RETROSPECTIVE STUDY ON THE MANAGEMENT OF LIVER TRAUMA: A 7-YEAR EXPERIENCE IN A HEPATOBILIARY CENTER

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"In the name of Allah, the most gracious and the most merciful"

Alhamdulillah, thankfully I was able to complete my research study. Thank you to both of my parents for their continuous Do'a and Prayers.

Special thanks and gratitude to both of my honourable supervisor, Mr Leow Voon Meng and Mr Zuhdi Bin Mamat, for their advice, constant encouragement and wholehearted support throughout this research work.

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Acknowledgment seems to be incomplete without a word of thanks and huge appreciation to my lovely wife, Dr Samirah Jahubar Sathik and both of my children, Sumayyah and Muhammad Muneeb, who constanty giving their love and support.

Love you all.

ABSTRAK

Latar belakang: Kecederaan hati kerap berlaku dalam kecederaan yang melibatkan bahagian abdomen akibat kemalangan jalan raya. Untuk pesakit yang stabil, kaedah rawatan telah berubah dari pembedahan kepada bukan pembedahan semenjak tiga dekad yang lalu. Namun, faktor-faktor yang boleh mengakibatkan kegagalan dalam kaedah bukan pembedahan haruslah diambil berat. Oleh kerana itulah, kajian ini dijalankan bagi mengenal pasti faktor-faktor tersebut supaya langkah-langkah awal dapat diambil bagi mengurangkan kadar morbiditi dan kematian.

Kaedah: Kajian ini menggunakan kaedah retrospektif melalui rekod pesakit yang mengalami kecederaan hati di Hospital Sultanah Bahiyah, Alor Setar mulai 1 Januari 2012 sehingga 31 Desember 2018. Kesemua pesakit yang memenuhi kriteria dimasukkan ke dalam kajian ini. Analisis data dibuat menggunakan perisian Statistical Package for the Social Sciences (SPSS) versi 26.

Keputusan: Sebanyak 158 pesakit dimasukkan ke dalam kajian ini berumur di antara 12 ke 80 tahun, dengan min umur 25.6 tahun. Daripada jumlah tersebut, 125 pesakit adalah lelaki dan 33 perempuan. Kebanyakan kes melibatkan kemalangan jalan raya, iaitu 141 (89.2%), diikuti oleh jatuh, 6 (3.8%) dan kecederaan industri, 3 (1.9%). Gred III dan IV adalah yang tertinggi, masing-masing 43 (27.2%) dan 42 (26.6%). Sejumlah 53 (33.5%) pesakit menjalani pembedahan kecemasan dan 20 orang pesakit (37.2%) daripada kes-kes tersebut mengalami komplikasi selepas pembedahan. Sebanyak 105 (66.5%) kes dirawat secara bukan pembedahan. Kebanyakan kes di dalam kumpulan ini adalah pesakit muda dengan min umur 21 tahun. Berdasarkan logistic regresi mudah, terdapat enam faktor yang ketara mengakibatkan kegagalan kaedah bukan pembedahan, iaitu Haemoglobin semasa ketibaan (p 0.015), status pemindahan darah (p 0.008), jumlah unit

pemindahan darah (p 0.014), gred kecederaan hati (p 0.001), jangkamasa di hospital (p 0.028), dan kemasukan di unit rawatan rapi (p 0.041). Logistik regresi pelbagai pula menunjukkan dua faktor yang mengakibatkan kegagalan kaedah rawatan secara bukan pembedahan iaitu gred kecederaan hati dan jangkamasa di hospital, dengan nilai *p* sebanyak 0.003 dan 0.040 masing-masing.

Kesimpulan: Kaedah rawatan secara bukan pembedahan adalah selamat bagi pesakit kecederaan hati yang stabil. Faktor-faktor yang boleh meramal kegagalan kaedah ini haruslah diambil berat dan rawatan yang berpatutan perlu dilakukan untuk menyelamatkan pesakit supaya kadar morbidity dan ortaliti dapat diminimakan.

