PATTERNS OF COMPUTED TOMOGRAPHY FINDINGS IN PATIENTS WITH BLUNT ABDOMINAL TRAUMA AT THE KENYATTA NATIONAL HOSPITAL.

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H58/86770/2016

DISSERTATION TO BE SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF DEGREE IN MASTERS OF MEDICINE IN DIAGNOSTIC IMAGING AND RADIATION MEDICINE.

2021

DECLARATION

The underlying supervisors certify that this dissertation is the work of the below named candidate that was carried out under their direct supervision and hereby recommend for the dissertation titled "Patterns of Computed Tomography findings in patients with blunt abdominal injuries at the Kenyatta National Hospital" as partial fulfilment of the requirement for the degree of Masters of Medicine in Diagnostic Imaging and Radiation Medicine.

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DEDICATION

I dedicate this research to my husband Dr Cyprian Michieka Magangi and my children

Natalie Zulema Michieka, Neal Frankline Michieka and Nia Sonia Michieka.

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ABBREVIATIONS AND ACRONYMS

AAST – American Association for the Surgery of Trauma

ATLS - Advanced Trauma Life Support.

BAT – Blunt abdominal trauma

CECT – Contrast enhanced computed tomography

CT – Computed tomography

FAST – Focussed assessment with sonography for trauma

IVC – Inferior vena cava

KNH – Kenyatta National Hospital

MDCT – Multi-detector computed tomography

OIS – Organ injury scale

RTA – Road traffic accident

SPSS – Statistical Package for Social Sciences Program

US - Ultrasonography

WHO – World Health Organisation

ABSTRACT

Background:

Trauma is ranked among the leading causes of mortality globally among all age groups with abdominal trauma making up 10% of these. In Kenya abdominal trauma accounts for a huge proportion of patients referred to Kenyatta National Hospital (KNH). Clinicians cannot rely on physical examination as an accurate assessment for patients with blunt abdominal trauma (BAT) consequently, they rely on a number of diagnostic imaging modalities for evaluation of patients.

Ultrasonography (US) is a readily available imaging modality for investigating patients with suspected BAT but on the flip side it is not adequate for assessment of retroperitoneal organs. Computed tomography (CT) is not only fast but also the preferred imaging modality in a stable patients with BAT. It has been shown to reliably outline the patterns, severity and extent of injuries to both peritoneal and retroperitoneal organs.

Injury patterns among patients with abdominal trauma has been shown to vary between developing versus developed countries. Over the last few years developed countries have noted a rise in cases of penetrating injuries. This was likened to increase in gun violence, civil violence and criminal activities. Blunt abdominal trauma has been shown to dominate in developing countries and various authors postulated that this could be due to mechanisms of injury such as direct blow to the abdomen, impact on an object, a fall from a height, motor bike injuries and motor vehicles accidents (MVA). Knowledge of patterns of injury and their grading informs aspects of management such as availing necessary equipment at trauma centres, encouraging training of the much needed personnel and continuous medical education to health care workers at the trauma centres.

Trauma management in the developing world is faced with many challenges. The rising trends of trauma cases has been related to the poor infrastructure, rapid urbanization, lack of availability of skilled personnel and monitoring hospital equipment. There is no documentation of the local patterns and grading if injury following BAT. This study therefore aimed to determine the prevalence and to describe the spectrum of CT findings in intra – abdominal injuries of patients with BAT at KNH as one of the major trauma centres in the country.

Broad objectives:

To determine the prevalence and describe the spectrum of CT findings in intra-abdominal injuries of patients with blunt abdominal trauma at KNH.

Materials and methods:

Images of abdominal CT scans done for patients with history of BAT were analysed within 24 hours of the examination by the principal investigator and verified by two senior radiologists. Imaging findings of the patterns of abdominal injuries were described as the imaging reports were being generated and data entered in a data abstraction sheet.

Quantitative data was entered into SPSS for data cleaning and analysis. Descriptive summary statistics of baseline characteristics was analysed using univariate analysis and presented in form of means (with standard deviations) or medians (with interquartile ranges) for continuous data depending on distribution of data. Frequencies were used for categorical data in a frequency distribution table. Graphical displays using column charts and graphs were presented based on data type. In univariate analysis, frequency distributions showed the distribution of the study population by background characteristics such as age and gender.

Multivariate analysis was used to test the significance of the association between the dependent and independent variables. The results were then presented using tables, graphs and figures.

Results:

Out of the CT scans of the 84 participants enrolled for the study 81% of them were male while 19% were female with a male to female ratio of 4.25:1. The mean age of the participants was 29 years (SD = 12.8), while the median age was 29.5 (IQR = 18) years. The peak age distribution of the majority ranged between 21 – 30 years accounting for 32.1% of the patients. Motor vehicle accident (MVA) was the most reported mode of injury accounting for 78% of the cases, 14.6% were involved in motorbike injuries while 7.3% had history of a fall from a height and motor bike injuries. Patients in the working age population sustained injuries following MVA.

Liver injuries accounted for 50% of intra-abdominal injuries following BAT while splenic injuries accounted for 23.8% with renal injuries accounting for 21.4%. Grade III liver injury was the most common pattern of liver injury following BAT accounting for 44% of liver injuries while grade II splenic injury was the most common type of splenic injury at 14% and grade III renal injury pattern at 56% of renal injuries.

Features such as bowel wall thickening, enhancement and intramural air tracking were among the CT imaging findings reported as signs of bowel injuries. Pancreatic injuries were a rare occurrence. Multiplicity of visceral injuries was not age dependent and approximately one third of the patients presented with multiple intra – abdominal injuries.

Conclusion:

Male patients were most susceptible to blunt abdominal trauma as compared to their female counterparts. MVA was the commonest cause of BAT. Grade III liver injuries were the commonest injury pattern as compared to other intra – abdominal injuries. Splenic ad liver injuries were the most reported injuries following falls from a height and bowel injuries were commonly seen following motor bike accidents.

Keyword: Blunt abdominal trauma, AAST, computer tomogram.

CHAPTER 1

1.1 INTRODUCTION

Trauma is a leading cause of mortality in all age groups with abdominal trauma accounting for 10% of trauma cases (4). World Health Organisation (WHO) postulated that trauma would be the first or at least the second cause of mortality by the year 2020 (5).

In the United States, trauma is considered the leading cause of mortality in men and women aged 45 years and below (6). This leads to loss of active manpower which negatively impacts the economy. Over the past three decades Africa has demonstrated an increase in trauma related morbidities and mortalities. In 2013, the rate of mortality from RTA and subsequently abdominal trauma in low and middle income countries was at 26.6 per 100,000 persons. In Kenya, Musau et al found that cases of abdominal trauma accounted for approximately one third of the proportion of patients referred to Kenyatta National Hospital (KNH). In their study, males formed 92.5% of patients with BAT (5). In spite of the burden of injuries, a trauma registry for BAT is still elusive at the KNH, a major trauma centre. Abdominal trauma management in developing countries is faced by many challenges such as poor infrastructure and urbanization, an emergency response system that still experiences teething problems, lack of availability of the much needed skill set and equipment are among the glaring challenges that developing countries face (6). WHO developed guidelines for essential trauma care which outlines recommendations that can be put in place for low and middle income setups (7).

Injury patterns among patients with abdominal trauma has been shown to vary between developing versus developed countries with a rise in penetrating injuries seen in developed countries. In a study by smith et al up to one quarter of the cases of abdominal injuries admitted at their facility was due to penetrating injuries. They went further to reiterate that they had observed a 50% increase in the number of abdominal stab victims over the last several years. They attributed this changes to increase in gun violence and criminal activities (8). On the contrary blunt abdominal trauma dominated in developing countries including Kenya (9, 10). Authors postulated that this could be due to different modes or mechanism of injuries (11, 12), which involved direct blow to the abdomen, impact on an object, fall from a height and road traffic accidents (RTA) among others. Despite the burden of abdominal trauma, there is still a dearth of data outlining the patterns and grading of injuries in our local setup and trauma related data is also not standardized. In the algorithm of management of patients with BAT, there has been a major shift from operative to increasingly non – operative management is best in low grade solid organ injuries, some higher grades of injuries and patients who are haemodynamically stable (14). Other higher grades of injury and especially vascular trauma will necessitate operative management and other interventional procedures.

Knowledge of the patterns and grading of intra – abdominal injuries in patients with BAT is pivotal in determining management options for these patients. This can be achieved by using the American Association for the Surgery of Trauma (AAST) grading system for trauma.

1.2. LITERATURE REVIEW

1.2.1. ABDOMINAL CT SCAN PROCEDURE

A CT scan of the abdomen is a specialized imaging modality that uses x-rays to show cross-sectional images of the abdomen. A trauma patient scheduled for an abdominal CT receives a bolus of intravenous contrast material, typically 80 – 100 mls of non-ionic low osmolar contrast medium injected at a rate of 4mls/sec through an 18 or 20 gauge cannula located in a large peripheral vein. A 128 slice Siemens syngovia multidetector CT scanner, available at KNH, is then used with a 120 Kv, 3-5mm slice thickness and a pitch of 0.6. Arterial, portal venous and delayed phase images of the abdomen and pelvis are acquired after the beginning of intravenous contrast material administration. Arterial phase images are important in identification of vascular pathologies while the portal venous phase offers a good compromise to maximise detection of parenchymal injuries and delayed phase images are important in analysing the renal system (6). Post processing of the images and coronal and sagittal reconstruction is done. The images are then stored in a picture archiving and communication system (PACS) and analysed.

1.2.2. PREVALENCE OF INTRA-ABDOMINAL INJURIES FOLLOWING BLUNT ABDOMINAL TRAUMA

Road traffic accidents (RTA), falls and assaults are among the most common causes of BAT (17). In a study by Asuquo et al, RTA accounted for 83.6% of patients with BAT (18). Mortality rates in patients with BAT has been shown to be high as compared with patients with penetrating wounds because of inadequate access to early diagnostic facilities and optimal management (19). Knowledge of the prevalence of intra-abdominal injuries helps in defining low risk vs. high risk subgroup of patients and this also informs their management (20). Diagnostic algorithms dictate that patients who have sustained BAT and have a negative diagnostic evaluation in the ED may have a CT scan of the abdomen in addition to an admission to evaluate for occult intra-abdominal injuries (21). Isolated hollow visceral injury may have a better outcome if there's are no other associated concomitant intra-abdominal injuries. However delays of more than 24hours have been associated with higher mortality than those with immediate repair. This calls for a high index of suspicion and prompt diagnosis (22,23). Some authors observed that the spleen is injured in 58.1% of the cases following BAT(24)(6). Other authors reported that liver injuries top the list of organs injured following BAT (25)(26)(27). Injuries to the pancreas are rare being that it's a retroperitoneal organ, consequently many at times pancreatic lesions go unnoticed. These only manifest when complications arise or during treatment for other injuries (28). Mortality following pancreatic injuries are as high as 30% and if treatment is delayed it is higher at 60% (29). Kidney injuries can be categorised as minor, intermediate and severe with 75 – 85% being minor injuries (30). Approximately 5% of patients with severe BAT have been shown to have injuries to hollow viscera and mesentery (31). Adrenal glands being retroperitoneal organs are injured in approximately 2% of patients. Many at times the right adrenal will be injured in 75% of the cases, with the left injured in 15% of the time while both will be injured in 10% of the cases (32). Diaphragmatic injuries are caused by a sudden increase in intra-abdominal pressure. Injuries rarely occur singly and in 75% of disruptions will be on the left hemi-diaphragm (33). Knowledge of this will not only help in stratifying patients but also identify risk factors that may culminate to a mortality.

