DECOMPRESSIVE CRANIECTOMY FOR SEVERE TRAUMATIC BRAIN INJURY: FUNCTIONAL OUTCOME AT 3 MONTHS AND 6 MONTHS

BY

NURULLISA BT RASHID

A dissertation submitted in fulfilment of the requirement for the Master of Surgery (General Surgery)

Kulliyyah of Medicine
International Islamic University Malaysia

JANUARY 2021

ABSTRACT

Head injury was the commonest diagnosis leading to intensive care unit (ICU) admission in 2008 and it contributed high disease burden which later may lead to socioeconomic problem. Purpose of this study is to determine the functional outcome of decompressive craniectomy (DC) for severe traumatic brain injury patients in HTAA and the associative factors in the poor functional outcome of severe TBI patients who had undergone DC at 3 months and 6 month. From 2017 through 2018, we recruited 54 patients in our local center, 16 to 65 years of age with severe traumatic brain injury that has to undergo decompressive craniectomy. The primary outcome was the rating on the Extended Glasgow Outcome Scale (GOS-E) (an 8-point scale, ranging from death to "upper good recovery" (no injury-related problems) at 3 months and 6 months. We used Pearson chi-square or Fisher Exact test to identify the associations between the study variables and the functional outcome for univariate analysis. This study is ethically approved by National Malaysia Research Committee. The proportional odds assumption was rejected, and therefore results are reported descriptively. Good functional outcome at 3 month among severe TBI patients noted for patients with Marshall score less than 4 and at poor functional outcome noted at 6 months for smoker and GCS than 5 upon presentation. Patient selection and patient resuscitation with Multidiciplinary Team (MDT) involvement may be expected to further improve the outcome following the procedure in severely brain-injured patients.

APPROVAL PAGE

I certify that I have supervised and read this study and that in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Master of General Surgery

……
Mohamed Saufi Awang
Supervisor

……
Mohd Aidil Bin Mohd Nor
Co-Supervisor

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Master of General Surgery

……
Samuel Gunasekar
Examiner

This dissertation was submitted to the Department of General Surgery and is accepted as a fulfilment of the requirement for the degree of Master of General Surgery

……
Junaini Kasian
Head, Department of Surgery

This dissertation was submitted to the Kulliyyah of Medicine and is accepted as a fulfilment of the requirement for the degree of Master of General Surgery

……
Azmi Bin Md Nor
Dean, Kulliyyah of Medicine

DECLARATION

I hereby declare that this dissertation is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

Nurullisa Bt Rashid

Signature …… Date ……..

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

DECLARATION OF COPYRIGHT AND AFFIRMATION OF FAIR USE OF UNPUBLISHED RESEARCH

DECOMPRESSIVE CRANIECTOMY FOR SEVERE TRAUMATIC BRAIN INJURY: FUNCTIONAL OUTCOME AT 3 MONTHS AND 6 MONTHS

I declare that the copyright holder of this thesis/dissertation are jointly owned by the student and IIUM.

No part of this unpublished research may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise without prior written permission of the copyright holder except as provided below

1. Any material contained in or derived from this unpublished research may only be used by others in their writing with due acknowledgement.

2. IIUM or its library will have the right to make and transmit copies (print or electronic) for institutional and academic purpose.

3. The IIUM library will have the right to make, store in a retrieval system and supply copies of this unpublished research if requested by other universities and research libraries

By signing this form, I acknowledged that I have read and understand the IIUM Intellectual Property Right and Commercialization policy.

Affirmed by Nurullisa Rashid

…… ……..……..……
Signature Date

DEDICATION

This thesis is dedicated for my parents for laying the foundation of what I turned out to be in life.

ACKNOWLEDGEMENTS

All glory is due to Allah, the Almighty, whose Mercies and Graces have been with me throughout preparing my dissertation. Although it has been tasking, His Blessings on me ease the task of completing this thesis.

I am most indebted to by supervisor, Assoc. Prof. Dato Dr Mohamed Saufi Bin Awang, whose enduring disposition, kindness, promptitude, thoroughness and friendship have facilitated the successful completion of my work. I put on record and appreciate his detailed comments, useful suggestions and inspiring queries which have considerably improved this thesis. His brilliant grasp of the aim and content of this work led to his insightful comments, suggestions and que ries which helped me a great deal.