Kata kunci: Kecederaan hati . Rawatan bukan pembedahan . Gagal

ABSTRACT

Background: Liver trauma is one of the most common injury in abdominal trauma. For the last three decades, there was a paradigm shift from operative to non-operative management (NOM) in liver trauma, with stable haemodynamic, regardless to the grading of liver injury. There are factors that should be considered for anticipating failure of non-operative management. Therefore, this study is performed to identify these factors, to ensure that early intervention is done in order to achieve less morbidity and mortality in non-operative management of liver trauma.

Methods: This is a retrospective study of case record of patients diagnosed with liver injury in Hospital Sultanah Bahiyah, Alor Setar from 1st January 2012 to 31st December 2018. Subjects who met the inclusion criteria were recruited in this study. The outcome of non-operative management and factors leading to its failure were studied. The data were analyzed using Statistical Package for the Social Sciences (SPSS) version 26.

Results: A total of 158 patients were included in this study. They were 12 to 80 years old, with mean age of 25.6 years. The subject pool comprised of 125 males and 33 females. Majority of the liver traumas were due to motor vehicle accidents, 141 (89.2%), followed by fall, 6 (3.8%) and industrial injury 3 (1.9%). Grade III and grade IV liver injuries were the two most common grading with a total of 43 (27.2%) and 42 (26.6%) cases encountered respectively. Fifty-three patients underwent emergency laparotomy and 20 (37.2%) of them developed post-operative complications. Hundred and five patients were treated non-operatively. Majority of the patients in this group were young, mean age of 21.0 years old. Simple logistic regression revealed six predictive factors associated with failure of NOM, including haemoglobin at presentation (*p* 0.015), blood transfusion status (*p* 0.008), unit of blood transfused (*p* 0.014), liver injury grade (*p*

0.001), length of stay (*p* 0.028) and intensive care unit admission (*p* 0.041). Multiple logistic regression shown that liver injury grade and length of stay had significant association with failure of NOM, with *p* value of 0.003 and 0.040 respectively.

Conclusion: Non-operative management in liver trauma is a safe approach in haemodinamically stable patients. Factors related to its failure must be considered for better outcome in term of morbidity and mortality.

Keywords: Liver trauma ; Non-operative management ; Fail

CHAPTER 1.0: INTRODUCTION

1.1 INTRODUCTION AND LITERATURE REVIEW

Liver is the most injured organ in abdominal trauma. Road traffic accidents and violent behaviour account for the majority of liver injuries and the age groups of 20-40 years are mostly affected (Piper and Peitzman, 2010; Tarchouli *et al.*, 2018). As demonstrated by several studies, the management of liver trauma has significant change through the last three decades with favourable outcomes, especially in blunt trauma (Ahmed and Vernick, 2011). Most liver injuries are grade I, II or III and are successfully treated by conservative management, while two-thirds of grade IV or V injuries necessitate laparotomy (Piper and Peitzman, 2010).

Pathophysiologically, trauma to the liver is related to direct force, accelerated or decelerated forces to the liver. This organ is organized on a functional basis into eight segments according to the layout of the hepatic veins and is highly vascularized, receiving blood from both the hepatic artery and the portal venous system, which provides up to 75% of the total hepatic vascular inflow and half of its oxygenation. The fragile parenchyma is enclosed by a relatively fibrous capsule and fixed to the abdominal wall by the falciform, coronary and triangular ligaments.

In blunt trauma, the mechanism involved is deceleration injury with shear forces applied, particularly where the hepatic ligaments anchor it to the abdominal wall. The usual hepatic injury is fracture between the anterior and posterior segments of the right lobe and frequently ruptures the right hepatic vein. The posterior liver where it is anchored to the diaphragm is particularly vulnerable to shear injury generating retrohepatic venous injury with potentially catastrophic bleeding (Rivkind *et al.*, 1989). Parenchymal fractures radiate centripetally and may or may not rupture the capsule. If the capsule remains intact blood or bile will collect as a subcapsular or intraparenchymal collection.

Subcapsular venous haematomas are usually self-limited by tamponade whereas arterial bleeding causes extensive capsular expansion (Rivkind *et al.*, 1989).