1.2.3. PATTERNS OF CT FINDINGS OF INTRA ABDOMINAL ORGANS FOLLOWING BLUNT ABDOMINAL TRAUMA

1.2.3.1. Liver injuries

Prevalence of liver injury in patients with BAT is approximately 1 – 8% (34) with a reported mortality rate of 4.1% - 11.7% (35)(36). There has been a change over time in the management of blunt liver trauma with non-surgical management being the preferred method in haemodynamically stable patients. The success rate of this is as high as 85% - 94% (35).

Patients who are haemodynamically unstable should undergo emergency laparotomy (35)(37). Previous authors reports have shown that up to 86% of hepatic injuries have stopped bleeding by the time of surgery and 67% of exploratory laparotomies performed for BAT were non-therapeutic (37)(38). This shift has been made possible due to the ability of CT scans to interrogate the liver following BAT, assess complications and healing process in liver injuries. The patterns of CT findings in patients with BAT is based on organ injury scaling (OIS) classification. This classification scheme is based on the AAST grading system for various organs. This was adapted based on the anatomic disruptions of various organs scaled 1 to 6, from the least to the most severe injury (39). The major CT findings of the liver following BAT range from lacerations, sub-capsular and parenchymal haematomas, active haemorrhage and juxtahepatic venous injuries. Minor CT findings can include periportal low attenuations and flat inferior vena cava (IVC). Lacerations are usually classified as superficial (< 3cm) or deep (> 3cm). Lacerations extending to segment VII maybe associated with retroperitoneal and adrenal haematomas. Those that extend to the porta hepatis may be accompanied with bile duct injury and consequently development of a biloma (40). Sub-capsular haematomas will be seen as elliptic collection of low attenuation blood between the liver capsule and the liver parenchyma at CECT. The grading system for blunt liver trauma is based on the AAST liver injury scale revised in 2018 (39).

Table 1: AAST liver injury grading system (39).

Grading	Description
Grade 1	• hematoma: sub-capsular, <10% surface area • laceration: capsular tear, <1 cm parenchymal depth
Grade 2	• hematoma: sub-capsular, 10-50% surface area • hematoma: intraparenchymal <10 cm diameter • laceration: capsular tear 1-3 cm parenchymal depth, <10 cm length
Grade 3	• hematoma: sub capsular, >50% surface area of ruptured sub capsular or parenchymal hematoma • hematoma: intraparenchymal >10 cm • laceration: capsular tear >3 cm parenchymal depth • vascular injury with active bleeding contained within liver parenchyma
Grade 4	• laceration: parenchymal disruption involving 25-75% hepatic lobe or involves 1-3 Couinaud segments • vascular injury with active bleeding breaching the liver parenchyma into the peritoneum
Grade 5	• Laceration: parenchymal disruption involving >75% of hepatic lobe or more than 3 couinauds segments within a single lobe. • vascular: juxtahepatic venous injuries (retrohepatic vena cava / central major hepatic veins)
Grade 6	• vascular hepatic avulsion

1.2.3.2. Splenic injuries

The spleen is reported to be the most frequent injured organ following BAT accounting for up-to 49% of all visceral injuries (25)(24). Authors reported that mortality after splenic injury was as high as 14% in patients treated with non – operative management and 17% in patients treated with splenectomy and splenorrhaphy (41) (42). Preservation of the spleen after BAT is the current management option as long as the patient has met the criteria of non-operative management. Accurate identification of injuries that may require surgical or angiographic intervention is of paramount importance (43). Several authors (44)(45)(46)(47) have suggested that vascular injuries such as active splenic bleeding, pseudo aneurysm and arteriovenous fistula are associated with increased rates of unsuccessful non – surgical treatment. Multidetector CT scanning plays a critical role in diagnosing splenic injury in haemodynamically stable patients after BAT (48). The pattern of CT findings in splenic injury is based on AAST classification of splenic injury as shown in table 1.2 below. Major CT findings in splenic injuries encompass lacerations, sub-capsular and parenchymal haemorrhage, active haemorrhage and vascular injuries. Active haemorrhage appears as an area of high attenuation on a CT imaging with HU of 85 – 350 due to extravasated contrast (48). Sub-capsular haematomas appear as elliptical collections that are of low attenuation between the splenic capsule and the enhanced splenic parenchyma following CECT. These cause an indentation of flattening of the underlying splenic margin (49). In 2006, a new CT grading system was proposed that incorporates non bleeding vascular injury and active splenic haemorrhage as shown in table 3 below.

Table 2: AAST grading for splenic injury (39)

Grading	Description
Grade 1	• Sub-capsular haematoma < 10 % of the surface area • Parenchymal laceration <1cm depth • Capsular tear
Grade 2	• Sub-capsular hematoma 10 – 50 % of surface area • Intraparenchymal hematoma <5cm • Parenchymal laceration 1 – 3 cm in depth
Grade 3	• Sub-capsular hematoma >50% of surface area • Ruptured sub-capsular or intraparenchymal hematoma > 5cm • Parenchymal laceration >3 cm in depth
Grade 4	• Any injury in the presence of a splenic vascular injury or active bleeding confined within splenic capsule • Parenchymal laceration involving segmental or hilar vessels producing > 25 % devascularisation.

Grade 5	• Shattered spleen • Any injury in the presence of splenic vascular injury with active bleeding extending beyond the spleen into the peritoneum

Table 3: Proposed new grading system incorporating splenic vascular injury (50)

Grade	Criteria
1	Sub-capsular haematoma <1cm thick Laceration < 1cm parenchymal depth Parenchymal haematoma <1cm diameter.
2	Sub-capsular haematoma 1-3cm thick Laceration1 – 3cm in parenchymal depth Parenchymal hematoma 1-3cm in diameter
3	Splenic capsular disruption Sub-capsular hematoma >3 cm thick Laceration > 3cm in parenchymal depth Parenchymal hematoma > 3cm in diameter.
4a	Active intraparenchymal and sub-capsular splenic bleeding Splenic vascular injury (pseudo aneurysm or arteriovenous fistula) Shattered spleen
4b	Active intraperitoneal bleeding

1.2.3.3. Kidney and urinary tract

Renal injury occur in 8 – 10 % of BAT and they may be encountered in isolation or in association with other visceral injuries with the kidneys being the most frequently injured organ of the genitourinary system. Cumulatively renal injuries account for approximately 1-5% of all abdominal injuries (51)(52). Minor injuries of the kidney and urinary tract can be managed with conservative therapy with no significant complications (53). CT scanning has since replaced IVU as an imaging modality for interrogating suspected renal injuries. Patterns of CT findings in renal injuries are based on the AAST classification as shown on table 1.4

below. Major CT features of blunt renal injuries include contusions, Sub-capsular hematomas and lacerations (53).

Table 4: AAST grading for renal injuries (39)

Grade	Type of injury	Description of injury
I	Contusion Hematoma	Microscopic or gross haematuria, urologic studies normal. Sub-capsular, nonexpanding without parenchymal laceration
II	Hematoma Laceration	Non expanding peri-renal hematoma confirmed to renal retro peritoneum <1.0 cm parenchymal depth of renal cortex without urinary extravasation.
III	Laceration	>1.0 cm parenchymal depth of renal cortex without collecting system rupture or urinary extravasation
IV	Laceration Vascular	Parenchymal laceration extending through renal cortex, medulla and collecting system. Main renal artery or vein injury with contained haemorrhage
V	Laceration Vascular	Completely shattered kidney Avulsion of renal hilum which devascularise the kidney

1.2.3.4. Bowel and mesentery

Injuries to the gut and mesentery are encountered in 1-5% of BAT cases (54)(23)**.** The commonest injured sites of the gut are the proximal jejunum and distal ileum. A delay in diagnosis greatly increases morbidity and mortality which is usually due to haemorrhage or peritonitis (55). Many at times symptoms are absent at the time of presentation and when present are usually non-specific (56). Diagnostic modalities commonly employed include diagnostic lavage which has a sensitivity of 90% but non-specific and unreliable in evaluation of retroperitoneal injuries. Bowel perforation can be missed in as high as 10% of the cases

(57)(58). US has been found to be non-specific for hollow visceral and mesentery despite a sensitivity of 86% and specificity of 98% for free intra-abdominal fluid. Despite its low sensitivity CT scanning is still superior to US and peritoneal lavage for the diagnosis of bowel and mesenteric injuries. CT findings in bowel and mesenteric injuries include contrast extravasation and/ or extra-luminal air. Non-specific findings that might suggest bowel or mesenteric injury include free fluid without solid organ injury, bowel thickening and dilatation among others (59)(60). The organ injury scale grading system for bowel trauma as adopted by AAST is as shown on the table 1.5 below.

Table 5: AAST grading of bowel injury (39)

Grade	Type of injury	Description of injury
I	Hematoma Laceration	Contusion or hematoma without devascularisation Partial thickness, no perforation
II	Laceration	Laceration <50% of circumference
III	Laceration	Laceration >50% of circumference without transection
IV	Laceration	Transection of the small bowel
V	Laceration Vascular	Transection of the small bowel with segmental tissue loss DE vascularized segment

1.2.3.5. Pancreas

Pancreatic injuries account for less than 2% of BAT with a prevalence of up-to 12% (61)(62). Pancreatic injuries are attributed with a high mortality and complication rate of more than 60% (63). The most frequent mechanisms of injury are compression of the pancreatic gland against the spine and handle bar, seat belt and acceleration-deceleration injuries (61)(64). The body of the pancreas is the commonest site for pancreatic trauma and this is usually to the left of the superior mesenteric vessels (65). Timely diagnosis of pancreatic injuries is important in delivering timely interventions. CT scanning being a superior imaging modality promptly delivers in offering timely diagnostics (66)(67)(68). CT findings following pancreatic injuries may be subtle and sometimes the pancreas may appear normal. The integrity of the pancreatic duct is the most important factor in the deciding whether or not to operate (61)(69)(66). CT features of pancreatic injuries include lacerations of the pancreas, edema or hematoma of the pancreatic parenchyma, active haemorrhage from the pancreas and blood collections between the parenchyma and splenic vein (70)(71). Grading of pancreatic injuries is based on the AAST grading system as shown in the table below.

Table 6: AAST grading of pancreatic injuries (39)

Grade	Type of injury	Description of injury
I	Hematoma Laceration	Minor contusion without duct injury Superficial laceration without duct injury
II	Hematoma Laceration	Major contusion without duct injury or tissue loss Major contusion without duct injury or tissue loss
III	Laceration	Distal transection or parenchymal injury with duct injury
IV	Laceration	Proximal transection or parenchymal injury involving ampulla
V	Laceration	Massive disruption of pancreatic head.

CHAPTER 2

2.1. STUDY JUSTIFICATION

Being that WHO is projecting a rise in trauma cases by the year 2020. It significantly remains public health problem in all countries (5)(72). FAST ultrasound are portable, cheaper and safer on all age groups albeit the sensitivity is low. CT supersedes as the imaging modality of choice in BAT. This study therefore aims at creating a local database on the patterns of CT findings following BAT at our local referral hospital moreover correlate FAST ultrasound findings and CT findings. The findings of this study is important to the primary clinicians, surgeons, radiologists and interventional radiologists for surgical and endovascular planning. The findings are also useful in developing local guidelines in imaging of patients with BAT.

2.2. STUDY QUESTION

What are the patterns of CT findings in patients with blunt abdominal injuries at KNH?