Despite his commitments, he took time to listen and attend to me whenever requested. The moral support he extended to me is in no doubt a boost that helped in building and writing the draft of this research work. I am also grateful to my co-supervisor, Mr Mohd Aidil Bin Mohd Nor and Proffesor Dr Jamalludin Abdul Rahman, whose support and cooperation contributed to the outcome of this work.

Lastly, my gratitude goes to my beloved husband parents and children; for their prayers, understanding and endurance while away.

Once again, we glorify Allah for His endless mercy on us one of which is enabling us to successfully round off the efforts of writing this thesis. Alhamdulillah.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE

INTRODUCTION

1.1 STUDY BACKGROUND

TBI has been a significant contributing factor for morbidity and mortality in our country. The primary injury mostly will result in vascular changes and brain edema which later will cause increase in intracranial pressure (ICP) and progress to complications or secondary damage represent by damage of neurons that were unharmed during the primary injury.

It is difficult to evaluate the actual incidence of TBI with regards to its severity. According to our national trauma database (NTrD), decompressive craniectomy (DC), accounted as the highest procedure of all intracranial procedure among major trauma cases (23.15%).

Management of the patients that involved in brain injury remain difficult in particularly post operatively. This also includes human resources and socioeconomic burden. Early surgical intervention by DC for severely head injured patients without brain stem dysfunction is recommended within 24h after the injury. The purpose is to remove intracranial collections or hematoma. Some data has suggested that complications of TBI may be reduced following early DC. However, the exact time to decompress a patient is still under discussions to date.

The decision for type of surgery usually is made on table based on the patient's age, degree of underlying cerebral swelling, mechanism of injury and the operating surgeon's experience in estimating the possibility that the patient will develop severe

intracranial haemorrhage (ICH)**.** DC can be the treatment of choice to prevent brain herniation in places where intensive care unit is available.

Primary DC refers to removal of a large bone flap (part of the skull) , approximately about a palm size after evacuating an intracranial haematoma (mass lesion) in the early phase after the head injury.

The key points for surgery include opening of the dura, leaving it unsutured or performing a wide non-constricting duroplasty and left a large craniectomy window. Severe TBI is defined as loss of consciousness of greater than 6 hours following a brain injury resulting in a Glasgow Coma Scale of 3 to 8 while DC is defined as a surgical procedure to remove of a large part of the skull (fronto/parietal/temporal @ palm size) and opening of the underlying dura mater to reduce ICP.

Glasgow outcome scale extended (GOSE) is a detail global scale for functional outcome that rates patient status into 8 different categories.

1.2 STUDY JUSTIFICATION

When we initiated this study, there has been no published local literature examining the outcome post decompressive craniectomy in severe TBI, particularly in Asian population. Decision upon DC often delayed especially if patients stayed in remote areas and not treated appropriately, fail to manage family members expectations and patients learn to live with symptoms thus affecting overall productivity. We were encouraged by these to proceed with this study and as well with the hope of this study of being a forerunner for other studies in the future to come .

1.3 OBJECTIVES AND RESEARCH'S QUESTION

1.3.1 General Objective

To determine the functional outcome of DC for severe TBI patients in HTAA based on GOSE (Extended Glasgow Outcome Scale)

1.3.2 Specific Objectives

To determine the associative factors in the poor functional outcome of severe TBI patients who had undergone DC at 3 months and 6 month

1.3.3 Research's Questions

1. What is the incidence of severe TBI following trauma in Pahang?
2. What is the functional outcome of decompressive craniectomy (DC) for severe TBI patient in HTAA ?

CHAPTER TWO

LITERATURE REVIEW

2.1 DECOMPRESSIVE CRANIECTOMY FOLLOWING SEVERE TBI

In our Malaysian National Trauma Database (NTrD) in 2007, 584 cases have been reported as major trauma to NTrD by five tertiary hospitals. Out of the 184 (48.29%) major trauma, 74.74% of cases underwent intracranial surgery operations in which 23.15% were decompressive craniectomy (DC). Current therapies for management of TBI reduce the effects of cerebral edema that however, may lead to increase in ICP, which considered as secondary injury, particularly in high ICP. A DC can be performed for patients for whom medical therapy has failed.

