury severity. Gender distribution varied between groups (a higher proportion of males in DCWL), and mechanisms of trauma differed (falls were more common in DCWL, RTAs more common in DC), both of which are known to influence recovery trajectories. Interestingly, although a larger proportion of DCWL patients presented with non-reactive pupils, this group still showed better functional recovery, reinforcing the role of the surgical approach itself as the most decisive factor.

Taken together, these findings suggest that DCWL, by addressing both intracranial hypertension and non-viable parenchymal tissue, offers improved functional outcomes even in patients with apparently similar baseline injury characteristics.

However, even though TBI, often known as TBI, is one of the leading causes of death all over the world, its treatment was not well understood until very recently. Because brain lobectomy is a therapy option for TBI that is up for debate, we set out to establish the mortality rate and long-term effects of this technique in TBI patients. According to research by Hakan AK and colleagues, patients with blunt severe TBI who were transported to the hospital had a Glasgow Coma Scale (GCS) of 4-7 (mean = 5.5) when they arrived. A lobectomy and a decompression operation were carried out. It was found that after surgery, 60% of patients survived years. [5]

A study conducted in 2020 analyzed the medical records of 135 patients who had undergone brain lobectomy procedures following traumatic brain injuries.[11] The vast majority of these patients had suffered from a brain contusion or ICH. In addition to this, we examined the patients' rates on the Glasgow Outcome Scale (GOS) and the Glasgow Coma Scale (GCS), and we looked for an association between the two scales. Patients with TBI who had a brain lobectomy were predominantly male (77%), with only 23% of patients being female. They numbered 43,420.3 in total, and 62.2% of them have survived to the present day; 71% of the women and 60% of the men did so, respectively. Patients who were male had a 53% better chance of having a favorable GOS than patients who were female had a 27% chance.[12]

High intracranial pressure is the main cause of mortality and impairment among those who have suffered TBIs of significant severity. Treatment for this ailment often involves the use of normothermia, sedation, and several other techniques that are considered to be first-line therapy (moderate hypocapnia, mannitol, etc.). The use of barbiturates, hyperventilation, moderate hypothermia, or the removal of a variable amount of skull bone (secondary decompressive craniectomy) are examples of second-line treatments that may be used if these first-line treatments prove ineffective.[13]

There was a slight decrease in the risk of death at six months with DC, according to a meta-analysis of three trials (RR 0.66, 95% CI 0.43 to 1.01; 3 studies, 571 participants; I2 = 38%; moderate quality evidence). 14 In one study, the risk of death at 12 months was clearly reduced (RR 0.59, 95% CI 0.45 to 0.76; 1 trial, 373 participants; high quality evidence), and in another, the risk of death at 6 months was clearly reduced with DC.[15]

TBIs are one of the primary causes of death and disability among young people. Brain edema and an increase in intracranial pressure are potential outcomes of head trauma of any degree, including first and second degrees. To treat traumatic brain

injuries, it is necessary to take steps (including surgery) to lower the intracranial pressure.[16] When patients are taken to the hospital with severe brain injuries, their medical history is looked at. Participants in the study group were required to have suffered severe brain injuries (a score of 8 on the Glasgow Coma Scale) and to have undergone both decompression surgery and temporal lobectomy procedures. During the course of the study's duration of three years, there were a total of ten participants.[17] Each patient presented with a severe case of blunt TBI. Accidents involving motor vehicles were the cause of eight of the traumas, while other types of automobile accidents were responsible for two of them, and falls from significant heights were responsible for the other two. All of the victims had received injuries consistent with blunt force trauma.[18]

CONCLUSION

There is a difference in the surgical outcome of brain contusions treated by Decompressive craniotomy with or without lobectomy by using the Glasgow Outcome Scale Extended (GOS-E); and DCWL showed better outcomes than DC alone.