2.3. OBJECTIVES

2.3.1. BROAD OBJECTIVES

Determine the patterns of CT findings in patients with blunt abdominal injuries at KNH.

2.3.2. SPECIFIC OBJECTIVES

1. Prevalence of abdominal injuries among patients following blunt abdominal trauma at KNH.
2. Describe patterns of CT scan findings of abdominal viscera following blunt abdominal trauma.

CHAPTER 3: MATERIALS AND METHODOLOGY

3.1. STUDY DESIGN

This was a cross-sectional descriptive study carried out in KNH.

3.2 STUDY AREA DESCRIPTION

The study was conducted in the Department of radiology at Kenyatta National Hospital, a national teaching and referral hospital located in the capital city of Nairobi, largely serving middle and lower income populations.

3.3 STUDY POPULATION

All patients referred to the radiology department KNH with history of blunt abdominal trauma aged 1 year and above drawn from the KNH catchment population and referrals from peripheral health facilities countrywide during the study period.

3.4 SAMPLING METHOD

Consecutive sampling method was used.

3.6. SAMPLE SIZE DETERMINATION

Using the formula for proportions as follows

$$n = \frac{Nz^2pq}{E^2(N-1) + z^2pq}$$

n = Desired sample size

N = population size (The estimated number of patients with blunt abdominal trauma seeking services at Kenyatta National Hospital per week is approximately 7 and for 4 months of the study duration the total will be approximately 112).

Z = value from standard normal distribution corresponding to desired confidence level (Z=1.96 for 95% CI)

p = expected true proportion estimated at 36% (5)

$q = 1 - p$

E = desired precision (0.05)

$$n = \frac{112\ x\ 1.96^2\ x\ 0.36\ x\ 0.64}{0.05^2(112-1) +\ (1.96^2\ x\ 0.36\ x\ 0.64)} = 85$$

A Sample size of 85 participants was required for the study.

3.7 INCLUSION CRITERIA

Abdominal CT scan images of patients with history of blunt abdominal trauma.

3.8 EXCLUSION CRITERIA

- CT scan images of all paediatric patients below the age of 1 year.
- CT scan images of patients with penetrating abdominal injuries.

3.9. STUDY PROCEDURE

Abdominal CT scan images of patients who satisfied the inclusion criteria, saved in the PACS system were retrieved and handled with absolute confidentiality. Analysis was done by the principal investigator and two senior radiologists. Patterns of abdominal injuries were described and data collected for analysis.

3.10. DATA COLLECTION AND ANALYSIS

Abdominal CT scan images saved in the PACS system were retrieved and handled with absolute confidentiality. Analysis was done by the principal investigator and verified by 2 senior radiologists. Patterns of abdominal injuries were described and data collected for analysis. Quantitative data was checked daily for completeness and coded for appropriate computer entry. Equivalent responses were pooled to arrange the response in different categories. The quantitative data was entered into SPSS for data cleaning and analysis. The study utilised univariate and multivariate analysis.

Descriptive summary statistics of baseline characteristics was analysed using univariate analysis and presented in form of means (with standard deviations) or medians with interquartile ranges) for continuous data depending on distribution of data. In form of frequencies and proportions for categorical data in a frequency distribution table. Graphical displays using pie charts, bar graphs and histograms were presented based on data type. In univariate analysis, frequency distributions showed the distribution of the study population by background characteristics such as age and gender. Multivariate analysis was used to test the significance of the association between the dependent and independent variables. The results were then presented using tables, graphs, pie chart and figures.

3.11. CONFIDENTIALITY OF PARTICIPANTS AND DATA OBTAINED

There were no identifiers linking research data to the patient. Each abdominal CT scan was assigned a unique numerical code that was in the data abstraction tool and database. There was restricted access to patient data. Only authorised persons were allowed to access participant's records. All electronic database was password protected.

3.12. ETHICAL CONSIDERATION

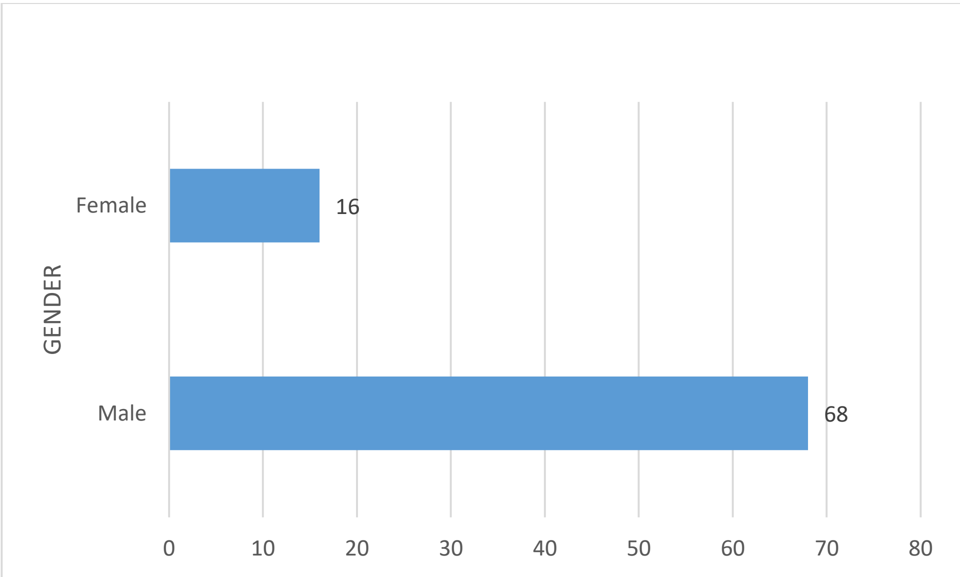
Patients who had an abdominal CT scan done had to have a request generated by the referring clinicians and only those with justifiable requests were scanned. Waiver of consent was sought from KNH-UoN Ethics and Research Committee (ERC). Institutional approval was obtained from the University of Nairobi and KNH.

CHAPTER 4: RESULTS

4.1. PATIENTS CHARACTERISTICS:

During the study period, 84 participants with a history of blunt abdominal trauma were recruited for the study. Of the study participants 81% of them were male, while 19% were female as shown in Figure 1 below with a male to female ratio of 4.25:1.

Figure 1: Bar chart showing gender distribution of the patients



Patients from all age groups older than one year were recruited for the study. Participants were between 3 and 60 years of age with a mean age of 29 years and a median age of 29.5 years (IQR = 18years). The peak age incidence of the majority ranged between 21-30 years as shown on figure 2 below and accounted for 27 of the cases. Table 1.7 highlights the frequency of injuries among the various age groups.

Figure 2: Column chart demonstrating age distribution of the patients

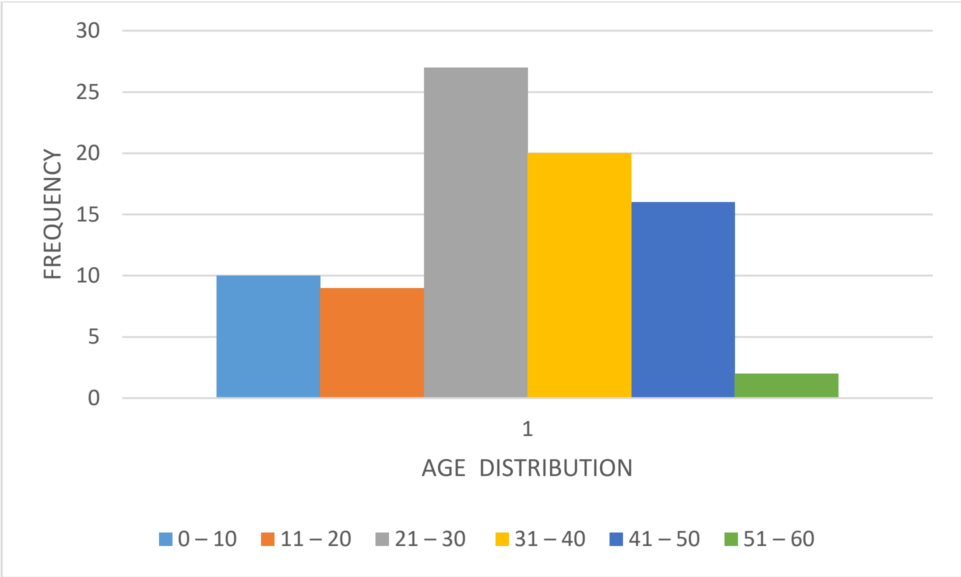


Table 7: Table showing the frequency of the various age groups:

Age distribution	Frequency: n (%)
0 – 10	10 (11.9)
11 – 20	9 (10.7)
21 – 30	27 (32.1)
31 – 40	20 (23.8)
41 – 50	16 (19.0)
51 – 60	2 (2.4)

78% of the participants were involved in MVA as a cause of injury, 14.6% motorbike injuries and 7.3% fell from a height. Most paediatric patients sustained injuries following a fall from a height and motorbike injuries while patients in the working age population sustained injuries following motor vehicle accidents as shown in the table 1.8 below.

Table 8: Comparison of age distribution and mode of injury

	Fall from a height	Motorbike injury	Motor vehicle accident	Total
0 – 10	4	4	2	10
11 – 20	0	1	8	9
21 – 30	2	2	23	27
31 – 40	0	5	15	20
41 – 50	0	0	16	16
51 – 60	0	0	2	2

4.2. PREVALENCE OF VISCERAL INJURIES FOLLOWING BAT

50% of the participants had liver injuries, 23.8% had splenic injuries, 21.4% had renal injuries, 23.8% had bowel and mesenteric injuries while 2.4% had pancreatic injuries as shown in the figures below.

