Systematic Review: Identifying The Most Common Type And The Mostly Shown Clinical Manifestations Of Brain Herniation In Traumatic Brain Injury

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SYSTEMATIC REVIEW: IDENTIFYING THE MOST COMMON TYPE AND THE MOSTLY SHOWN CLINICAL MANIFESTATIONS OF BRAIN HERNIATION IN TRAUMATIC BRAIN INJURY

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Abstract

Background: Brain herniation occurs when there is something in the brain that pushes brain tissue. Brain herniation is a mechanical dislocation of brain organs to other regions due to mass, trauma, neoplastic, ischemic or infection. Because the herniation itself causes high pressure on certain brain structures, it is fatal. Hence at all hospitals, the first action performed is nothing but reducing intracranial pressure.On neurological examination, there is a decrease in the degree of consciousness. Depending on the severity of the herniation, interference with one or more brainstem reflexes as well as the function of the cranial nerve may occur. Patients will also show a consistent inability to breathe and irregular heartbeats..

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Methods: Using established systematic review methods, three databases (PubMed, Cochrane, ScienceDirect) with publication time before June 2021. We only include English literature in this review. Inclusion criteria was the study that published at the last 10 years, and only take a study that discuss about brain herniation in traumatic brain injury, the exclusion criteria that this review didn't take an article journal as a reference.

Results and conclusion: Ten studies (more than 1000 patients) were included.The current researches about the most common type and the most shown clinical manifestation of brain herniation in traumatic brain injury have been studied for the past few years, the result shows that most common type of the brain herniation is supratentorial herniation (transcalvaria/ekstracranial herniation (40%), transtentorial/central herniation (30%), uncal herniation (30%)). While The most common clinical manisfestation of brain herniation in traumatic brain injury based on this research are dilated pupil and decreased of consciousness.

Keywords: Most common type, Clinical Manifestation, Brain Herniation, Traumatic Brain Injury, Systematic review.

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Introduction

Brain herniation occurs when there is something in the brain that pushes brain tissue. Brain herniation is a mechanical dislocation of brain organs to other regions due to mass, trauma, neoplastic, ischemic or infection. Because the herniation itself causes high pressure on certain brain structures, it is fatal. Hence at all hospitals, the first action performed is nothing but reducing intracranial pressure. On neurological examination, there is a decrease in the degree of consciousness. Depending on the severity of the herniation, interference with one or more brainstem reflexes as well as the function of the cranial nerve may occur. Patients will also show a consistent inability to breathe and irregular heartbeats.[1,2]

Brain herniation is an emergency case. Recognizing earlier about increases in intracranial pressure through clinical symptoms and radiographic features is essential for the prevention of herniation. Computed tomography scanning (CT scan) or Magnetic Resonance Imaging (MRI) is a very important role for evaluation of brain herniation. The main handling should save the patient's life. To prevent the recurrence of brain hernia, treatment should aim to decrease the increase in intracranial pressure and decrease cerebral edema.[3]

In order to make a diagnosis, the clinician should know which location of brain herniation is presenting in the patients that can determine the clinical manifestation and make a differences one type to another type of brain herniation, beside that clinician also need to know what the most common type of brain herniation to growth so that we can predict the diagnosis based on the clinical manifestation using the epidemiological data that we have. This research is aimed to identifying what is the most common clinical manifestation and the most common type of brain herniation.[4,5]

Method

Search strategy and inclusion criteria

The search was conducted at an online database PUBMED, COCHRANE and SCIENCE DIRECT with publication time before June 2021 for every study about the brain herniation in traumatic brain injury. The Medical Subject Headings text or keywords used in the search were ‘brain herniation’ in combination with each of the following terms: ‘type’ and ‘clinical manifestation’ and ‘traumatic brain injury’. Inclusion criteria in this study were the studies were required to be cohort study, randomized study, case report and descriptive data of brain herniation in traumatic brain injury.[6]