2.2 EFFECTS OF DC ON FUNCTIONAL OUTCOME

It has been more than 100 years since Theodor Kocher first description of DC, particularly during the 20th century. During that time, the functional outcome of head-injured patients still remain uncertain regarding effects of DC to the patients. However, DC has been demonstrated to be the best way to reduce intractably elevated intracranial pressure after severe traumatic brain injury in the Brain Trauma Foundation Guidelines Harvey Cushing published in 1908, the use of DC following TBI in his first modern report of describing treatment of head-injured patients. DC showed a substantial reduction in mortality (subtemporal decompression).

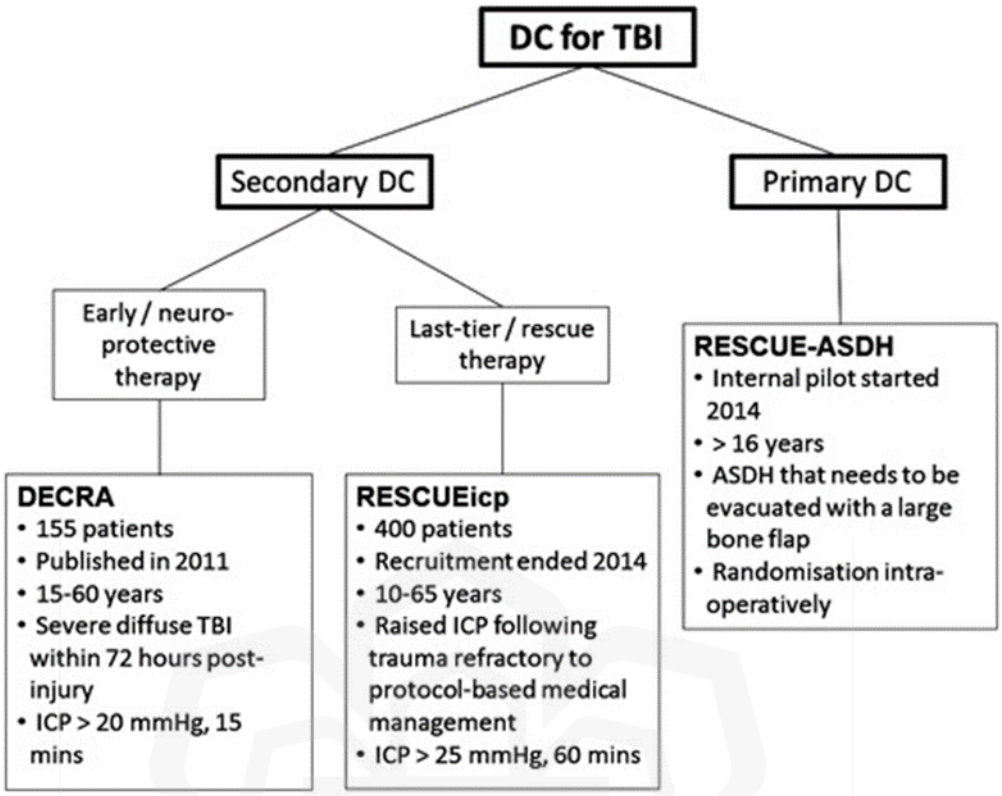
In other study, the RESCUE-ASDH which was funded by the UK National Institute for Health Research (NIHR), trial that aims to compare the clinical and cost-effectiveness of primary DC versus craniotomy for the management of adult head-injured patients undergoing evacuation of an ASDH. It was a multicentre, pragmatic,

parallel group randomised control study. In this study, eligible patients were randomised to craniotomy or DC which was decided intraoperatively after evacuation of ASDH. Patients who were not suitable for randomisation were being followed-up in the context of an observational cohort, eg. those with significant brain edema which prevent safe replacement of the bone flap.

In RESCUE-ASDH, the primary outcome were also measured by the Extended Glasgow Outcome Scale (GOSE), similar as our study it was measured at 12 month post injury.

