USAGE OF FOCUSED ASSESSMENT WITH SONOGRAPHY IN TRAUMA (FAST) SCAN IN BLUNT INTRAABDOMINAL TRAUMA

DR LEE KEE CHOON

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TABLE OF CONTENTS

CHAPTER 3: MANUSCRIPT

CHAPTER 4: APPENDICES

LIST OF ABBREVIATIONS

BAT	Blunt Intraabdominal Trauma
ED	Emergency Department
FAST	Focused Assessment with Sonography in Trauma
CT	Computed tomography
USG	Ultrasonography
FF	Free fluid
RUQ	Right upper quadrant
LUQ	Left upper quadrant
SP	Suprapubic
RR	Respiratory rate
HUSM	Hospital Universiti Sains Malaysia
HoSHAS	Hospital Sultan Haji Ahmad Shah
HRPB	Hospital Raja Permaisuri Bainun

LIST OF FIGURES

CHAPTER 2: STUDY PROTOCOL

2.10 Operational Definition

2.16 Flow Chart

CHAPTER 3: MANUSCRIPT

3.5 Results

LIST OF TABLES

CHAPTER 3: MANUSCRIPT

3.5 Results

ABSTRAK

Latar Belakang

Kecederaan tumpul pada bahagian dalaman abdomen adalah kes yang sering dirawat di jabatan kecemasan. Keterbatasan dalam memperolehi sejarah trauma dan melakukan pemeriksaan fisikal yang menyeluruh menyebabkan kesukaran dalam membuat diagnosis yang tepat. Umumnya, bahagian Morrison pouch merupakan kawasan pemeriksaan FAST yang paling kerap positif cecair bebas. Selain itu, tiada kajian yang dilakukan untuk menentukan kaitan di antara kuadran yang positif cecair bebas dengan jenis kecedaraan organ dalaman abdomen. Tujuan kajian ini adalah untuk menentukan kekerapan kuadran dan sub-kuadran yang positif dalam pemeriksaan FAST serta kaitan dengan jenis kecederaan.

Tatacara Kajian

Kajian retrospektif ini melibatkan 86 pesakit yang mengalami kecederaan tumpul bahagian dalaman abdomen di Jabatan Kecemasan di tiga buah hospital. Pemeriksaan FAST dilakukan mengikut garis panduan trauma. Pesakit yang dipastikan mempunyai kecederaan dalaman abdomen melalui pemerikasaan CT abdomen atau pembedahan diambil sebagai subjek sekiranya pemeriksaan FAST juga positif cecair bebas. Data yang dikumpul merangkumi kuadran yang positif cecair bebas memalui pemeriksaan FAST dan jenis kecederaan organ dalaman. Ini adalah untuk menentukan kekerapan kuadran serta sub-kuadran yang terlibat dan kaitan diantaranya dengan jenis kecederaan. Bahagian yang berkenaan adalah kuadran atas kanan (RUQ), kuadran atas kiri (LUQ dan pelvik (SP). Sub kuadran yang terlibat adalah RUQ 1 – hepato-diaphragmatic, RUQ 2 – Morison's pouch, RUQ 3 – caudal liver edge dan superior para-colic gutter, LUQ 1 – Splenic-diaphragmatic, LUQ 2 – spleno-renal, LUQ 3 – around

inferior pole of kidney, SP 1 – bilateral to bladder, SP 2 – posterior to bladder dan SP 3 – posterior to uterus.

Keputusan

RUQ mempunyai kekerapan positif cecair yang paling tinggi (n=82/86, 95.3%). RUQ 3 merupakan kawasan yang paling kerap positif cecair bebas (n=78/86, 90.75%) disusuli oleh RUQ 2 (n=73/86, 84.9%) dan seterusnya LUQ 2 (n=51/86, 59.3%). Kajian ini juga menunjukan terdapat kaitan yang signifikan di antara pemeriksaan FAST LUQ yang positif cecair bebas dengan kecederaan organ limpa (p=0.006).