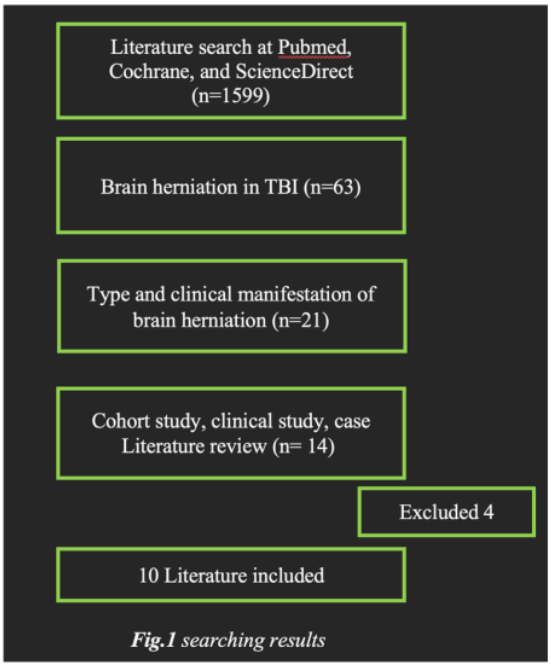

Fig.1 searching results

Inclusion and Exclusion Criteria

a. Inclusion Criteria

- Genuine article that relevan to this topic
- Cohort Study (Retrospective and Perspective), Randomized Study, Case resport
- Published at least 10 years ago
- Using English as main language of the literature

Based on PICO

Patients : The patients with brain herniation in traumatic brain injury

Intervention : All intervention of patients was included, this study aimed to identifying the most common type and clinical manifestation of brain herniation in TBI

Control : -

Outcome : The main outcome for this study is to identifying the most common type and clinical manifestation of brain herniation in TBI.

b. Exclusion Criteria

- The publication that mostly discussed about brain herniation in cases other than TBI
- Article Journal
- Published at least more than 10 years ago

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Result

The most common type and mostly shown clinical manifestation of brain herniation Of 63 results that we found (PubMed, Cochrane, ScienceDirect), only 14 of them were Cohort study (retrospective and prospective), randomized study, case report and literature review of brain herniation in traumatic brain injury that that describe about type and clinical manifestation then only 10 studies were included, the other were excluded because it didn't meet the inclusion criteria.[7]

Table 1. Summary of brain herniation in traumatic brain injury patients

Author (year)	Sample size (type of study)	Type of herniation (Supratentorial or Infratentorial)	Severity of patients' condition	Clinical manifestation (sign and symptom)	Outcome assessment
Hamed et al (2016)	196 subject (a single-center series and multivariate analysis) Pubmed	Didn't describe the type of brain herniation	Mild and moderate to severe	• Unilateral dilated pupil • Bilateral dilated pupil	Unilateral dilated pupil (P=0.006)
He-xiang Zhao et al (2016)	336 subjects (PRECIS is a prospective, randomized, assessor-blind, single center clinical trial) Pubmed	Transcalvaria herniation (Supratentorial)	Severe	• GCS (5-8) • Pupillary response (both reactive or one reactive or no reactive	NA

Edson Bor Seng Shu et al (2013)	19 subjects (Prospective studied) Pubmed	Transtentorial herniation (Supratentorial)	Severe	• Cerebral oligoemia • Cerebral hyperemia • Nonspecific circulatory pattern	□ Hyperemia (15.8%) □ Oligoemia (52.7%) □ Nonspecific (31.5%)
Zhigang Lan et al (2019)	194 subjects (retrospective study) Cochrane	Uncal herniation (Supratentorial)	Severe	• Lower GCS • Pupil dilation	• GCS score (5-8) P=0.005 • Pupil dilation (P=<0.001)
Zhong-Min Li et al (2012)	182 subjects (Randomized study) Cochrane	Transtentorial herniation (Supratentorial)	Severe	• Deterioratin g level conciousnes s • Pupil dilation • GCS score	• Deteriorating level consciousness (p=0.934) • Pupil dilation Unilateral (p=0.929) Bilateral (p=0.766) • GCS score 3 (p=0.899) 4 (p=0.968) 5 (p=0.941) 6 (p=0.950) 7 (p=0.824) 8 (p=0.962)