While the secondary outcomes were:

- Quality of life (EQ-5D) at discharge, 6 and 12 months
- GOSE at 6 months post injury
- Glasgow Coma Scale (GCS) on discharge (from neurosurgical ward or ICU)
- Discharge destination from acute neurosurgical ward
- Length of stay in ICU and rehabilitation unit
- Serious surgical complications or adverse events (Eg: incidence of hydrocephalus)
- Readmissions within 12 months
- Follow-up period
- Return to operating theatre after randomisation for any cranial surgery within 2 weeks
- Post-operative period measurement of therapy intensity level
- Socioeconomic evaluation



RESCUE-ASDH trial was a retrospective study of patients undergoing evacuation of ASDH that suggested a favourable outcome in 35% of the studied subjects (moderate disability or good recovery).

On the other hand, the DECRA study – study that looked on the role of DC in decreasing ICP plus durability in increase CPP. It was an RCT that observed poor follow up outcome for patients undergoing DC that focused on early decompression, compared with standard therapy.

The 21st century highlights many efforts to develop the evidence base study for DC outcome following TBI. The evidence that we have currently suggests that early bifrontal DC (neuroprotective) for patients with diffuse TBI is not superior to medical management. In RESCUEicp study, secondary DC for severe and refractory post-traumatic intracranial hypertension is considered as a last-tier therapy. On the other hand, primary DC for patients with ASDH in the context of the RESCUE-ASDH trial

is being systematically evaluated. Owing to the number of complications with DC and in respect of the current available evidence , it is not appropriate to indiscriminate the role of DC for patients with severe TBI.

2.3 PREDICTORS AND RISK FACTORS FOR POOR OUTCOME

In another study by Cooper and colleagues, they theorised that poor outcome could be due to the axonal stretch and subsequent neuronal injury as well as due to changes in cerebral blood flow and brain tissue metabolism . It happens when the brain is unable to expand inside the skull following trauma or contusion. Soustiel and colleagues reported that the cerebral metabolic rate of oxygen uptake was significantly lower than in the non-DC group although DC led to an increase in Cerebral Perfusion Pressure (CPP). The study noted that good functional outcomes for patients were associated with the higher rates of cerebral oxidative metabolism.

RESCUEicp TRIAL shows that decompressive craniectomy for severe and refractory intracranial hypertension after TBI resulted in lower mortality by 22% and higher vegetative state compared with medical treatment group at 6 months.

Few studies have reported a wide range of functional outcomes after the surgery. Ucar et al. has reported that only 16% of the 100 patients reviewed has a favorable outcome after DC as measured by the GOS (Glasgow Outcome Scale). Timofeev and Hutchinson described a series of 49 patients in which 61% had a favorable outcome during the same year (2005).

In a study published in 2008, Howard et al. reported that 30% of patients (n 40) had a favorable outcome after DC with a 55% mortality rate. At 6 months time, they noted poor outcome (GOSE score, 1–4) in 39 patients (68%), and a good outcome (GOSE score, 5–8) was noted in 15 patients (26%). Age (26 years vs 43 years) and

higher pre-decompression GCS (7 vs 6) were identified as the factors that associated with good functional outcome.

2.4 ARGUMENTS ON PITFALLS IN DC

Most recent in 2015, a meta-analysis done by a group of author from Shanghai, China suggested that the benefits of DC in cases of TBI were not significant enough for DC to be recommended over conventional medical management. They identified 8 studies for review, with 3 randomized controlled trials s having a total of 256 patients (123 DCs, 133 non-DCs) included in the meta-analysis. They concluded that although DC might effectively reduce ICP and shorten hospital stay in patients with TBI, its effect in decreasing mortality has not reached statistical significance.

In a retrospective study conducted in Melbourne by conjoint neurosurgeon and intensivist in a Trauma Centre, they concluded that DC did not result in an overall improvement in CPP but, as expected, it resulted in lower ICP postoperatively.

DC is not exempted from complications and therefore these complications can be following a time-dependent pattern. First possible complications are expansion of hemorrhagic contusion, followed by the new subdural hematoma that appears on contralateral side, leakage of CSF, brain herniation and seizures. Some complications such as intracranial infection and contralateral intracranial haematoma can be directly fatal while other complications can adversely affect the patient's intellectual and neurological recovery later on.