Figure 3: Prevalence of visceral injuries following BAT

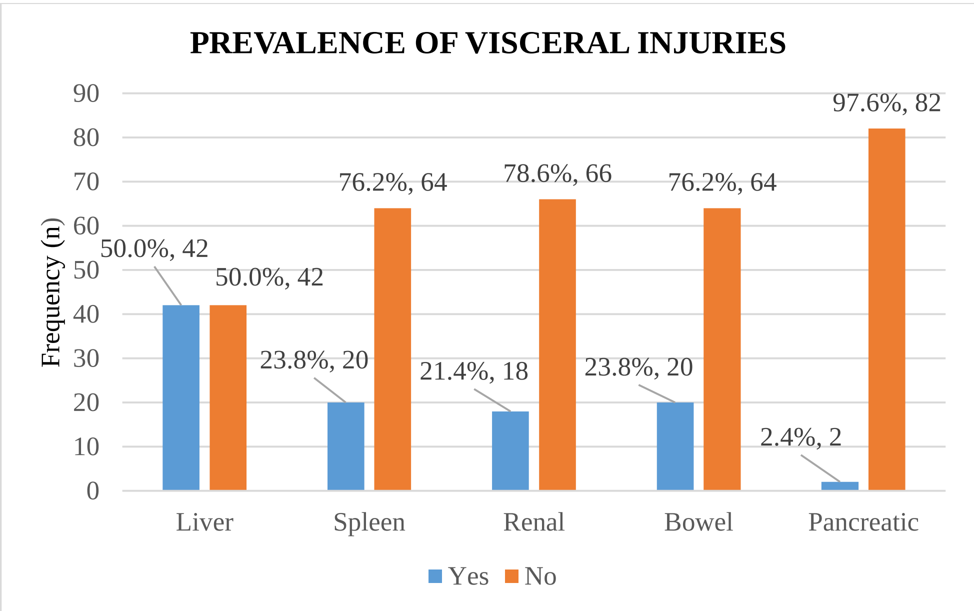
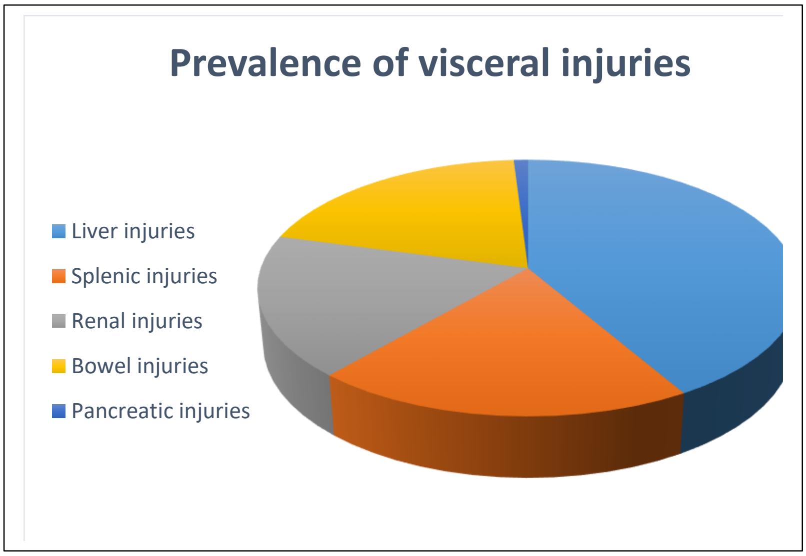
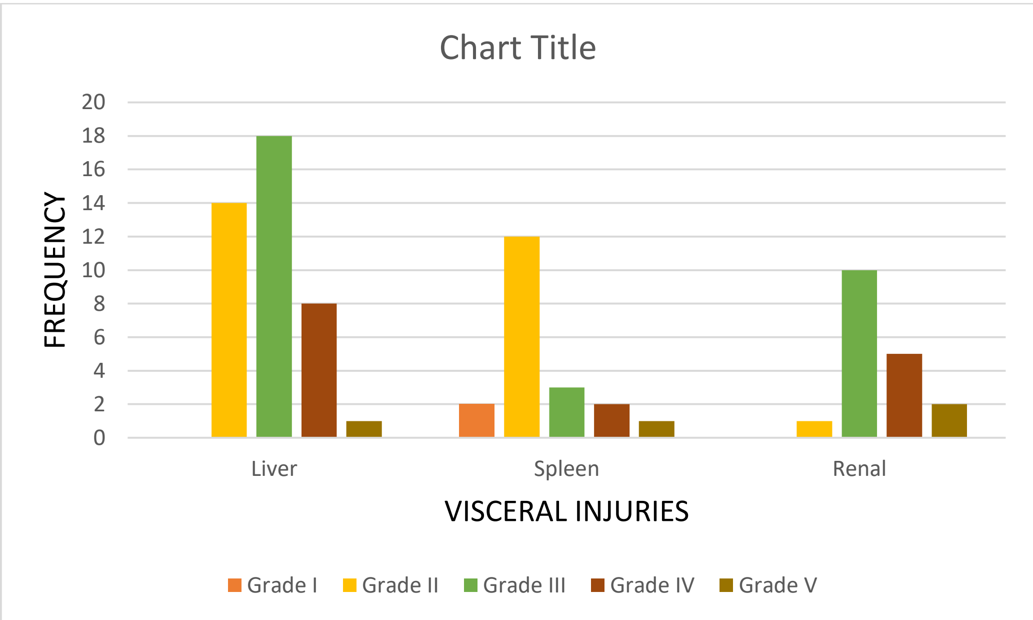


Figure 4: Pie chart showing the distribution of the various visceral injuries among patients



Liver injuries were the commonest visceral injuries with grade III injury pattern observed as the frequent injury pattern. This was followed by splenic injuries and more so grade II injury pattern was the commonest. Renal injuries were the fourth highest incurred injuries among patients with BAT with grade III injuries as the most common pattern.

Figure 5: Graph demonstrating frequency of various grades of visceral injuries



The pattern of bowel injuries observed were not graded as per the AAST grading system. Findings such as bowel wall thickening, dilatation of bowel loops and intramural air tracking were documented features of bowel injury. Pancreatic injuries were a rare occurrence and only 2 cases were reported. For both cases the CT scan imaging done was as a follow up to blunt abdominal trauma incurred several weeks prior.

The most common injury observed following motor vehicle accidents was liver injuries. Whereas, bowel injuries were common following motorbike injuries. Splenic and liver injuries occurred following falls from a height.

Among the pediatric age group, patients were susceptible to bowel and liver injuries while in the working age population, injuries to solid organs was common. The commonest multiple visceral injuries observed, were liver injuries coupled with renal injuries.

67% of patients who presented with multiple abdominal injuries had history of a fall from a height, 33% had history of motor vehicle accident and 17% had history of a motorbike injury. Multiplicity of visceral injuries was not age dependent and approximately a third of the patients presented with multiple visceral injuries.

Table 9: Comparison between MOI and multiplicity of injuries

Mode of Injury	Multiplicity of abdominal organ injuries N (%)	Solitary / No abdominal organ injuries N (%)	Total
Motor vehicle accident	22 (33%)	44 (66%)	66
Motor bike injuries	2 (17%)	10 (83%)	12
Fall from a height	4 (67%)	2 (33%)	6

Table 10: Comparison between the various age groups and multiplicity of injuries

Age (Years)	Multiplicity of abdominal organ injuries N (%)	Solitary / No abdominal organ injuries N (%)	Total
< 10	2 (20%)	8 (80%)	10
10 – 20	3 (33%)	6 (66%)	9
21 – 30	8 (30%)	19 (60%)	27
31 – 40	7 (35%)	13 (65%)	20
41 – 50	6 (38%)	10 (62%)	16
51 - 60	0	2	2

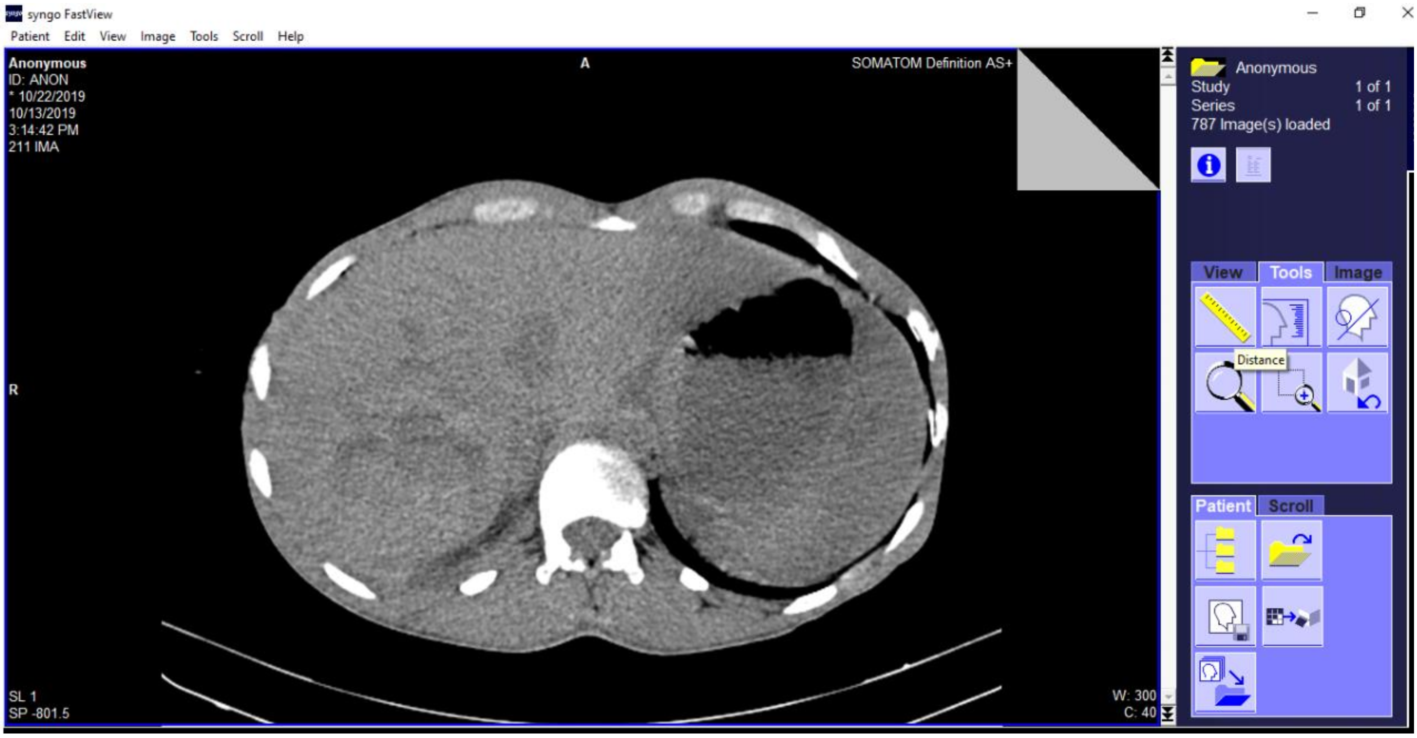
4.3 PATTERNS OF CT FINDINGS FOLLOWING BLUNT ABDOMINAL TRAUMA

All patients with BAT sent for a CT scan of the abdomen had IV contrast administered with arterial phase and venous phase obtained. Delayed phase were acquired for patients with renal injuries or as specified by the radiologist and or the clinician.

4.3.1. LIVER INJURIES

Among patients with liver injuries, grade III pattern of injuries was the most reported. The patterns of CT findings in liver injuries following BAT entailed: Lacerations more than 1cm deep, sub capsular hematomas of more than 10% of the surface area. Multiple cases of intraparenchymal hematomas were reported some with active contusional haemorrhage. Several cases reported associated hemoperitoneum. In most patients the biliary system was unaffected. There were no cases with reported involvement of the hepatic and portal veins or avulsion liver injuries.

Figure 6: Serial images showing a case of liver injury with associated complications.



