THE PRACTICE, OUTCOME AND COMPLICATIONS OF TRACHEOSTOMY FOR TRAUMATIC BRAIN INJURY PATIENTS IN NEUROSURGICAL INTENSIVE CARE UNIT

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DISSERTATION SUBMITTED IN

PARTIAL FULFILLMENT OF THE

REQUIREMENTS FOR THE DEGREE OF

MASTER OF MEDICINE (ANAESTHESIOLOGY)

UNIVERSITI SAINS MALAYSIA

2020

ACKNOWLEDGEMENT

I would like to have this opportunity to express my utmost appreciation to all who had helped me right from the beginning until the completion of this dissertation.

Firstly, I would like to express my sincere gratitude to my advisor Professor Dr Wan Mohd Nazaruddin for the continuous support of my study and related research, for his patience, motivation, and immense knowledge. His guidance helped me in all the time of research and writing of this dissertation. I could not have imagined having a better advisor and mentor for my postgraduate study.

I would also like to thank my co-supervisor Dr Mohd Hasyizan and my respective colleagues for their insightful comments and encouragement. It has incented me to widen my research from various perspectives.

My sincere thank also goes to my beloved family. Without their precious support it would not be possible to conduct this research.

Yusrina Binti Zahari

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LIST OF ABBREVIATIONS

CPIS	Clinical Pulmonary Infection Score
ET	Early Tracheostomy
GCS	Glasgow Coma Scale
GOS	Glasgow Outcome Scale
ICU	Intensive Care Unit
JEPeM	Jawatankuasa Etika Penyelidikan Manusia USM
LT	Late Tracheostomy
ORL	Otorhinolaryngology
PT	Percutaneous Tracheostomy
SD	Standard Deviation
SPSS	Statistical Package for the Social Sciences
ST	Surgical Tracheostomy
TBI	Traumatic Brain Injury
TTS	Thoracic Trauma Severity Scoring
USM	Universiti Sains Malaysia
VAP	Ventilator Associated Pneumonia

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ABSTRAK

Tajuk: Praktis, Kesan dan Komplikasi Trakeostomi Terhadap Pesakit Kecederaan Otak Trauma di Unit Rawatan Rapi Neurosurgikal.

***Latar belakang*:** Prosedur trakeostomi selalu diperlukan untuk membebaskan pesakit kecederaan otak trauma (TBI) dari alat bantuan pernafasan. Tujuan kajian ini adalah untuk mengenalpasti praktis, teknik dan kesannya kepada pesakit TBI di Unit Rawatan Rapi Neurosurgikal (Neuro-ICU).

Kaedah: Kajian semula retrospektif ini melibatkan 268 pesakit TBI yang memerlukan trakeostomi semasa mendapat rawatan di Neuro-ICU dari 1 Januari 2013 sehingga 31 Disember 2017. Kajian ini menggunakan maklumat yang diambil dari rekod perubatan pesakit.

Keputusan: Berdasarkan teknik, trakeostomi perkutaneus (PT) menunjukkan perbezaan ketara lebih cepat dari segi perancangan [7.0(2.5) vs. 8.3(2.6) days; p<0.001], pelaksanaan [7.2 (2.6) vs. 8.6(2.9) days; p<0.001], tempoh alat bantuan pernafasan [9.8(3.4) vs. 11.3(3.1) days; p<0.001], dan tempoh rawatan di Neuro-ICU [12.3(3.7) vs. 13.8(3.5) days; p<0.003] berbanding trakeostomi melalui teknik pembedahan (ST). Berdasarkan masa, trakeostomi awal (ET) menunjukkan perbezaan ketara lebih cepat dari segi keputusan [4.9(1.0) vs. 8.7(2.4) days; p<0.001], rujukan kepada pasukan otorinolaringologi [5.0(0.9) vs. 8.8(2.3) days; p<0.001], perancangan [5.9(1.0) vs. 9.9(2.2) days; p<0.001], pelaksanaan [6.0(0.9) vs. 10.3(2.6) days; p<0.001], tempoh alat bantuan pernafasan [8.8(2.1) vs. 12.9(2.9) days; p<0.001], tempoh rawatan di Neuro-ICU [11.4(2.4) vs. 15.2(3.5) days; p<0.001], dan tempoh berada di hospital berbanding trakeostomi lewat (LT).