Hui Wu et al (2014)	63 subjects (Retrospective study) Pubmed	Central brain herniation (Supratentorial)	Severe	• GCS score	• GCS score 15-13 (7.9) 12-8 (52.4) 7-3 (39.7)
Udayakumaran et al (2011)	4 subjects (case report and literature review) Pubmed	Uncal herniation (Supratentorial)	Didn't describe	• Complex parssial seizure • Headache • Vomiting • Diplopia • Neuralgia	• NA
Angelo et al (2019)	50 subject (A retrospective, consecutive cohort study) ScienceDirect	Transcalvaria herniation (Supratentorial)	Severe	• GCS score • Pupil reactivity	• GCS score (p=0.015) 3-5 (26%) 6-8 (40%) >8 (26%) Not measured (4%) • Pupil reactivity (p=0.024) One reactive (32%) Both reactive (62%)
Marini A et al (2020)	Literature Review ScienceDirect	Transcalvaria brain herniation (Supratentorial)	Severe	• Poor neurological status • Increased head circumference	• NA
Kingsley et al (2018)	56 subjects (Retrospective study) ScienceDirect	Extracranial / transcalvaria herniation (Supratentorial) Uncal herniation (Supratentorial)	Severe	• Pupils were fixed and dilated • GCS score was 3T	• NA

NA: not applicable

Result

At the first journal that we found is discussing about Acute Traumatic Subdural Hematoma: Surgical Management in the Presence of Cerebral HerniationeA Single-Center Series and Multivariate Analysis, its written by Hamed M., et al, the goals of research was We therefore performed an analysis of our institutional data to analyze factors determining outcome in patients with isolated traumatic aSDH and signs of cerebral herniation., this journal resulting is Overall of patients with aSDH achieved favorable outcome. In further analysis, unilateral or bilateral dilated pupils as a sign of cerebral herniation were present in 47% of the included patients. In the multivariate analysis, age >70 years and the presence of cerebral herniation were significant prognostic predictors for unfavorable outcome in patients with aSDH. However, 15% of patients with aSDH and signs of cerebral herniation achieved favorable outcome during follow-up.[1,7]

At the second journal that we found is discussing about Prospective randomized evaluation of therapeutic decompressive craniectomy in severe traumatic brain injury with mass lesions (PRECIS): study protocol for a controlled trial, writen by He-xiang Zhao et al, in this present study, they designed a prospective, randomized, controlled trial to clarify the effect of decompressive craniectomy in severe traumatic brain injury patients with mass lesions. This study will provide evidence to optimize primary decompressive craniectomy application and assess outcomes and risks for mass lesions in severe traumatic brain injury. The Primary endpoint is a favorable outcome in this study at 12 months after randomization as measured by GOSE/Glasgow Outcome Score (5–8). The core secondary endpoint is the quality of life indicated by EQ-5D. Further secondary endpoints include mortality and complications at corresponding time point, ICP and CPP control and incidence of salvage DC in craniotomy patients.[2,8]

At the third journal that we found is Posttraumatic Refractory Intracranial

Hypertension and Brain Herniation Syndrome: Cerebral Hemodynamic Assessment before Decompressive Craniectomy, written by Edson Bor Seng Shu., et al. The goals of this study was to investigate the cerebral hemodynamic changes associated with brain herniation syndrome due to traumatic brain swelling. A wide variety of cerebral hemodynamic findings were observed on the resulting of this study. Ten patients (52.7%) presented with cerebral oligoemia, 3 patients (15.8%) with cerebral hyperemia, and 6 patients with nonspecific circulatory pattern. Circulatory disturbances were more frequently found in the side of maximal cerebral swelling than in the opposite side. Pulsatility index (PI) values suggested that ICP varied from acceptable to considerably high; patients with increased PI, indicating higher microvascular resistance. No correlation was found between cerebral hemodynamic findings and outcome.[7]

At the fourth journal that we found is about Outcomes of patients undergoing craniotomy and decompressive craniectomy for severe traumatic brain injury with brain herniation : A retrospective study, written by Zigang Lan, MD., et al, the aim was to identity factors contributing to decompressive craniectomy (DC) and evaluate treatment outcomes in patients with severe TBI with brain herniation. This study revealed that, DC is not mandatory for all TBI patients with brain herniation. Nevertheless, DC decreases mortality rate in severe TBI patients with brain herniation. Subdural hematoma and timing of surgery >1hour are key indicators for DC. Lower GCS, bilateral pupil dilation, delayed timing of surgery and advance age are indicators of poor outcomes.[8,9]