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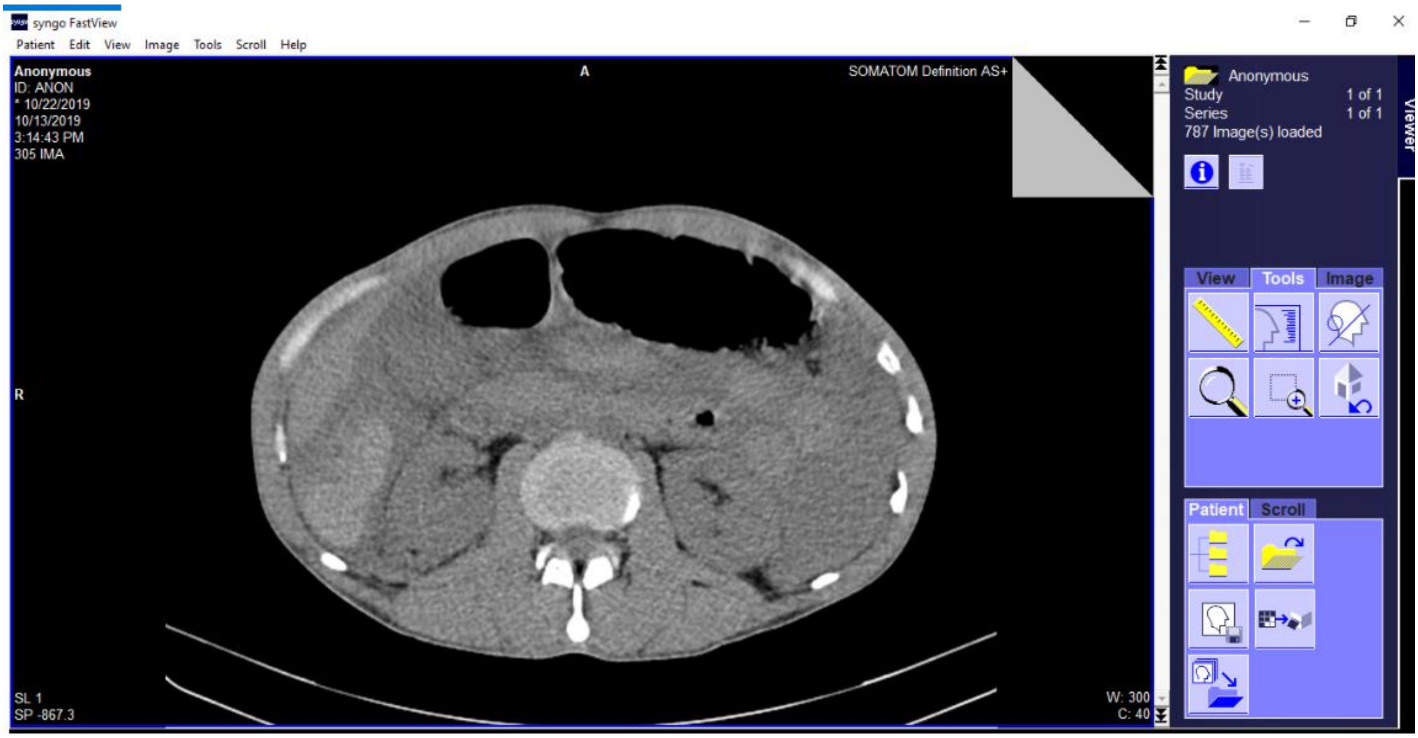

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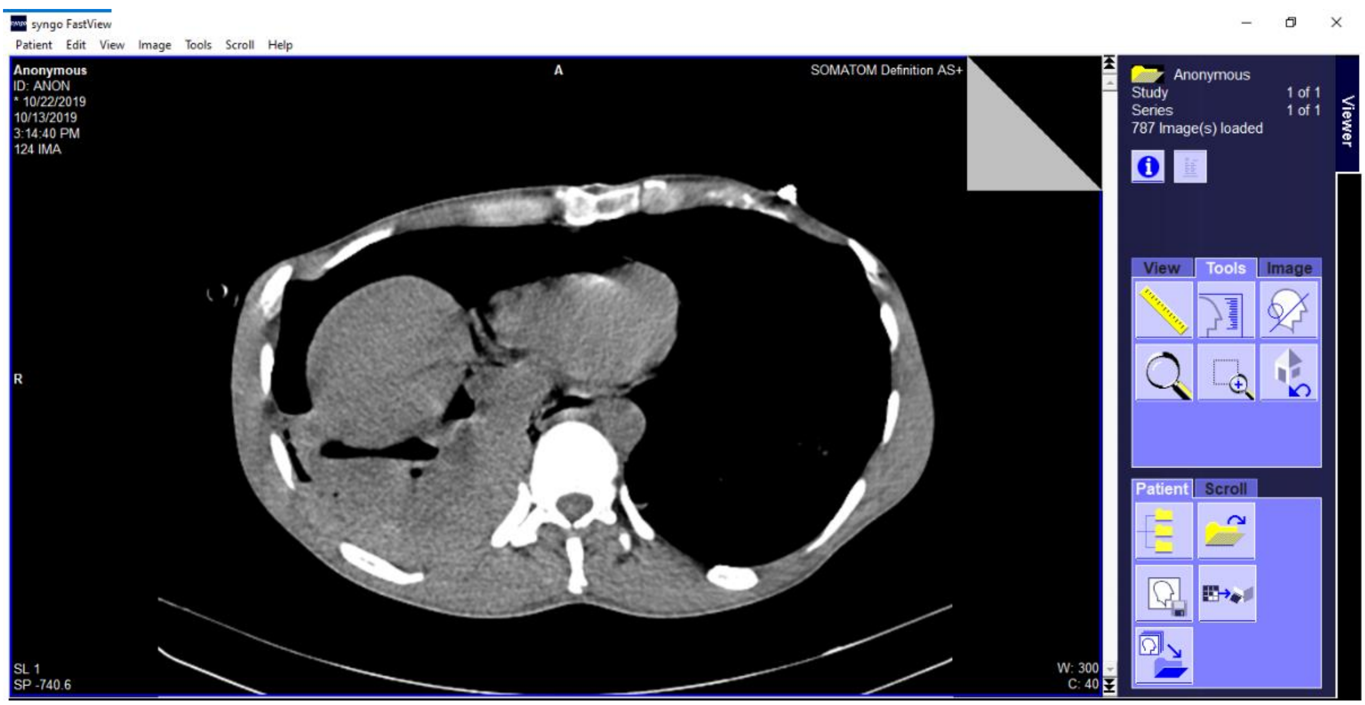


C

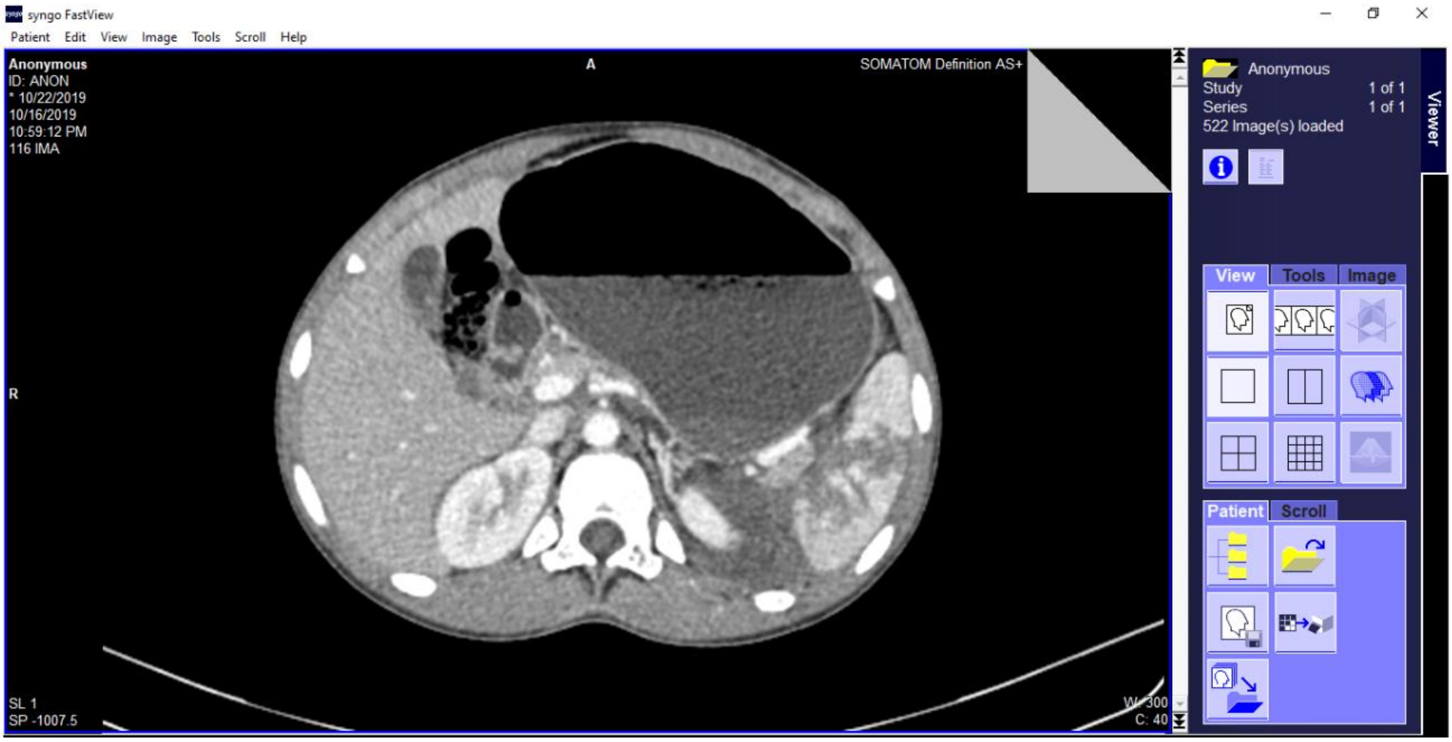
Case of a 30 yr. old female involved in a motor vehicle accident sustaining multiple injuries.

Image depicts an intraparenchymal haematoma (A) with active bleeding into the peritoneum with haemoperitoneum (B) and haemopneumothorax (C).

4.3.2. SPLENIC INJURIES

Grade II splenic injuries was the commonest pattern of injury observed among patients with trauma to the spleen. Patterns of CT findings were lacerations of more than 1cm in depth, intraparenchymal hematomas, sub-capsular hematomas affecting over 10% of the splenic surface area. In most patients splenic vessels were unaffected.