Meanwhile the effect of penetrating injuries such as stab injuries and missile injuries are dependent on the entry site and degree of energy transfer induced. Stab wounds are resulted from a low energy transfer mechanism and the level of injury is dependent on the depth of penetration and whether major vessels are transected. Missile injuries, especially gunshot wounds have the capacity for extensive hepatic injury. The higher the level of energy transfer, the greater the degree of tissue damage, meaning very high levels of energy transfer can result in the liver exploding (Parks *et al.*, 1999).

The recognition that between 50 and 80 per cent of liver injuries stop bleeding spontaneously, coupled with better imaging of the injured liver by computed topography (CT), has led progressively to the acceptance of non-operative management (NOM) with a resultant decrease in mortality rates (Ahmed and Vernick, 2011).

CT scanning is essential to the grading of hepatic injury, as hepatic trauma ranges in severity between minor capsular tears to extensive lobar disruption and major vessel (inferior vena cava, hepatic veins and portal vein) injury.

The most widely recognized liver injury scoring system is the Organ Injury Scale (Liver) published by the American Association for the Surgery of Trauma (AAST), devised in 1987 and revised in 1994 (Table 1). It can be classified as minor (grade I, II), moderate (grade III) or major/severe (grade IV, V) injuries. This classification is not well defined in the literature but aims to define the type of management that can be adopted and the related outcome.

Grade	Description of injury
I	Haematoma: subcapsular, <10% surface area Laceration: capsular tear, <1cm depth
II	Haematoma: subcapsular, 10-50% surface area; intraparenchymal lesion <10cm diameter Laceration: capsular tear, 1-3cm depth, < 10cm length
III	Haematoma: subcapsular, > 50% surface area of ruptured subcapsular or parenchymal haematoma;intraparenchyma haematoma >10cm or expanding Laceration: >3cm parenchymal depth
IV	Laceration: parenchymal disruption involving 25-75% hepatic lobe or 1-3 Counaud segments
V	Laceration: parenchymal disruption involving > 75% hepatic lobe or > 3 Couinaud segments within single lobe Vascular: juxtahepatic venous injuries (retrohepatic vena cava / central major hepatic veins)
VI	Vascular: hepatic avulsion

Table 1: AAST organ injury scale – liver injury, AAST liver injury scale (1994 revision)

There are some patients with high-grade lesions but haemodynamically stable had been treated with non-operative management. This demonstrates that the classification of liver injuries as minor or major ones must consider not only the anatomical AAST classification but more importantly, the hemodynamic status of the patient and the associated injuries. In one prospective study conducted by Hommes et al, they found out that NOM of blunt liver injury has a high success rate (95%) in patients who responded to resuscitation, irrespective of the grade of liver trauma (Hommes *et al.*, 2015).

As being mentioned above, management of liver trauma has deeply changed through the last three decades and NOM is progressively being accepted as management of choice for many cases. However, many aspects of NOM remain controversial with the discrepancy between CT findings and operative findings for blunt liver injury being the most significant (Croce *et al.*, 1991).

Technological advances in CT scanner capabilities have been pivotal in enabling NOM of intraperitoneal solid organ injury by providing a mechanism to assess the severity of

the organ injury and identifying other associated injuries that may require surgical intervention, such as hollow visceral or pancreatic injury. This concept of NOM represents a dramatic divergence from traditional surgical dogma and mandates delineation of those patients at risk for failure of nonoperative management.

Despite the concept of NOM of liver trauma has been widely accepted, factors that lead to failure of this concept have been reported in the literature. Four criteria had been identified as predictors which lead to NOM failure: hemodynamic instability, American Association for the Surgery of Trauma (AAST) grade of liver injury, periportal tracking, and contrast pooling on CT scan (Knudson *et al.*, 1990; Pachter *et al.*, 1996). Hemodynamic instability, unresponsiveness to fluid resuscitation, and recurrence after initial stabilization are predictors of the need for surgical or angiographic intervention. These data was supported by a systematic review done by Boese et al showing that six prognostic factors reached statistical significance predicting the failure of NOM, which were blood pressure, fluid resuscitation, blood transfusion, peritoneal signs, Injury Severity Score and associated intrabadominal injuries (Boese *et al.*, 2015).