Namun begitu, LT menunjukkan kadar GCS semasa discaj [9.8(2.6) vs. 8.3(2.7); p<0.001] dan kadar GOS-6-bulan [3.7(0.8) vs. 3.3(0.8); p<0.001] lebih baik dengan ketara berbanding ET.

Kesimpulan: PT menunjukkan tempoh alat bantuan pernafasan dan tempoh rawatan di Neuro-ICU lebih pendek. Manakala ET menunjukkan tempoh alat bantuan pernafasan, tempoh rawatan di Neuro-ICU dan tempoh berada di hospital lebih pendek. Namun begitu, LT menunjukkan kadar GCS semasa discaj dan kadar GOS-6-bulan lebih baik.

ABSTRACT

Title : The Practice, Outcome and Complications of Tracheostomy for Traumatic Brain Injury Patients in Neurosurgical Intensive Care Unit

Background: The tracheostomy procedure is commonly required to wean severe traumatic brain injury (TBI) patients. This study aimed to determine the practice, techniques and outcomes in TBI patients in a neurosurgical intensive care unit (Neuro-ICU).

Methods: This was a retrospective, cross-sectional study conducted from January 1st, 2013, until December 31st, 2017, involving 268 severe TBI patients who required tracheostomy during Neuro-ICU management. The data were obtained from their medical records.

Results: When based on techniques, percutaneous tracheostomy (PT) displayed a significantly shorter *day of tracheostomy plan* [7.0(2.5) vs 8.3(2.6) days; p<0.001], *day of execution* [7.2 (2.6) vs 8.6(2.9) days; p<0.001], *duration of mechanical ventilation* [9.8(3.4) vs 11.3(3.1) days; p<0.001], and *duration of ICU stay* [12.3(3.7) vs 13.8(3.5) days; p<0.003] than surgical tracheostomy (ST). If based on timing, early tracheostomy (ET) showed a significantly shorter *duration of mechanical ventilation* [8.8(2.1) vs 12.9(2.9) days; p<0.001], *length of ICU stay* [11.4(2.4) vs 15.2(3.5) days; p<0.001], and *length of hospital stay* [17.1(3.2) vs 20.0(4.0) days; p<0.001] than late tracheostomy (LT).

Conclusion: PT showed a shorter mechanical ventilation and ICU stay duration than ST. In comparison, ET showed shorter mechanical ventilation, ICU stay, and hospital stay duration than LT.

CHAPTER 1: INTRODUCTION

1.1 Background

1.1.1 Traumatic Brain Injury

Traumatic brain injury (TBI) is the leading cause of mortality and morbidity in the age group of 18-45 years worldwide (1). Most of the victims survive with significant disabilities, contributing to major socioeconomic burden for both patients and their families. The financial burden of TBI is outrageous.

Severity of TBI can be quantified using a variety of parameters. The widely used assessment scale are the Glasgow Coma Scale (GCS) score. It is used to grade the severity of the trauma. TBI are graded as mild (GCS > 13), moderate (GCS 9-13) and severe (GCS 8 or less) (2). Prognosis is often determined based on this clinical severity. There is linear relation between this GCS score to poor patient outcomes such as debilitating neurological sequelae, vegetative state or death. This outcome was evaluated based on Glasgow Outcome Scale (GOS). GOS are scored 1 to 5 ; death = 1, vegetative state = 2, severe disability = 3, moderate disability = 4 and 5 = good recovery (3). The significance of these severity assessment in relation to outcome is ambiguous. All grades of TBI can be associated with persistent, and sometimes progressive physical, emotional, behavioral, and cognitive long-term debilitating effects. These will affect an individual's ability to go back to their normal daily life (4).