Kesimpulan

Kuadran RUQ dan sub kuadran RUQ 3 merupakan bahagian paling kerap positif cecair bebas dalam pemeriksaan FAST. Manakala, LUQ yang positif cecair bebas mempunyai kaitan dengan kecederaan organ limpa di dalam kecederaan tumpul dalaman abdomen.

ABSTRACT

Background

Blunt intra-abdominal trauma (BAT) encompasses a major portion of trauma cases in the emergency department (ED). It poses a difficulty in diagnosis due to its low sensitivity and specificity of history and physical examination. Morison pouch is typically considered the most common area of free fluid (FF) in BAT visualized on the focused assessment with sonography in trauma (FAST) scan. However, no studies to date have investigated the correlation of the abdominal quadrant for positive FF with the type of abdominal trauma. This study aims to determine the most common quadrant and subquadrants for detecting FF and their association with the type of injury in BAT patients.

Methods

This multicenter study evaluated 86 BAT patients who presented to the ED. The FAST scan was performed per trauma life support protocol, and video clips were extracted for patients with positive FAST findings confirmed by abdominal computed tomography (CT) or exploratory laparotomy. The most common quadrant and subquadrant positive for FF were then determined. Positive quadrants and their association with type of injury were also analyzed. Areas studied were the right upper quadrant (RUQ), left upper quadrant (LUQ), and suprapubic area (SP). Subquadrant areas were RUQ 1–hepato-diaphragmatic; RUQ 2–Morison pouch; RUQ 3–caudal liver edge and superior para-colic gutter; LUQ 1–splenic-diaphragmatic; LUQ 2–spleno-renal; LUQ 3–around the inferior pole of kidney; SP 1–bilateral to bladder; SP 2–posterior to bladder; and SP 3–posterior to uterus.

Results

The most frequent region with positive FF results was the RUQ, seen in 82 (95.3%) patients. In subquadrant analysis, RUQ 3 was the most common region (78 patients, 90.75%), followed by RUQ 2 (73 patients, 84.9%) and LUQ 2 (51 patients, 59.3%). A significant association was observed between the LUQ region positive for FF and the presence of splenic injury (p = 0.006).

Conclusion

In patients with BAI, the RUQ is the most frequent quadrant and RUQ 3 is the most frequent subquadrant positive FF. A positive LUQ free fluid suggests the presence of splenic injury in BAT.

Keywords

Blunt intra-abdominal trauma, focused assessment with sonography in trauma scan

CHAPTER 1: INTRODUCTION

1.1 Background

Trauma has been one of the leading causes of mortality and morbidity among Malaysians. The majority of the trauma cases are contributed by road traffic accidents. Department of Statistics Malaysia has estimated around 521,466 cases of road traffic accidents in 2016 and the numbers are increasing annually (Research, 2017).

According to Malaysia National Trauma Database, abdominal injury encompasses around 4.79% of major trauma cases presented to the emergency department (Jamaluddin et al., 2007). Therefore, blunt abdominal trauma (BAT) is one of the usual presentations to ED. Unfortunately, it poses a difficulty in diagnosis due to the low sensitivity and specificity of the history and physical examination (Nishijima et al., 2012).

Traditionally, diagnostic peritoneal lavage (DPL) was used to diagnose BAT. Meta-analysis showed that incidence of major complication after DPL is 0.6% (Hodgson et al., 2000). Although the incidence is low, the risk is still present in comparison to ultrasonography (USG) and also computed tomography (CT) which are non-invasive. Apart from that DPL is difficult to perform in serial, in pregnant or obese patient which eventually cause high negative laparotomy rate (Jansen and Logie, 2005).

CT abdomen has better specificity than DPL in detecting intraabdominal injury in BAT (Griffin and Pullinger, 2007). However, the disadvantages are the difficulty to perform in hemodynamically unstable patients and requires transferring of the patient. Meanwhile focus assessment with sonography in trauma (FAST) scan has become the important

alternative diagnostic tool in assisting diagnosis of intraabdominal injury in BAT comparing to DPL and CT (Korner et al., 2008), (Savatmongkorngul et al., 2017).