In this study we want observe the recovery trend for patient with severe traumatic brain injury post-operative decompressive craniectomy. With this findings, we can identify the common causes for poor functional outcome (eg. preoperative GCS,

time of extubation, smoking, alcohol) and hoping to identify and improve the modifiable risk factor for a better outcome in the future.

CHAPTER THREE

METHODOLOGY

3.1 STUDY DESIGN AND SAMPLING

3.1.1 Study Design

Prospective observational study

3.1.2 Study Period

April 2017- May 2018

3.1.3 Study Location

Neurosurgery Department, Hospital Tengku Ampuan Afzan, Kuantan (HTAA)

3.1.3 Reference Population

All patients with Severe Traumatic Brain Injury (TBI) presented to Hospital Tengku Ampuan Afzan between April 2017 and May 2018.

3.1.5 Study Population

All patients with Severe TBI presented to Hospital Tengku Ampuan Afzan between April 2017 and May 2018 that underwent decompressive craniectomy.

3.1.6 Facilities

HTAA is a tertiary center that covers the whole Pahang state (largest state in peninsular Malaysia). It is a referral center for neurosurgery cases (from government or private hospital) from all over Pahang including southern Terengganu.

3.1.7 Sampling Unit

1) Attendance list for patient with Severe TBI post decompressive craniectomy during TCA.
2) Patient's relative/ caretaker will be given TCA before discharge and the TCA date and contact no. will be documented in the Proforma.

3.1.8 Inclusion criteria :

1. Traumatic intracranial bleed
2. Age (16yo – 65yo)
3. GCS 3-8 (preoperative/presedation)

3.1.9 Exclusion criteria :

1. Non-traumatic brain injury
2. Trauma patient that treated conservatively
3. Surgery for spontaneous ICB
4. ASA status > 2

3.2 SAMPLING METHOD

All patients with Severe Head Injury presented to HTAA between April 2017 and May 2018 recruited using the universal sampling method. Only selected patients who met the inclusion and exclusion criteria were enrolled in the study. Patient information sheet was given to all studied patients and a written consent is obtained. Patients were recruited in the ward following admission or during TCA in clinic.

3.3 SAMPLE SIZE CALCULATION

The sample size determined based on two proportions to get appropriate sample size for the associated risk factors of poor functional outcome of DC among severe TBI patients at 6 months. The calculation of sample size was performed based on numeric results for testing Two Proportions using the Z-test with Unpooled Variance. The parameters evaluated in the calculation of sample size were as follows:

1. Level of significance (α) is the probability of rejecting the null hypothesis when it is true. The allowed probability was set as 0.05 of making false conclusion in this thesis.
2. Power of the study (1-β) is the probability of successfully rejecting null hypothesis. Generally, allowance of β in a study was up to 0.2. This equivalent to the power of the study 0.8 or 80% to infer the result to the population.
3. Glasgow Coma Scale (GCS) , Marshall Score were used to determine the potential associated factors in sample size.

3.3.1 Glasgow coma scale scores and GOSE

i. P0 = Proportion of poor functional outcome among severe TBI patients with GCS <5 based on literature review.
ii. P1 =Expected proportion of poor functional outcome among severe TBI patients <5 from expert opinion.
iii. m = Ratio of GCS <5/>5 from expert opinion.

3.3.2 Marshall Score (CT scan findings) and GOSE

i. P0 = Proportion of poor functional outcome among severe TBI patients with score 1-4 based on literature review.

ii. P1 =Expected proportion of good functional outcome among severe TBI patients with score 1-4 from expert opinion.

iii. m = Ratio Marshall Score 1-4 using scale from expert opinion.

Table 3.1 Sample size determination

Associated factor of Visual Outcome	**P0**	**P1**	**m**	**n**	**Total sample size +20% loss to follow up**
GCS <5	0.80[a]	0.4	1	20*2 (per group)*1(ratio) =40	48
Marshall Scale 1-4	0.80	0.3	1	12*2(per group)*1(ratio =24	29

It was expected that 20% of the subjects will loss to follow-up or death as in Table 3.1.

3.4 RESEARCH TOOLS AND MATERIALS

3.4.1 Sociodemographic Data

All sociodemographic data were collected either from patient's record or self-reported by the patients or caretaker during admission or follow up. These are gender, age and ethnicitiy.