The impact of TBI can be divided into primary and secondary insult. The primary injury are immediate consequences of head trauma while secondary insult are due to aftermath of ischaemia and hypoxia (5). Both are important determinants of patients'

outcomes. The main aim of management in TBI is to minimize the secondary insult (5). Patients with TBI have impaired consciousness where they are unable to protect their airway, absence of respiratory drive and airway reflexes (6). Hence, intubation is a necessary adjunct in this group of patients to prevent secondary insult from hypoxia. However, with a profound suppression of cellular immune system in TBI patients, this put them at greater risk of developing ventilator-associated pneumonia, where the incidence ranges from 23 to 60% (VAP) (7) (8) (9). This will further contribute to prolonged ventilatory support, subsequently Intensive Care Unit (ICU) and hospital stay.

1.1.2 Tracheostomy

Tracheostomy implies formation of artificial opening in the trachea which acts as conduit of air from the atmosphere to lung parenchyma (10). It is perceived to provides more patient comfort, reduced sedative drug use, faster weaning from mechanical ventilation, and reduced incidence of nosocomial pneumonia (11). The potential reduction in mechanical ventilation will possibly reduce Intensive Care Unit (ICU) stay, hospital stay and other complications associated with prolonged ventilation, namely VAP (6). There are two techniques of tracheostomy, surgically or percutaneously (12).

Complications from tracheostomy can be divided into early and late (13). Early complications are those that happen within one week before the maturation of stoma, whereas late is after the maturity (13). Early complications include bleeding, posterior wall injury, pneumothorax, subcutaneous emphysema, tracheostomy obstruction or dislodge and early extubation (13)(14). While late complications consist of infection, subglottic or tracheal stenosis, tracheomalacia, trachea-oesophageal fistula and disfiguring scar (13)(14)(15)(16).

Recent study suggested both techniques are equally safe (17)(18). The main indications of tracheostomy are as a relieve of upper airway obstruction, weaning method in prolonged ventilation, facilitation of pulmonary toilet and as part of another procedure such as in head and neck surgery (12)(14)(19).

1.1.3 Surgical Tracheostomy

Surgical tracheostomy (ST) or open technique of tracheostomy involve 2-3cm incision in the anterior neck between the cricoid cartilage and the sternal notch (15). The skin and platysma was dissected, strap muscles retracted laterally exposing the thyroid isthmus which was then mobilised (20). A cricoid hook are used to expose the trachea and then a small opening is made on the trachea. Part of a tracheal cartilage is incised, folded and sutured to maintain patency of the stoma. The tracheostomy tube is then introduced through this stoma (20).

ST are indicated in patients with difficult anatomy, and when the need to secure airway immediately in upper airway obstruction are required (21). When there is tumour relating to the neck and upper airways ST is also a preferred technique (20). ST are dominantly executed by Otorhinolaryngology (ORL) surgeon in operation theatre setting where they have a better control of sterility and haemostasis (22).

Neck wall infection and haemodynamic instability are contraindications for ST (15). Traditionally, relative contraindications were obesity, bleeding diatheses, limited neck movement, altered anatomy, previous neck surgery, and high ventilatory requirements (15). The most common complications of ST are bleeding and stomal infections (13).

1.1.4 Percutaneous Tracheostomy

Percutaneous tracheostomy (PT) was introduced in late 1950s but only received worldwide acceptance recently following introduction of commercial kits (14). PT are usually performed by anaesthetist or intensivist bedside, under fibreoptic bronchoscopic guidance (23).