During the early phases of NOM of liver injuries, only grades I, II and III were treated in this fashion. Subsequently, several large series of patients with hepatic injuries documented management without surgical intervention of grade IV and V injuries. A natural selection process appears to be at work because most patients requiring surgical intervention have grade IV or V injuries and undergo urgent laparotomy for hemodynamic instability and most patients without hemodynamic instability can be successfully managed nonoperatively (Knudson *et al.*, 1990; Meredith *et al.*, 1994).

The radiographic finding of periportal tracking on CT scans has been associated with failure of NOM (Davis *et al.*, 1996).This is because low attenuation noted around

segments of the portal vein is believed to be blood that has dissected along the portal triad and that represents a more pronounced injury than injuries without the attenuation. However recently periportal tracking have been questioned, and none of the reports of the most recent series of liver injuries managed nonoperatively has cited this finding as a predictor of failure for nonoperative management (M Gage Ochsner, 2001).

Another predictor as mentioned above is contrast pooling on CT scan. Contrast pooling is a focal area of high density on CT scan images seen after intravascular injection of contrast material that represents a collection of extravasated contrast material secondary to arterial bleeding. This finding has been associated with subsequent hemodynamic instability due to ongoing hemorrhage and often leads to surgical intervention. Multiple case reports and several large series of hepatic injuries have documented the association of this finding with failure of nonoperative management (Ciraulo *et al.*, 1998; DiGiacomo *et al.*, 1996).

Despite the emergence and well accepted NOM for liver trauma, emergency laparotomy is still needed especially when an injured patient cannot be stabilized by fluid resuscitation or is in severe shock on arrival (Letoublon *et al.*, 2016). Literature showed that overall complication rate after initial operative management was 58% and the most common abdominal complications were postoperative abscess, postoperative haemorrhage, wound dehiscence and prolonged ileus (Leppäniemi *et al.*, 2011).

1.2 RATIONAL OF STUDY

Trauma is one of the most common problems encountered in a daily basis practice. Liver is well known to be the frequently injured internal organ in abdominal injury despite its relatively hidden location behind the subcostal region (Swift and Garner, 2012). Non-operative management is now the standard of care for blunt liver injury in hemodynamically stable patient and treatment outcomes depend on the severity of injuries to the organ. Thus, it is important to look for the current practice of liver trauma management and to identify factors that lead to fail non-operative management and to identify the consequences of major liver trauma. As for the advancement of management of liver injury worldwide and the outcome of patients may differ from one center to another as it depends on the availability of the expertise, recent data regarding liver trauma management is important to evaluate the effectiveness and outcome of current local management. This study will highlight the recent advances in management of liver trauma in Hospital Sultanah Bahiyah (HSB). Hence, it is reasonable to provide these recent local data, which may help and improve management of liver injury in HSB as a Northern Malaysia referral hepatopancreatobiliary center and perhaps to other regional tertiary hospitals as well. We hope this study will improve the morbidity and mortality rate of liver traumas in the near future in Malaysia.

CHAPTER 2.0: STUDY PROTOCOL

2.1 DOCUMENT SUBMITTED FOR ETHICAL APPROVAL

RETROSPECTIVE STUDY ON THE MANAGEMENT OF LIVER TRAUMA: A 7-YEAR EXPERIENCE IN A HEPATOBILIARY CENTER

Medical Research & Ethics Committee, Kementerian Kesihatan Malaysia: NMRR-

JEPeM Code: USM/JEPeM/19100618

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INTRODUCTION:

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JUSTIFICATION OF STUDY

Trauma is one of the most common problems encountered in a daily basis practice. Liver is well known to be the frequently injured internal organ in abdominal injury despite its relatively hidden location behind the subcostal region (Swift and Garner, 2012). Non-operative management is now the standard of care for blunt liver injury in hemodynamically stable patient and treatment outcomes depend on the severity of injuries to the organ. Thus, it is important to look for the current practice of liver trauma management and to identify factors that lead to fail non-operative management and to identify the consequences of major liver trauma. As for the advancement of management

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OBJECTIVE

General Objective:

1. To determine factors that contributes to failure of non-operative management (NOM) in managing liver trauma

Specific Objectives:

1. To determine the proportion of non-operative management of liver trauma cases at Hospital Sultanah Bahiyah, Alor Setar in seven years period

2. To determine the morbidity and mortality of operative management in liver trauma

RESEARCH QUESTION

1. What are the factors that contribute to failure of non-operative management (NOM) in managing liver trauma cases?

2. What is the proportion of non-operative management of liver trauma patient in Hospital Sultanah Bahiyah for the past seven years?