Figure 7: Serial images showing a case of splenic injury



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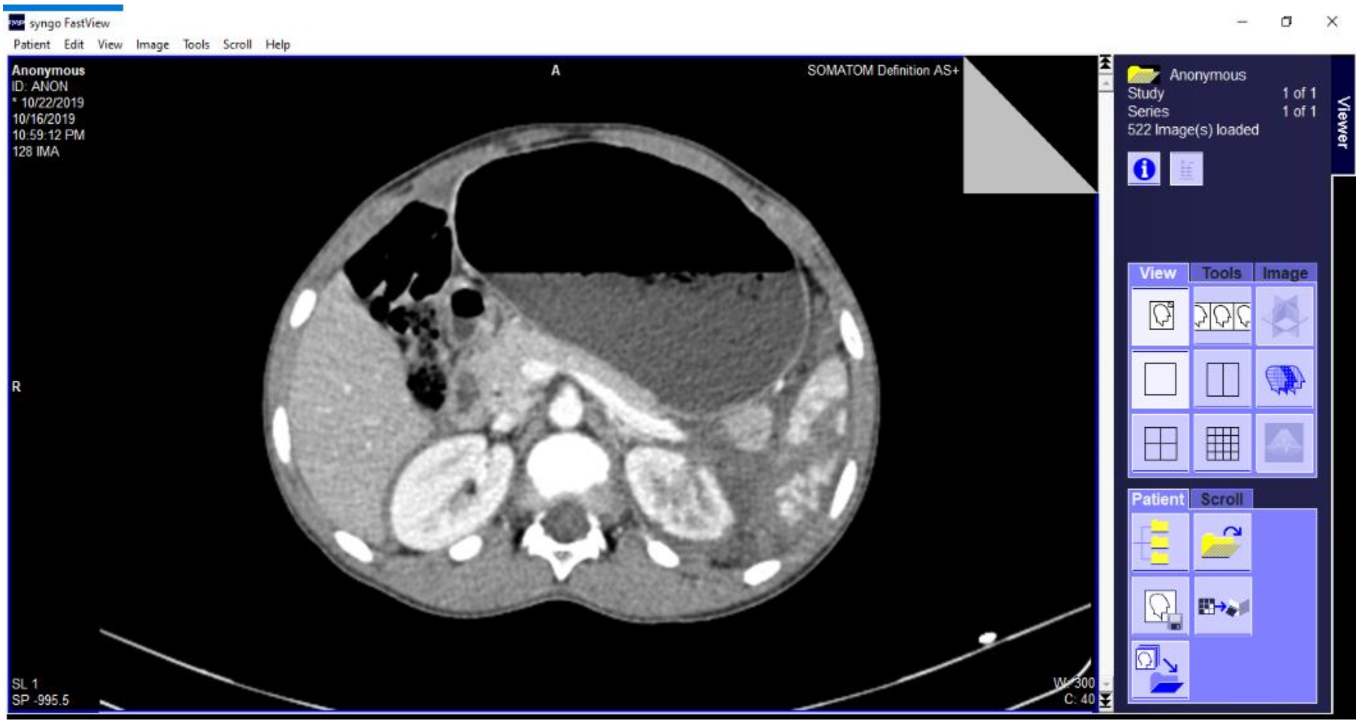
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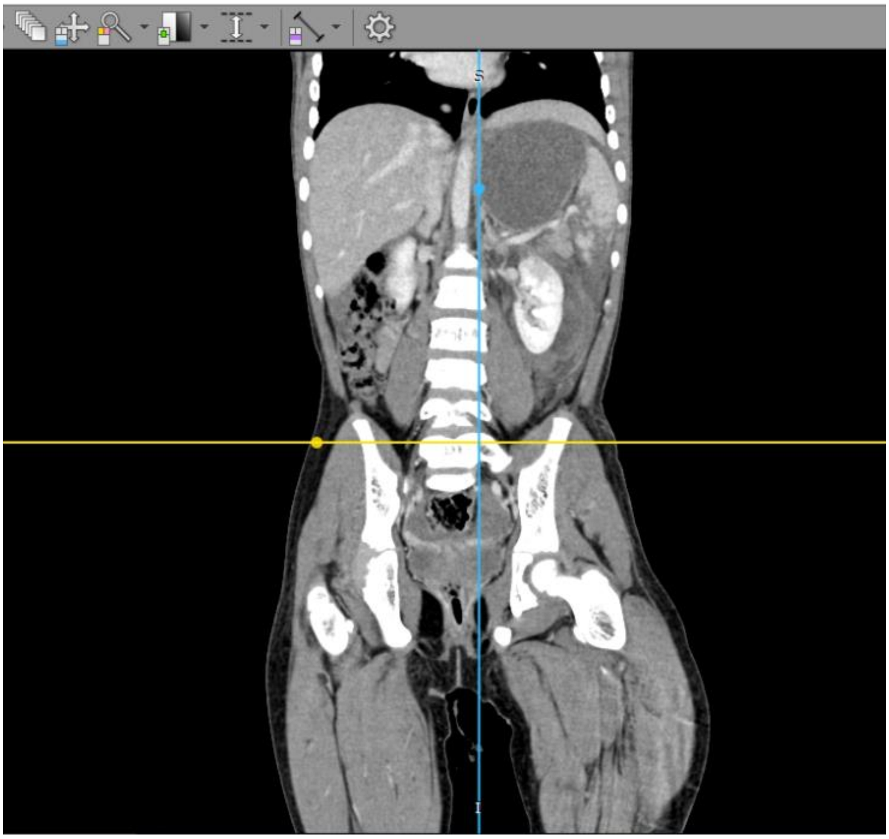
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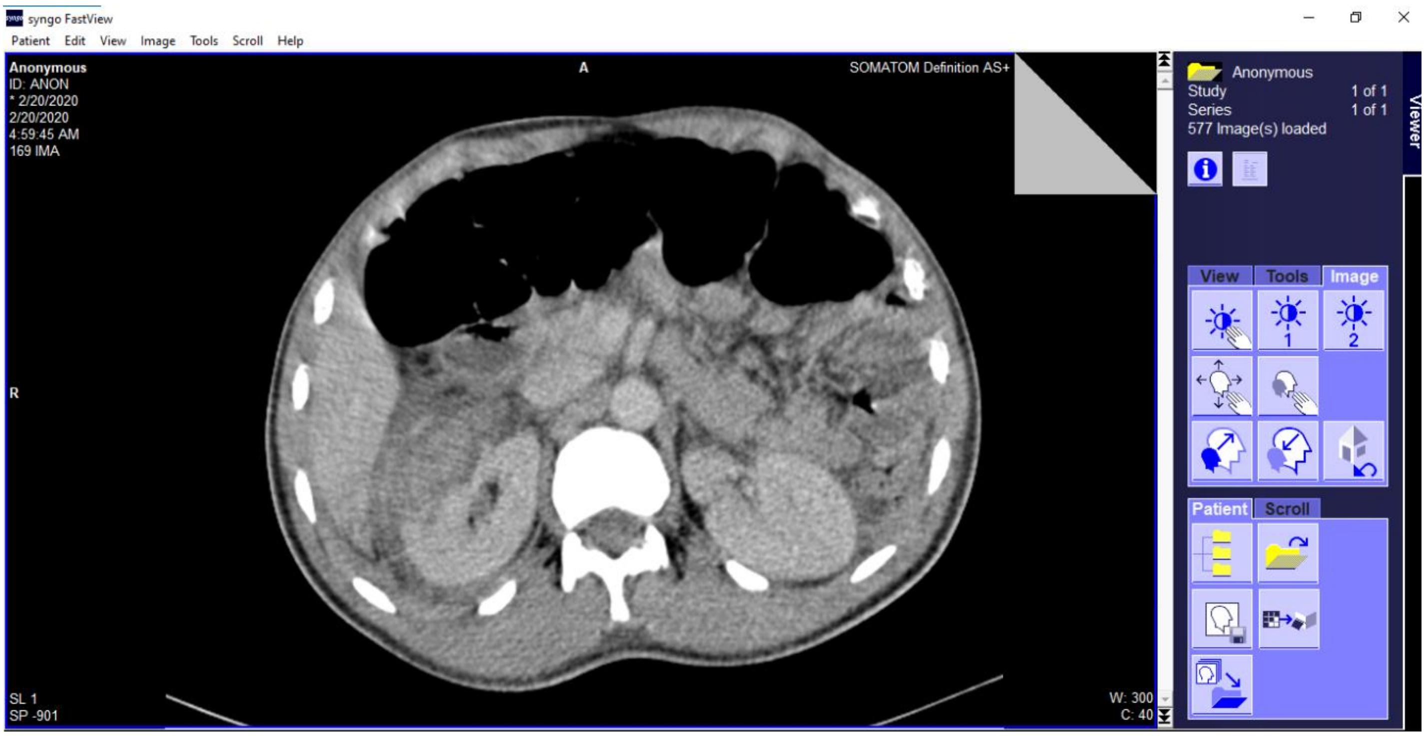
D

Case of a 7yr. old female hit by a motorbike, sustaining multiple parenchymal lacerations extending to the splenic hilum sparing the splenic vessels as shown in image A,B and C. Other associated injury included a femur fracture.

4.3.3. KIDNEYS AND URINARY TRACT

Patients who sustained injuries to the urinary tract had grade III pattern of injuries. The patterns of CT findings ranged from lacerations with some extending to the medulla to devascularization with ischaemia of the kidneys. These findings were associated with an enlarged and edematous kidney with peri-renal fat stranding.

Figure 8: Serial CT scan images demonstrating injury a case of injury to the kidney



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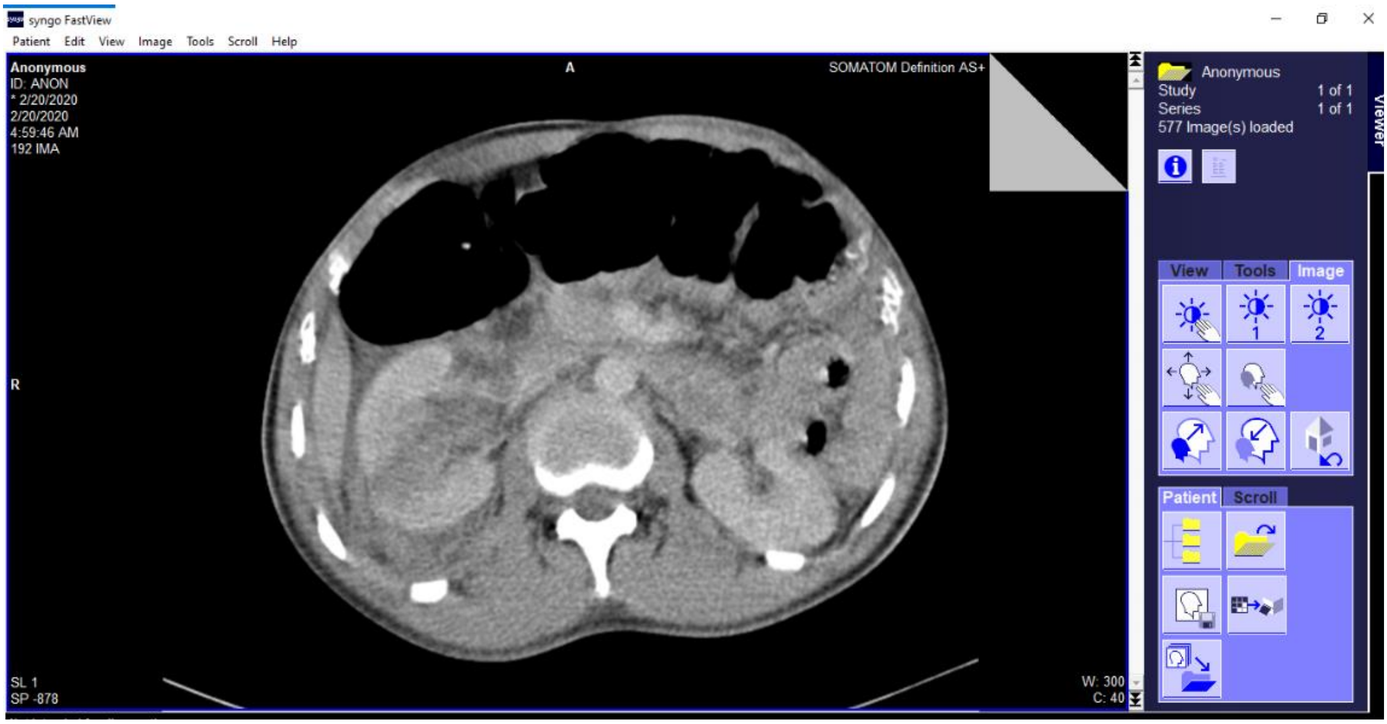