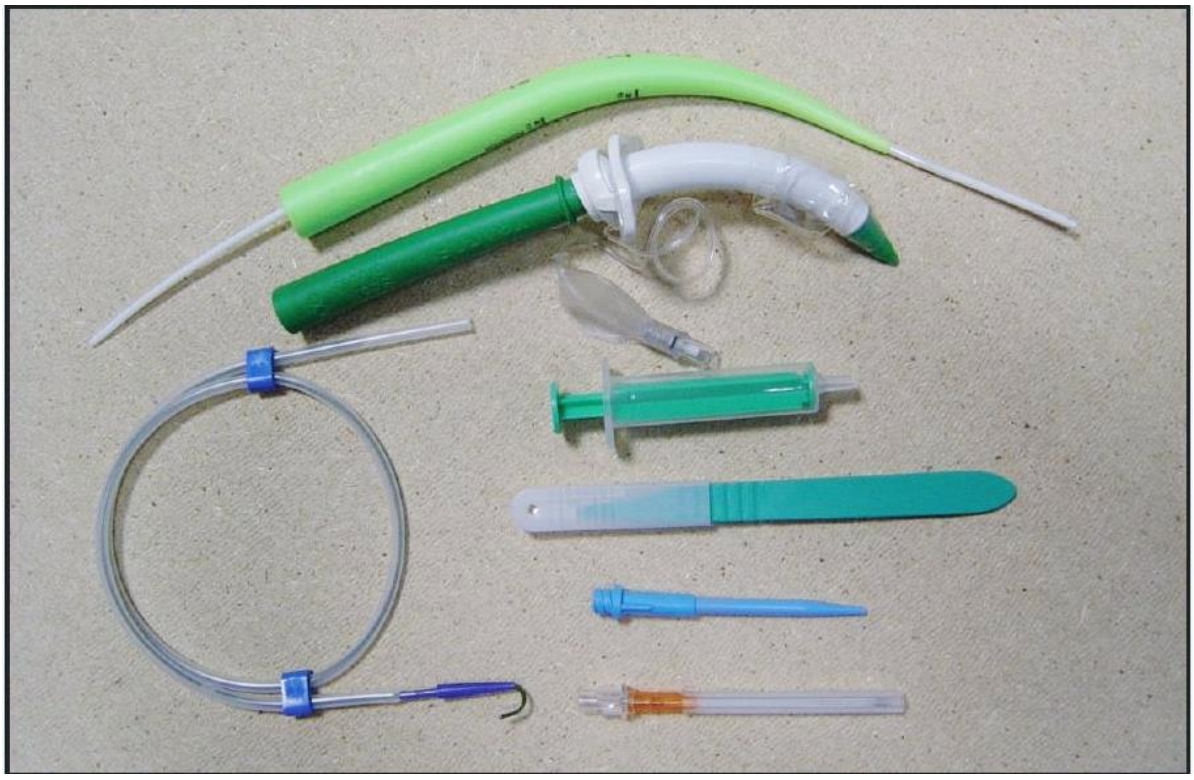

Figure 1. The Tracoe Experc Set **(**TRACOE Medical GmbH, Germany).

There are wide range of commercial kits, however all work based on same Saldinger technique. A needle is inserted through the interspace in between tracheal rings. A guidewire introduced through the needle, then followed by dilatation of the stoma after the needle is

removed. Once the stoma is sufficiently dilated, tracheostomy is loaded over straight dilator then inserted over guidewire into the trachea (20). The gold standard confirmation of it placement are by bronchoscopic view (24).

The kit that was available in our centre is The Tracoe Experc set (Figure 1). The set consist of scalpel, syringe, 14G puncture needle with Teflon catheter, Saldinger guidewire, 14Fr short dilator, guiding catheter with safety stop, and dilator with hydrophilic coating . This set is tailored for both fenestrated and non-fenestrated tracheostomy tube. The atraumatic inserter, short dilator and catheter with safety stop minimizes the risk of injury during the insertion of tracheostomy tube into the trachea (TRACOE Medical GmbH, Germany).