At the fifth journal that we found is about Surgical Treatment of Transtentorial Herniation After Traumatic Brain Injury, written by Zhong-Min Li, MD., et al. This randomized study was designed to investigate the safety and efficacy of surgical incision of the cerebellar tentorium in the treatment of transtentorial herniation after

traumatic brain injury. The result is There was no significant difference in age, sex, location of intracranial hematoma or other brain injuries, or preoperational Glasgow Coma Scale (GCS) between the study and the control group (P>0.05). There was no significant difference in the rate of individual complications between the 2 groups (P>0.05). However, the overall percentage of patients who experienced postoperational complications in the control group was higher than in the study group (45.6% vs. 19.6%, P=0.047). Patients were followed up between 5 to 60 months. The Glasgow Outcome Scale (GOS) 5 was achieved in 60.5% of the study group and in 29.1% of the control group (P<0.01). GOS 2 was found in 9.3% of the study group and in 24.1% of the control group (P<0.01). The mortality rate in the study group was lower than in the control group (5.4% vs. 12.2%, P<0.05).[10]

At the sixth journal that we found is about The Diagnosis and Surgical Treatment of Central Brain Herniations Caused by Traumatic Bifrontal Contusions writen by Hui Wu MD, et al 2014. The objective of this study was to investigate the diagnosis and surgical treatment of central brain herniations caused by traumatic bifrontal contusions. A total of 63 patients (45 men and 18 women; mean age of 43 years with a range from 20 to 72 years) who suffered from traumatic bifrontal contusions between January 2007 and December 2012 were inspected. The clinical and imaging results were studied for all patients, and we found that swelling of the mesencephalon and a downward shift of the bilateral red nucleus were significant signs of central brain herniation in the image of magnetic resonance imaging. All patients were given a simultaneous bilateral craniotomy for balanced decompressive surgery. The Glasgow Outcome Scale was used to monitor the patients during the follow-up period, which lasted from 6 to 52 months with a mean of 22 months. At the termination of the follow-up period, the following Glasgow Outcome Scale scores were obtained: 14 patients scored 5 points, 22 patients scored 4 points, 7 patients scored 3

points, 13 patients scored 2 points, and 7 patients scored 1 point. Therefore, our study suggested that an early magnetic resonance imaging scan could result in a more timely diagnosis of central brain herniation, and simultaneous bilateral craniotomy was found to be one of the best treatments for central brain herniation to improve patient outcomes.[1,2]

At the seventh journal that we found is written by Udayakumaran et al 2011, this literature is Chronic uncal herniation secondary to posterior fossa shunting: case report and literature review. The aim of this journal was illustrate a case with this rare finding, including MR imaging, and analyze this phenomenon about the chronic herniation syndrome. Chronic herniation syndromes other than tonsillar herniation are not well-recognized. Transtentorial uncal herniation in its chronic form has been reported in only few case. The result is We conclude that a negative pressure gradient in the posterior fossa, relative to the supratentorial compartment, is the etiology of the chronic uncal herniation n our patient. Comparing the case reports in the literature with our case, we postulate that chronic uncal herniation is a complication of shunting of a posterior fossa fluid cavity in children, many of them with Dandy–Walker syndrome and/or other cerebellar cystic formations. The treatment priority at presentation should be to rule out shunt malfunction. In the event of association with clinical over-drainage syndrome, there may be a role for changing the shunt system into a more conservative drainage combination.[3,4]

At the eighth journal that we found is written by Angelo R et, al 2019 the tittle of this journal was Transcalvarial brain herniation volume as a predictor of posttraumatic hydrocephalus after decompressive craniectomy. For study the influence of these factors we conducted a retrospective observational single-center cohort study in a tertiary care center with special attention to the transcalvarial herniation(TCH) volume after decompressive craniectomy.The Results: 17 patients developed hydrocephalus (34%). TCH volume after decompression($p < 0.01$),

subdural hygroma ($p < 0.01$), lower admission Glasgow Coma Scale score ($p=0.015$), unilateral pupil reactivity ($p=0.042$) and higher Zumkeller index($p=0.044$) were significant risk factors for hydrocephalus. Logistic regression analysis showed that factors independently associated with the development of hydrocephalus was the TCH volume (odds ratio 11.08; 95%CI 2.10, 58.4; $p=0.0046$), and presence of hygroma (odds ratio 49.59; 95% IC 4.1, 459; $p=0.002$). There was a clear association between severity of TBI, TCH volume and subdural hygroma with the development of hydrocephalus. Clinicians should follow closely patients with those findings in order to avoid late deterioration.