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REFERENCES

1. Kaur P, Sharma S. Recent advances in pathophysiology of traumatic brain injury. Curr Neuropharmacol. 2018;16(8):1224-38. Doi: 10.2174/1570159X15666170613083606.
2. Roozenbeek B, Maas AI, Menon DK. Changing patterns in the epidemiology of traumatic brain injury. Nat Rev Neurol. 2013;9(4):231-6. Doi: 10.1038/nrneurol.2013.22.
3. Carney N, Totten AM, O'Reilly C, Ullman JS, Hawryluk GW, Bell MJ, et al. Guidelines for the management of severe traumatic brain injury. Neurosurgery. 2017;80(1):6-15. Doi: 10.1227/NEU.0000000000001432.
4. Faleiro RM, Faleiro LCM, Caetano E, Gomide I, Pita C, Coelho G, et al. Decompressive craniotomy: prognostic factors and complications in 89 patients. Arq Neuro-Psiquiatr. 2008;66:369-73. Doi: 10.1590/s0004-282x2008000300017.
5. Hakan A, Daltaban I, Vural S. The role of temporal lobectomy as a part of surgical resuscitation in patients with severe traumatic brain injury. Asian J Neurosurg. 2019;14(02):436-9. Doi: 10.4103/ajns.AJNS_240_18.
6. Lad KA, Maheshwari A, Saxena B. Repositioning of an anti-depressant drug, agomelatine as therapy for brain injury induced by craniotomy. Drug Discov Ther. 2019;13(4):189-97. Doi: 10.5582/ddt.2019.01056.
7. Zheng F, Xu H, von Spreckelsen N, Stavrinou P, Timmer M, Goldbrunner R, et al. Early or late cranioplasty following decompressive craniotomy for traumatic brain injury: a systematic review and meta-analysis. J Int Med Res. 2018;46(7):2503-12. Doi: 10.1177/0300060518755148.
8. Oncel D, Demetriades D, Gruen P, Salim A, Inaba K, Rhee P, et al. Brain lobectomy for severe head injuries is not a hopeless procedure. J Trauma. 2007;63(5):1010-3. Doi: 10.1097/TA.0b013e318156ee64.
9. Jiang J-y, Collaborators CHTS. Head trauma in China. Injury. 2013;44(11):1453-7. Doi: 10.1016/j.injury.2012.08.045.
10. Sinha S, Rathore YS, Mahapatra AK, Sharma BS. Surgical outcome of brain contusions treated by decompressive craniotomy with or without lobectomy at high volume tertiary care trauma centre. Indian J Neurotrauma. 2014;11(1):5-9. https://doi.org/10.1016/j.ijnt.2013.12.003
11. Wang X-P, Zhong J, Lei T, Wang H-J, Zhu L-N, Chu S, et al. Epidemiology of traumatic brain injury-associated epilepsy in western China: An analysis of multicenter data. Epilep Res. 2020;164:106354. Doi: 10.1016/j.eplepsyres.2020.106354.

12. Snell DL, Martin R, Surgenor LJ, Siegert RJ, Hay-Smith EJC, Melzer TR, et al. Wrestling with uncertainty after mild traumatic brain injury: a mixed methods study. Disabil Rehabil. 2020;42(14):1942-53. Doi: 10.1080/09638288.2018.1542461.
13. O'neill M, Henderson M, Duffy OM, Kernohan WG. The emerging contribution of speech and language therapists in awake craniotomy: a national survey of their roles, practices and perceptions. Int J Lang Commun Disord. 2020;55(1):149-62. Doi: 10.1111/1460-6984.12510.
14. López MR. Effects of Either the Consumption of the Herbicide Atrazine or Brain Injury to Behaviors Related to Anxiety and Fear in Rats: University of Puerto Rico Medical Sciences (Puerto Rico); 2022.
15. Glynn N, Agha A. The frequency and the diagnosis of pituitary dysfunction after traumatic brain injury. Pituitary. 2019;22:249-60. Doi: 10.1007/s11102-019-00938-y.
16. Sasun AR. Physiotherapy Rehabilitation as an Adjunct to Functional Independence in Diffuse Axonal Injury: A Case Report. Cureus. 2022;14(10). Doi: 10.7759/cureus.30255.
17. Keelan RE, Mahoney EJ, Sherer M, Hart T, Giacino J, Bodien YG, et al. Neuropsychological characteristics of the confusional state following traumatic brain injury. J Int Neuropsychol Soc. 2019;25(3):302-13. Doi: 10.1017/S1355617718001157.
18. Saboori P, Walker G. Brain injury and impact characteristics. Ann Biomed Engin. 2019;47:1982-92. Doi: 10.1007/s10439-019-02199-z.

Additional Information

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Conflict of Interest: The Authors report no conflict of interest.
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AUTHORS CONTRIBUTIONS

Sr. No.	Author's Full Name	Intellectual Contribution to Paper in Terms of:
1.	Muhammad Abdur Rehman	Study design, methodology, literature review, referencing, paper writing/editing, and quality insurer
2.	Haseeb Ahmad	Data collection & calculations and analysis of data & and interpretation of results
3.	Inamullah Asghar	Editing and referencing