1.2 Problem Statement

Classical teaching mentioned that Morison's pouch is the most common area of free fluid finding. However, we have noted that there were other quadrants with positive free fluid frequently seen during clinical practice. The different most common region with positive free fluid also has been shown in a few recent studies. However, both studies had a relatively small sample size.

On top of that, no study at the moment has been done to look at the correlation of finding of free fluid in each quadrant with the CT finding or laparotomy finding if surgically managed. The inability to know which organ is involved has led to some degree of difficulty and anxiety for the managing team to decide the best next course of patient management.

1.3 Literature Review

Blunt Intraabdominal Trauma

Blunt trauma account for 65% of all trauma death and up to 33% of the cases are due to abdominal injury (Demetriades et al., 2004). It has been shown that the liver and spleen are the two most common injured organ in BAT (Intravia and DeBerardino, 2013). Although the most frequent organ injured in abdominal trauma is the liver, the most frequent organ involved due to sports injury is the spleen (Adam and De Luigi, 2018). Meanwhile, the majority of trauma cases presented to ED in Malaysia are due to road traffic accidents with 4.79% of it is due to abdominal injury and young age group (Jamaluddin et al., 2007).

The biomechanics of traumatic force determine which organs are more susceptible to injury and all abdominal organs are at risk in blunt trauma (Ferroggiaro and Ma, 2019). Abdominal organs are considered as relatively mobile or fixed. Therefore, compression, shearing or stretching, and acceleration or deceleration forces affect the abdominal compartment leading to abdominal wall, intra-abdominal solid organs, and hollow structures injury (Iaselli et al., 2015).

Clinical features of BAT are mainly due to pain and hemorrhage. Early presentation of the patient with BAT may have minimal change in vital signs (Surgeons. and Trauma., 2018). However, clinical features like heart rate, blood pressure, level of consciousness, and urinary output will change as the blood loss continues. Massive hemorrhage soon after the injury can lead to early mortality, meanwhile, patients who survived early traumatic events may eventually have a higher risk of infection and sepsis (Ferroggiaro and Ma, 2019).

Imaging Modalities and Method of Investigations

Multiple imaging modalities can be used in managing patients with BAT. A plain abdominal radiograph can be performed in a supine or right lateral decubitus position if visceral perforation is suspected (Intravia and DeBerardino, 2013). Nonetheless, plain abdomen radiographs are generally not helpful in BAT evaluation and management (Diercks et al., 2011).

In addition to radiographic evaluation, diagnostic peritoneal lavage (DPL) was used to diagnose BAT. The reported incidence of major complication after DPL in a meta-analysis was 0.6% (Hodgson et al., 2000). Although the incidence is low, the risk is still present in

comparison to ultrasonography (USG) and also computed tomography (CT) which are non-invasive. The other challenge of DPL is that it is difficult to perform in serial, in pregnant or obese patient which eventually cause high negative laparotomy rate (Jansen and Logie, 2005).

CT is the gold standard choice of radiography evaluation of abdominal trauma (Walter, 2007). CT abdomen has better specificity than DPL in detecting intraabdominal injury in BAT (Griffin and Pullinger, 2007). Apart from that, CT is also more sensitive than focus assessment with sonography in trauma (FAST) scan since it provides better anatomic details particularly liver, spleen, and kidneys (Adam and De Luigi, 2018). However, CT has disadvantages due to the difficulty to perform in hemodynamically unstable patients and requires transferring of the patient (Walter, 2007).

Focused Assessment with Sonography in Trauma (FAST) Scan

FAST scan has become the important alternative diagnostic tool in assisting diagnosis of intraabdominal injury in BAT comparing to DPL and CT (Korner et al., 2008), (Savatmongkorngul et al., 2017). Based on a study done to evaluate FAST scan among emergency physicians in the United Kingdom, the specificity and sensitivity are reported as high as 99% and 78% respectively (Brenchley et al., 2006).