At the ninth journal that we found is about Brain herniation into the subdural space: rare iatrogenic complication of treatment of a giant calcified subdural hematoma. written by Marini et, al 2020, This case illustrates a rare complication of the treatment of a chronic subdural hematoma caused by insufficient opening of the calcified inner mambrane of s the hematoma, and encouraged by gradient pressure between the ventricular and subdural compartments. In these cases, it is preferable to do not open the calcified inner membrane of the subdural hematoma in order to protect the brain from the risk of herniation, related to the in case of gradient pressure between the subdural collection and the ventricular compartment. However, in case of lack of clinical and radiological improvement, the opening of the visceral calcified membrane can be attempted, reccomending a wide opening in order to avoid brain strangulation. [5,6]

At the tenth journal that we found is written by Kingsley O et al, 2018, this journal is a retrospective study about Volume of Brain Herniation After Decompressive Craniectomy in Patients with Traumatic Brain Injury. In this study was applied this analytical approach to study brain herniation in the more heterogenous group of patients who underwent craniectomy procedures following TBI to determine whether the concept of the offset titanium plate can accommodate

postoperative brain swelling secondary to etiologies other than ischemic stroke. The result in this study were identified 56 patients with TBI and measured their postoperative brain herniation volumes. A moveable plate offset by 5 mm would create sufficient additional volume to accommodate the brain swelling measured in all but one patient. That patient had malignant intraoperative brain swelling and died the following day.[6,8]

Brain herniation occurs when there is something in the brain that pushes brain tissue. Brain herniation is a mechanical dislocation of brain organs to other regions due to mass, trauma, neoplastic, ischemic or infection. On neurological examination, there is a decrease in the degree of consciousness. Depending on the severity of the herniation, interference with one or more brainstem reflexes as well as the function of the cranial nerve may occur. Patients will also show a consistent inability to breathe and irregular heartbeats. In traumatic braun injury patient in this research the most common type of the brain herniation is supratentorial herniation (transcalvaria herniation 4 of 9 journal while 1 journal didn't describe the type of the brain herniation) with the result are transcalvaria/ekstracranial herniation (40%), transtentorial/central herniation (30%), uncal herniation (30%). While The most common clinical manisfestation of brain herniation in traumatic brain injury based on this research are dilated pupil and degree of consciousness.[5]

Discussion

The popularity of all journals that we found about the most type of brain herniation in TBI and the most shown clinical manifestasion is vary based on each journal, but we found some similiarity that conclude the most common type of brain herniation in TBI patient was supratentorial herniation (transcalvaria herniation). Discussing about the most shown clinical manifestation of brain herniation in TBI patients, almost all of the reviewed journal told that the clinical manifestation of brain herniation including dilated pupils (unilateral or bilateral) and decreased of consciousness, while the other rare

symptom are Complex parssial seizure, headache, vomiting, diplopia, and neuralgia

There are still many shortcomings in this review, especially those that arise when extracting and evaluating existing data. From the data available in the online database, studies that meet the inclusion criteria are still few, thereby reducing heterogeneity. Therefore, from further clinical research, it is necessary to increase the heterogeneity of the review studies on the most shown clinical manifestasion and the most type of brain herniation, especially in traumatic brain injury patients.

Conclusion

The current researches about the most common type and the most shown clinical manifestation of brain herniation in TBI have been studied for the past few years, the result shows that the most common type of the brain herniation is supratentorial herniation (transcalvaria/ekstracranial herniation (40%), transtentorial/central herniation (30%), uncal herniation (30%)). While The most common clinical manisfestation of brain herniation in traumatic brain injury based on this research are dilated pupil and decreased of consciousness.

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