The indications of PT are similar to ST (13). PT has gained popularity due to its relatively ease of execution, reduction of operating theatre cost, limiting patient travel, reduced risk of stomatitis, improved healing and lower unfavourable scarring (10)(24)(25). Despite these, PT are absolutely contraindicated in emergency tracheostomy, and relatively in difficult anatomy, moderate coagulopathy, significant gas-exchange problems, and age less than 12 years (14). The most common complication of PT is posterior wall of trachea injury (13).

1.2 Study Objective

1.2.1. General Objective

To determine the practice, complications and outcomes of tracheostomy in Neurosurgical Intensive Care Units of Hospital Universiti Sains Malaysia.

1.2.2 Specific Objective

- To describe techniques of tracheostomy in TBI patients in 5 years. (January 2013-December 2017)
- To determine mean time decision, time of referral, time of Otorhinolaryngology (ORL) team review, time of proposed for surgery, and time of tracheostomy execution
- To describe the feasibility and complications associated with two different techniques of tracheostomy
- To compare the outcomes of patients (mechanical ventilation duration, length of ICU stays, incidence of VAP, hospital mortality, GCS score upon discharge and length of hospital stay) between groups that received different timing and techniques of tracheostomy.

- To compare the survival of patients (Glasgow Outcome score at 6-month and 1 year) between groups that received different timing and techniques of tracheostomy.

1.3 Study Rationale

Early tracheostomy has been illustrated as a standard part in clinical management of patient with anticipated prolonged mechanical ventilation, however there are limited data exists to suggest on the most appropriate timing and its significance role in severe TBI (26). Some complications that might arise from tracheostomy such as haemorrhage, tracheal stenosis, laryngeal nerve or oesophageal injury, pneumothorax, and stoma infection further compounded these doubts (27).

Hence, this study is aiming to evaluate the practice of tracheostomy in severe TBI patients with the hope that it will guide the management algorithm in future practice. It is also to identify the best technique with probably lower complications and results in better patient outcomes. This study will analyse the survival of patients of severe TBI, with regards to their timing and technique of tracheostomy.

1.4 Literature Review

Majority of severe TBI patients ended up with prolonged mechanical ventilation due to delayed or poor recovery of neurological sequelae. Through the past years, tracheostomy has been part of TBI management as an adjunct of weaning in these group of patients. However, the timing, techniques and the benefits of it remains ambiguous. Scanning through literatures, this topic is widely studied in many countries.

The timing for the early tracheostomy (ET) ranges from day 2 to day 14 of admission (11)(28)(29)(30). Most of the studies suggested that early tracheostomy is associated with a better outcome in patients with severe TBI, mainly reduction in duration of mechanical ventilation, duration of ICU stay and hospital stay (30)(31)(32). Most studies showed an early tracheostomy did not affect the incidence of VAP and mortality (11)(29)(33). However, there is study that showed ET did reduce the long term mortality (28)(30)(34)(35). There are however contradicting studies on effect of ET on long term outcomes such as GOS (26)(36). Furthermore, there were analysis indicating that risk for hospital death increases with early ET(32). These findings imply that early tracheostomy for severe brain injury is not a pragmatic routine policy (32).

Regarding the techniques of tracheostomy, the preferable techniques are should be based on local clinical settings and treating physician's preference. With the advance of technology, PT has been a routine surgical procedure for critically ill patients who require prolonged ventilator support in most developed countries with established trauma centre (37).

PT is reckoned to have a lower overall complications compared to ST but requires training and experiences to ensure familiarity with the tools (37). Most studies concluded that both technique are equally safe with adequate personnel training and does not affect the clinical outcomes of the patients (23)(24)(38).

These indicate a complex relationship between tracheostomy timing , techniques and patient outcomes, but suggest that a strategy of ET, particularly when performed on patients with a reasonable chance of survival, results in a better overall clinical outcome than when the tracheostomy is performed in a deferred manner (39).

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