Apart from that, FAST scan was recommended as the first-line imaging modalities performed in unstable BAT to identify the need for emergency surgical intervention (Diercks et al., 2011). This is due to the ultrasound portability and less time-consuming making it more suitable for hemodynamically unstable patients with BAT (Amaral, 1997).

FAST scans examine 3 regions in the abdominal cavity and the pericardium for abnormal fluid accumulation. The 3 regions in the abdominal area are namely the right upper quadrant (RUQ), left upper quadrant (LUQ), and suprapubic (SP) region. The RUQ scan aims to detect free fluid at Morrison's pouch, right sub-diaphragmatic, and caudal edge of the left liver lobe. Next, the LUQ scan is to inspect the spleno-renal recess, left sub-diaphragmatic, and left paracolic gutter. Meanwhile, the SP scan is meant to detect free fluid in the rectovesical pouch in males and rectouterine (Pouch of Douglas) and vesicouterine pouches in females.

Rozycki GS et al (1998) showed that blood is most often found at right upper quadrant (RUQ) area in patients with multiple intraperitoneal injuries or isolated solid organ injury (Rozycki et al., 1998). This is consistent with classical teaching that mentioned Morison's pouch as the most common area of free fluid finding. However, a recent retrospective study showed that RUQ specifically at the caudal edge of left liver lobe is the most sensitive area for free fluid in FAST scan (Lobo et al., 2017). In another study by O'Brien et al (2019), it was shown that the most sensitive area for free fluid detection at the left upper quadrant is at the paracolic gutter (O'Brien et al., 2014).

Limitation of FAST Scan

Although the FAST scan has high specificity, a negative FAST scan without confirmation by CT abdomen may miss BAT due to the low sensitivity (Natarajan et al., 2010). Despite the accessibility of FAST scan, acquired images can be influenced by conditions such as body shape, obesity, surgical emphysema, and operator skill (Fleming et al., 2012). Apart from that, the presence of FF can be normal in a female or pregnant patient (Hussain et al.,

2011). Therefore, FAST scan has the potential to be interpreted wrongly and lead to misdiagnosis.

A study has shown that there is a correlation between positive FAST scan and solid organ injury in BAT (Talari et al., 2015). However, based on literatures search, no study was done to find the correlation of positive free fluid quadrant with the type of BAT.

1.4 Research Questions

1.4.1 What is the most common quadrant in detecting free fluid in FAST scan of intraabdominal injury?

1.4.2 What is the most common sub quadrant in detecting free fluid in FAST scan of intraabdominal injury?

1.4.3 What is the association of positive quadrant of FAST scan and type of intraabdominal injury?

1.5 Study Justification and Benefit of Study

This study is not meant to suggest USG to take over CT abdomen as the gold standard of diagnosis in a hemodynamically stable intraabdominal injury patient. Hopefully it will be able to give diagnostic clues to the attending physician and also surgical team regarding the possible injury sustained and better anticipation of patient clinical progression.

This study is aimed to determine which quadrants and sub quadrants in FAST scan which are most common for free fluid. This can raise awareness of the attending physician and thus, reduce false negative finding. We hope to improve and expedite the management of

the patient that has blunt intraabdominal injury based on quadrants of positive free fluid and eventually improve patient's disposition.

1.6 Research Objectives

General

To explore the usage of FAST scan in detecting free fluid in blunt abdominal injury.