3. What are the morbidity and mortality of operative management in liver trauma?

HYPOTHESIS

Hypothesis Null: There is no factor associated with failed non-operative management (NOM) in liver trauma

Hypothesis Alternative: There is factor associated with failed non-operative management (NOM) in liver trauma

MATERIAL AND METHODS

1. **Study design**

   Retrospective study

2. **Place and Duration of Study**

   Hospital Sultanah Bahiyah, Alor setar

   Study Period

   1st of January 2012 – 31st of December 2018

3. Sample Size

The sample size calculated to estimate the proportion of non-operative management of liver trauma patients using single proportion formula with the 95% confidence interval, $Z_\alpha = 1.96$ and precision, $\Delta = 0.10$ including the allowance of an additional 10% possibility of incomplete data.

$n = (Z_\alpha/\Delta)^2 P(1-P)$

Variable	P*	n	n+10%	References(Norrman *et al.*, 2009)
Non-operative	0.24	70	77	Norman *et al.* (2009)

P = Population's proportion

The sample size calculated to estimate the proportion of morbidity and mortality among operated liver trauma patients using single proportion formula with the 95% confidence interval, $Z_\alpha = 1.96$ and precision, $\Delta = 0.10$ including the allowance of an additional 10% possibility of incomplete data.

$n = (Z_\alpha/\Delta)^2 P(1-P)$

Variable	P*	n	n+10%	References(Gourgiotis *et al.*, 2007)
Morbidity	0.367	89	98	S. Gourgiotis *et al.* (2007)
Mortality	0.163	52	57	S. Gourgiotis *et al.* (2007)

P = Population's proportion

The sample size calculated to estimate the factors associated with failure of non-operative management of liver trauma was done using PS Software (dichotomous). Conventionally, the power of the study is set at 80% with $\alpha=0.05$. The ratio of control to case, m = 1. The

sample size was calculated for each variable including an allowance of 10% possibility of incomplete data.

Factors	P_0*	P_1	n	(nx2)+10%	Reference (Norrman *et al.*, 2009)
Liver injury grade ≥3	0.32	0.55	72	158	Norman *et al.* (2009)
Hemodynamically instable	0.03	0.20	54	118	Norman *et al.* (2009)

P_0 = Proportion of exposed in successful NOM

P_1 = Estimated proportion of exposed in failure NOM

Therefore, the biggest sample size for the study is 158.

4. Inclusion criteria

1. Patients diagnosed with liver injuries on computed tomography scan or during laparotomy
2. Age ≥ 12 years old

5. Exclusion criteria

1. Missing data (>20% of variables)
2. Age ≤ 11 years old

6. Data for collection

Data will be collected from medical records (Unit Rekod, HSB) and eHIS system at Hospital Sultanah Bahiyah. Data from referral cases will be collected from initial clerking or will be retrieved from the original referral letter from Medical

Record Unit. Phone call will be made to referral center if no data available and obtained data will be faxed for documentation. Any subject with missing data will be excluded in this study. Convenient non randomized sampling will be used as sampling method.

The grade of hepatic injury is established from initial CT determination or intraoperative findings, according to the Liver Injury Scale of the American Association for the Surgery of Trauma (AAST).

1. Demography
2. Comorbids
3. Date of admission and discharge
4. Mechanism of injury
5. Vital signs (Blood pressure, Pulse rate, SPO2), FAST scan
6. Haemoglobin level
7. Blood transfusion requirement
8. Grade of liver injury (CT and intraoperative findings)
9. Associated injury
10. Intervention done during early patient's assessment (ie; Emergency Laparotomy)
11. Indication for surgical intervention
12. Complication / sequelae post-surgery
13. Non-operative procedures
14. Decision for non-operative management (NOM)
15. Sequelae of Non-Operative management