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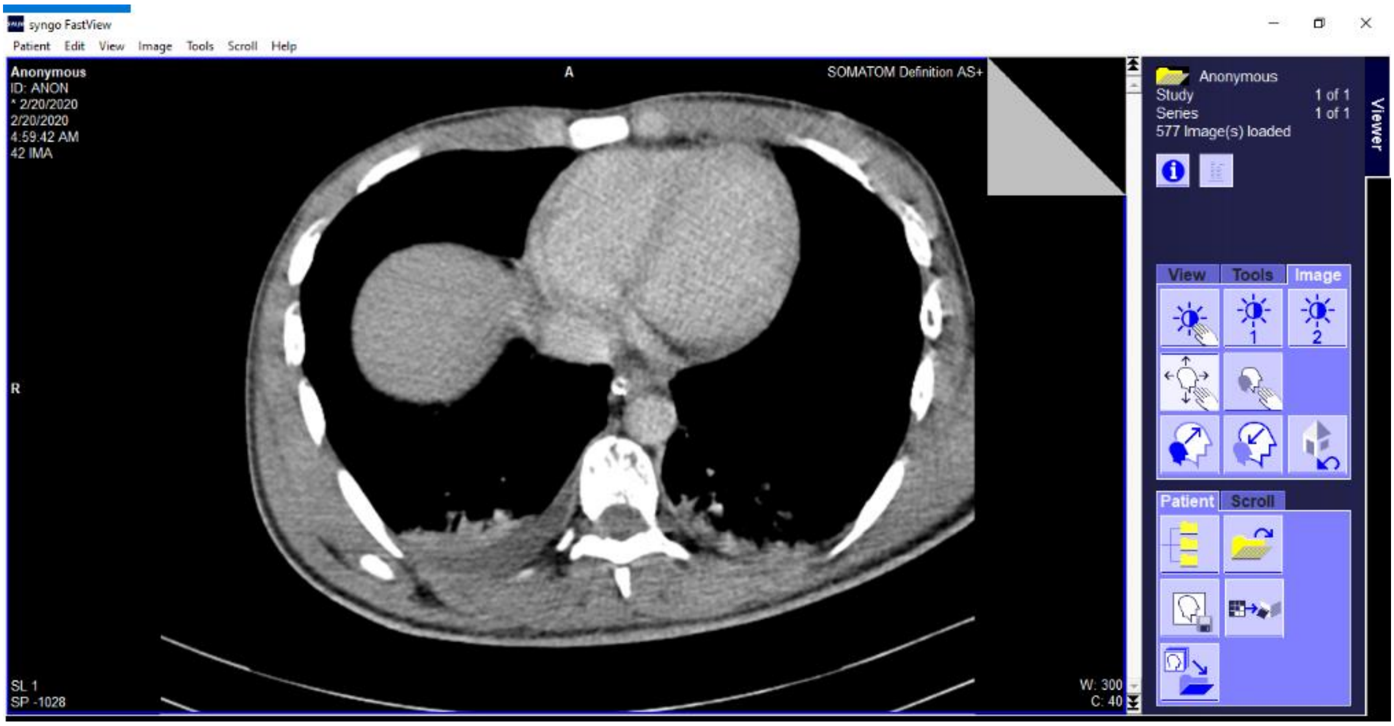


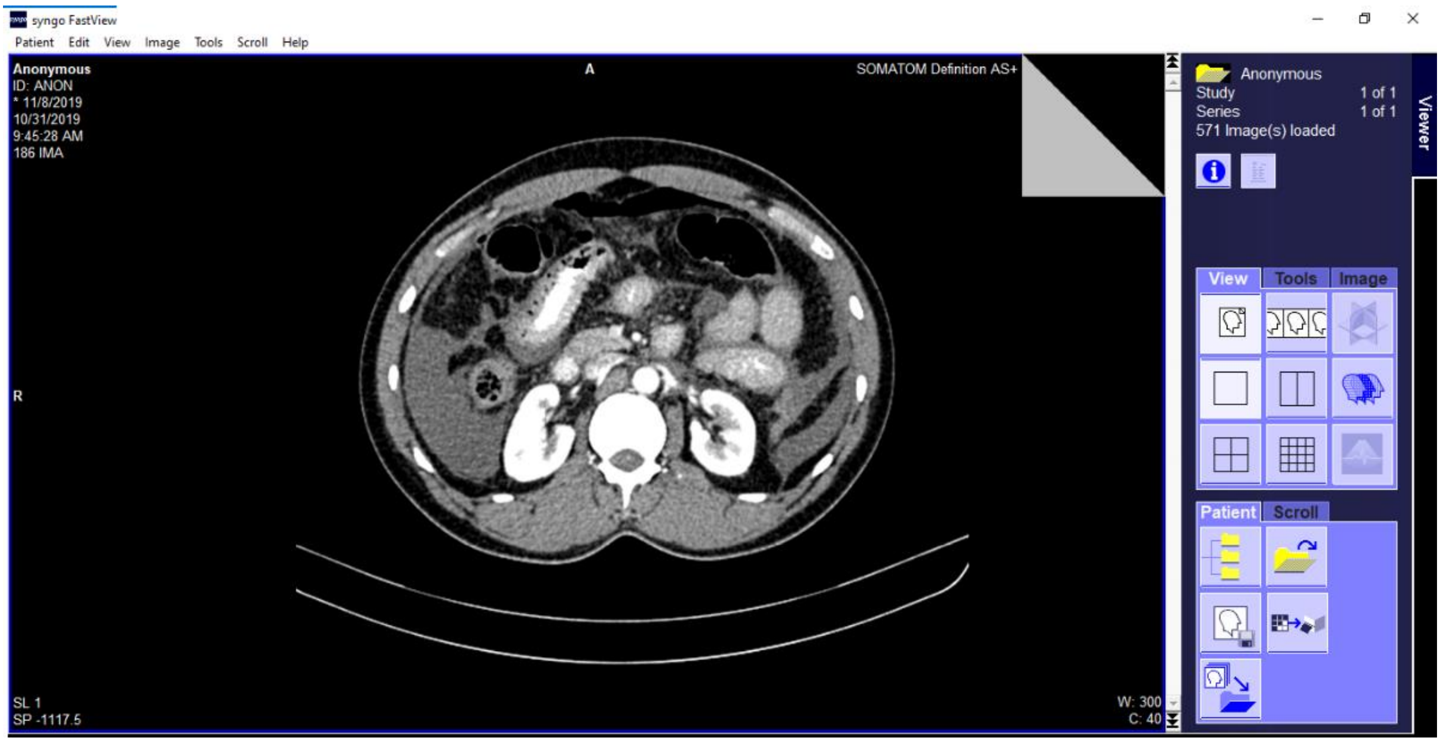
C

Case of a 19 yr. old with polytrauma following an RTA with grade 3 renal injury with associated contusions of the lung and pleural effusion.

4.3.4. BOWEL INJURIES

The patterns of bowel injury observed were not graded as per the AAST grading system. Findings such as bowel dilatation with or without a transition zone was reported, bowel wall thickening with enhancement and intramural air tracking. In other instances significant pneumoperitoneum with free fluid were the only findings suggestive of bowel and/ or mesenteric injury.

Figure 9: Serial CT scan images demonstrating bowel injury



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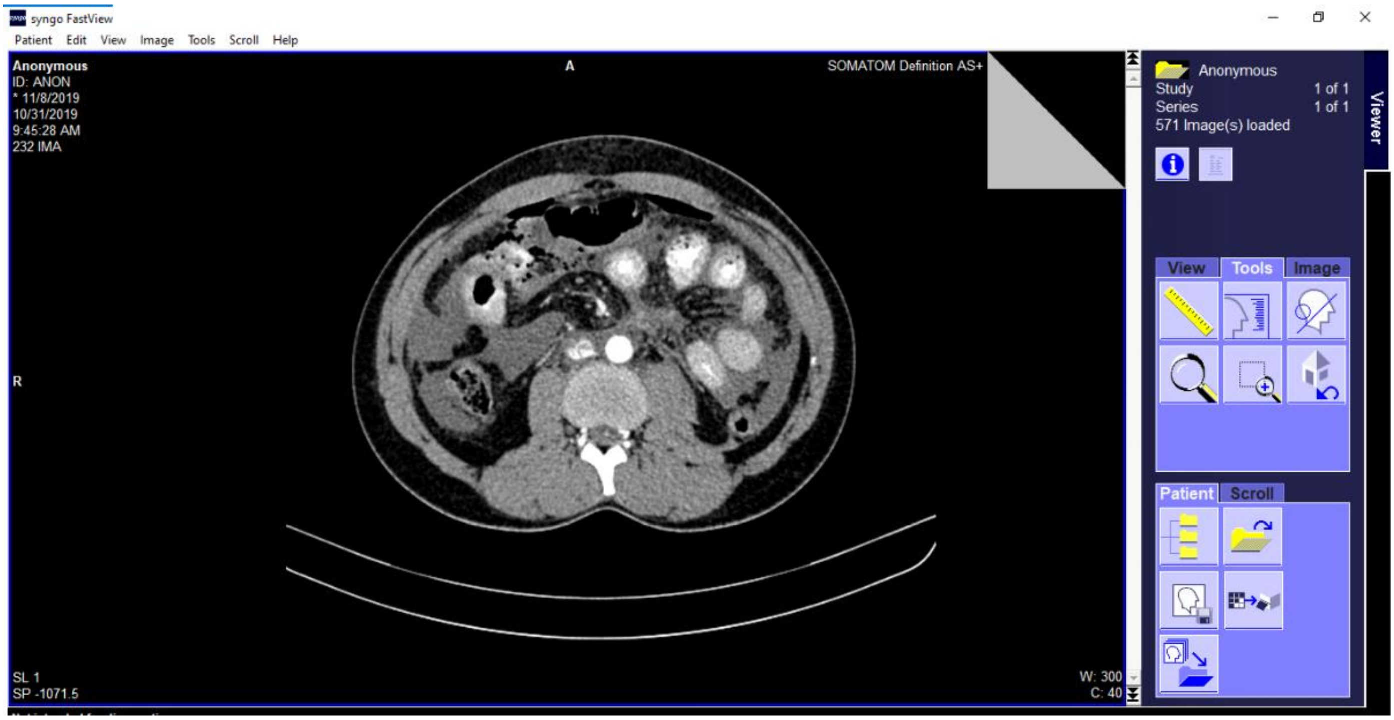
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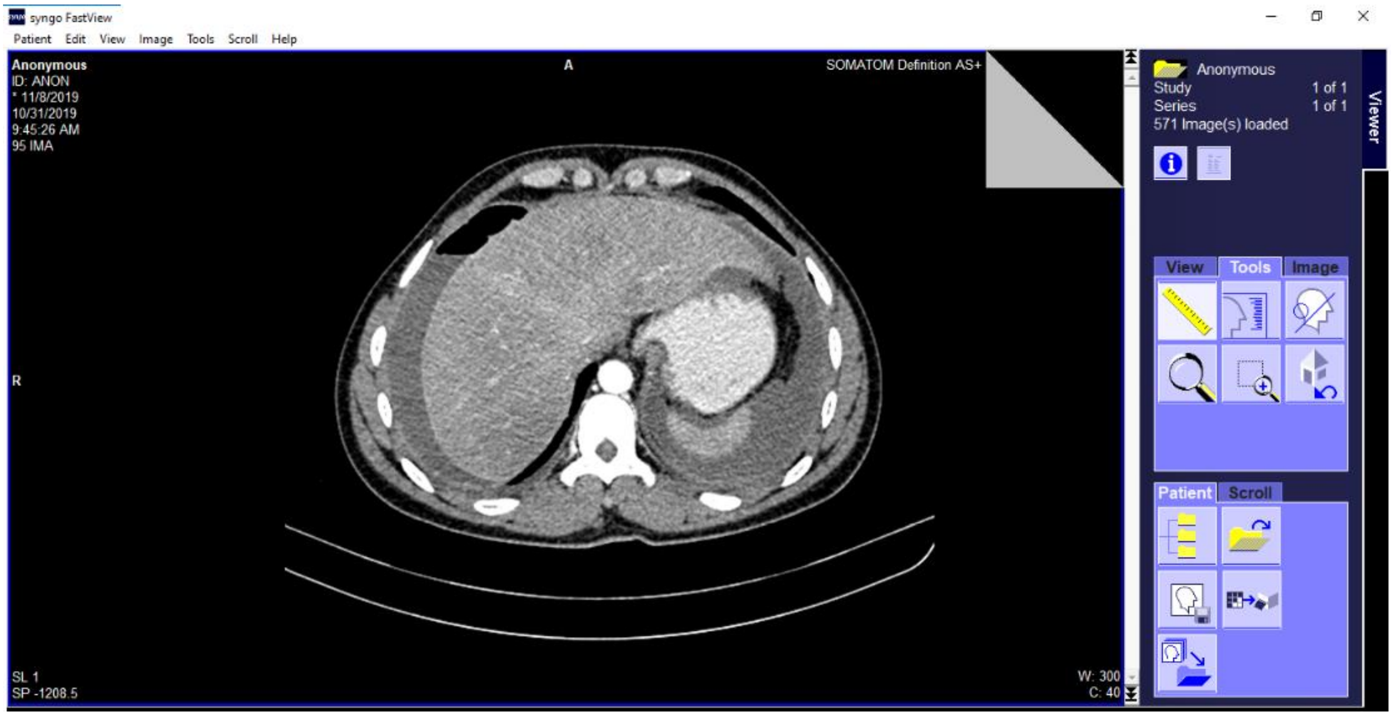
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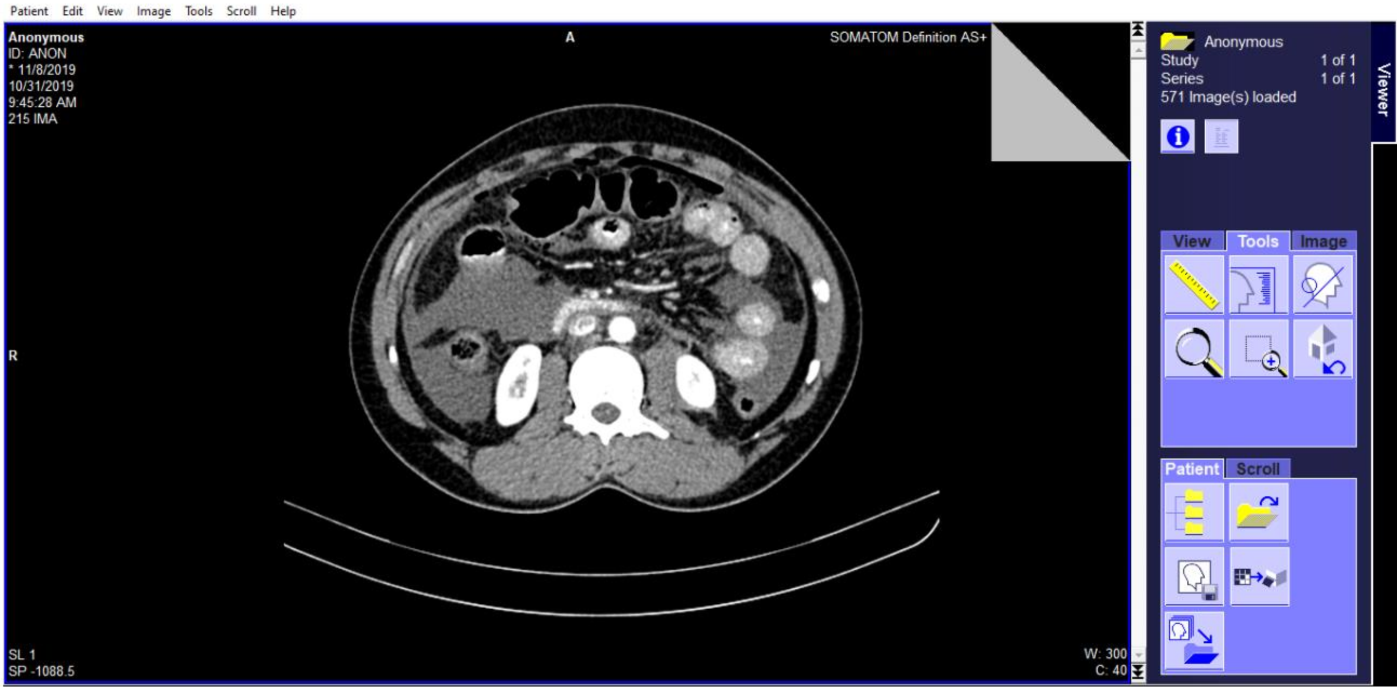