Specific

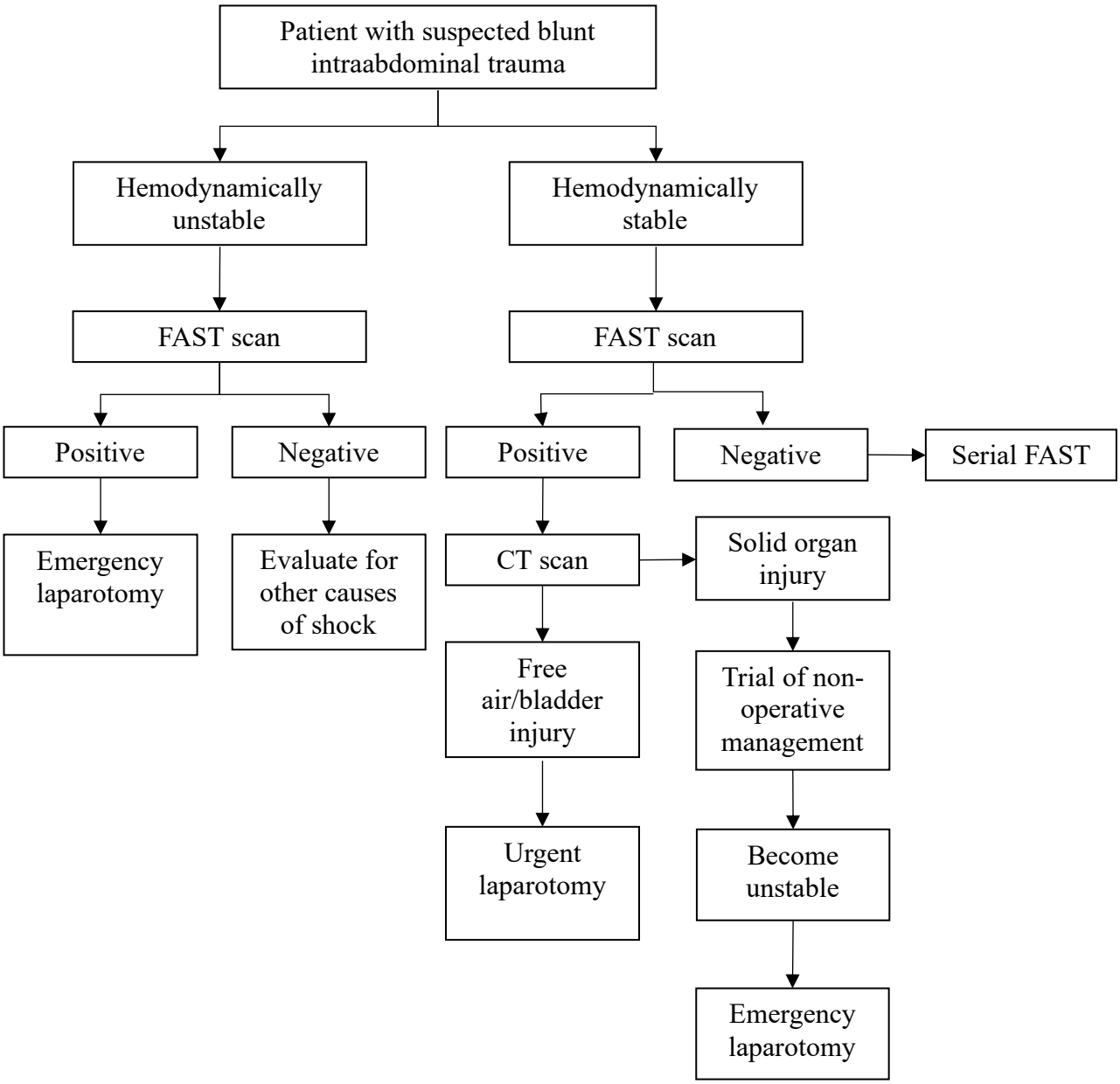
1.6.1 To determine most common quadrant positive of free fluid detection during FAST scan in BAT

1.6.2 To determine most common sub-quadrant positive of free fluid detection during FAST scan in BAT

1.6.3 To determine association of location of positive quadrant FAST scan and type of intraabdominal injury on CT or surgery.

CHAPTER 2: STUDY PROTOCOL

2.1 Conceptual Framework



2.2 Study design

Retrospective study

2.3 Study duration

December 2018 to Nov 2019

2.4 Study area:

2.4.1 Emergency Department Hospital Universiti Sains Malaysia (HUSM), Kota Bharu, Kelantan

2.4.2 Emergency Department Hospital Sultan Haji Ahmad Shah (HoSHAS), Temerloh, Pahang

2.4.3 Emergency Department Hospital Raja Permaisuri Bainun (HRPB), Ipoh, Perak

2.5 Study population

2.5.1 Reference population - Blunt abdominal trauma with intraabdominal injury patient

2.5.2 Source population

- Walk-in patient to the ED of respective hospital
- Referred case from health clinic or district hospital to the ED of respective hospital

2.6 Study participant

2.6.1 Inclusion criteria

- All trauma patient with positive FAST scan with confirmed blunt intraabdominal injury by CT abdomen or laparotomy finding.
- Age above 12 years old

2.6.2 Exclusion criteria

- Penetrating abdominal trauma
- Incomplete proforma
- Inadequate images

2.7 Sampling method

Non-probability sampling method

2.8 Sample size

2.8.1 Specific objective 1: To determine most common quadrant positive of free fluid detection during FAST scan in BAT

- Sample size was calculated by using Epiinfo version 7.2.2.6
- The acceptable margin of error: 10%
- Designed effect: 1
- Cluster effect: 1
  - The expected percentage of positivity of RUQ in FAST: 66.7 (Lobo et al., 2017)
    - Sample size: 85
  - The expected percentage of positivity of LUQ in FAST: 35.4 (Lobo et al., 2017)
    - Sample size: 88
  - The expected percentage of positivity of SP in FAST: 47.9 (Lobo et al., 2017)
    - Sample size: 88

2.8.2 Specific objective 2: To determine most common sub-quadrant positive of free fluid detection during FAST scan in BAT

- Sample size was not calculated since it is a sub group analysis.

2.8.3 Specific objective 3: To determine association of location of positive quadrant FAST scan and type of intraabdominal injury

- There was no previous study done before this.
- Therefore, the sample size is estimated based on Cohen's effect size table. (Cohen, 1992)
- For degree of freedom of 4, α value of .05 and medium effect, the sample size if 132. (Cohen, 1992)

2.9 Research tools

Probe selection

- Low frequency curvilinear transducer with frequency of 2-5 MHz

Reason for probe selection

- Low frequency probe allows greater tissue penetration and visualize deep structure
- Most commonly available probe in ED settings

Ultrasound machine

- Hospital USM - GE Logiq S7
- Hospital Raja Permaisuri Bainun, Ipoh – Mindray M9
- Hospital Sultan Haji Ahmad Shah, Temerloh – GE Logiq P6 & GE Logiq P7

2.10 Operational definition

Area scanned

- Right upper quadrant (RUQ)
    - RUQ 1 – Hepato-diaphragmatic: space between diaphragm and liver (Figure 1)
    - RUQ 2 – Morison's pouch: area between liver and right kidney (Figure 2)
    - RUQ 3 – Caudal liver edge: area between tip of left liver lobe and superior para-colic gutter (Figure 3)
- Left upper quadrant (LUQ)
    - LUQ 1 – Splenic-diaphragmatic: space between diaphragm and spleen. (Figure 4)
    - LUQ 2 – Spleno-renal: space between spleen and left renal. (Figure 4)
    - LUQ 3 – Around inferior pole of kidney: area between left kidney and left paracolic gutter. (Figure 4)
- Suprapubic area (SP)
    - SP 1 – Bilateral to urinary bladder. (Figure 5)
    - SP 2 – Posterior to urinary bladder: area between vesicle and rectum in males. Area between vesicle and uterus in female. (Figure 6)
    - SP 3 – Posterior to uterus (female): Area between uterus and rectum (Pouch of Douglas). (Figure 6)
- Location and direction of probe is shown in Figure 7.
- In this study, sub-xiphoid view to look for pericardial effusion is excluded due to objective of study is to look at intraabdominal free fluid.