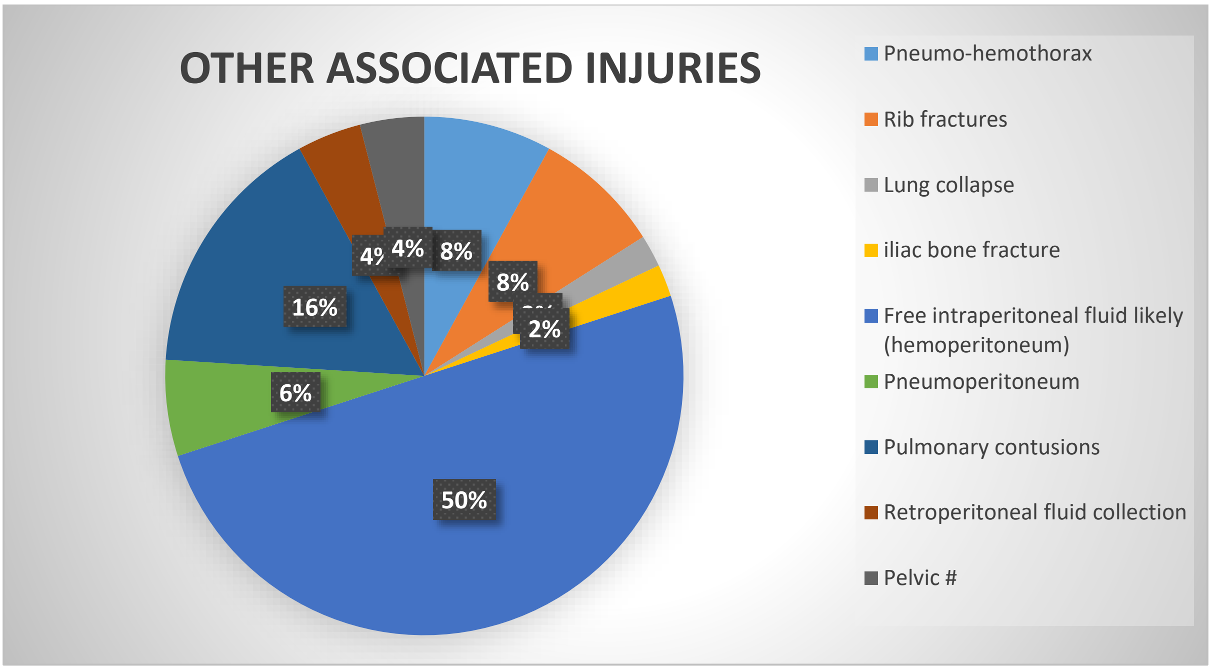
D

Case of a 30 yr. old with features that were consistent with bowel injury. In this case there was tracking of intramural air over a segment of jejunum associated with thickening of the bowel as shown in D. Pockets of intraperitoneal air were also seen. This was associated with presence of intraperitoneal fluid and pneumoperitoneum as depicted in image (C).

4.3.5: OTHER ASSOCIATED INJURIES

The most associated common occurrence was presence of haemoperitoneum, haemo-pneumothorax. The rest are as depicted in the pie chart below.

Figure 10: Pie chart depicting a representation of associated injuries



CHAPTER 5: DISCUSSION

Abdominal trauma is still attributed to as a cause of high frequency of trauma cases resulting to an admission. With the recent trends advocating for non-operative management of blunt abdominal trauma, CT became an integral part of evaluation of patients with BAT. This is because of its specificity in identifying visceral injuries.

In this study majority of the participants were male at 81% and 19% were female with a male: female ratio of 4.25:1. This was comparable to other studies where Kumar et al had 81% of male patients with BAT and 19% of female patients with a male: female ratio of 4.3:1(73). Similarly Naveen et al had a ratio of 4.9:1 (74), Surendra et al had a ratio of 4.23:1 (75) and Bajwa et al had a 5.9:1 as the ratio (76). Most of the authors postulated that male individuals are usually the bread earners in most households thus they tend to work outside the home and are therefore at an increased risk of accidental trauma.

In this study, the peak age distribution of patients involved in BAT was 21 – 30 years accounting for 32.1% of the cases. This was closely followed by 31 – 40 age group accounting for 20% of the cases. The mean age was 29 years. This finding was comparable to other studies. Bajwa et al, whose peak age incidence of the majority of the cases ranged between 21 -30 years with a mean age of 34.6 years (76). Surendra et al and Kumar et al studies also tallied with this finding (73,75). Other authors also noted that majority of mortalities following BAT were patients in the age group of 21 – 30 years of age (77).

Motor vehicle accidents (MVA), fall from a height and motor bike injuries are among causes of BAT globally. In this study, MVA was the most reported cause of BAT contributing 78% of the cases. This concurs with other authors who similarly reported a high incidence of MVA as a cause of BAT (18,73,78). The authors attributed the high incidence of MVA to bad road conditions, violation of traffic rules and traffic lights by many motorists and poorly maintained vehicles plying the roads.

Liver was the commonest organ injured at 50% of the cases with splenic injuries following suite at 23.8%. Grade III liver injuries were the highest pattern of liver injuries reported with grade II splenic injuries as the commonest pattern of splenic injuries. Different authors have reported different findings with regards to the commonest injured visceral organ. Afifi et al attributed 38% of cases of BAT to liver injuries with grade III as the most frequent pattern of injury (79). Solanki et al also did report that liver injuries accounted for the highest cases of BAT accounting for 34% of the cases (80). Bajwa et al, also concurred with our findings reporting 52% of cases due to liver injuries and grade III injuries were the commonest (76). Contrary to these findings Mehta et al reported splenic injuries as the commonest at 52% followed by liver injuries at 35%. Al-Busaidi et al equally concluded that splenic injuries were common at 48.8% with grade II injuries (5).

In this study bowel injury was the third highest in frequency accounting for 23.8% of visceral injuries following BAT. Features such as bowel wall thickening, bowel wall enhancement and intramural air were reported. In his study Polat et al found a high positive predictive value in features such as intraperitoneal air, bowel wall thickening, mesenteric air and contrast enhancement as CT features of bowel injury (81). These features were also reported by other authors as CT features of bowel injury (33,54,82). One author went further to state that bowel wall discontinuity remains as a CT feature with the highest specificity albeit not easily detected on CT imaging (33). Contrary to this Manoranjan et al did report that these features are not diagnostic but suggestive of bowel injury (59).

In this study renal trauma was the fourth highest in frequency accounting for 21.4% of the cases with most categorised under grade III renal injuries. Similar studies reported 20% (74)

of the cases as renal injuries and 19% (83) with both having most cases categorised as grade II injuries. With such percentages most authors emphasized the importance of urologists in management of trauma victims. Pancreatic injuries were a rare occurrence in this study. The case depicted in this study was identified during a follow up imaging of a patient that had had blunt abdominal trauma. Pancreatic injuries have been reported to occur in less than 2% of BAT. Multidetector CT imaging remains the mainstay of diagnosis.

CONCLUSION

Liver injuries are far more common injuries following BAT as compared to other visceral injuries. Patients with history of a fall from a height many at times tend to present with multiple visceral injuries. Abdominal CT scan is a useful evaluation tool for patients with BAT who are haemodynamically stable.

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APPENDIX 1: Data abstraction sheet

Ct scan serial number: __________

Gender/sex: ______________

Age: ______________

Abdominal visceral injuries:

1. Is there liver: YES____NO____

If yes, grading

Grade 1	
Grade 11	
Grade 111	
Grade 1V	
Grade V	
Grade VI	

2. Is there splenic injuries YES____NO___

If yes, grading

Grade 1	
Grade II	
Grade III	
Grade IV	
Grade V	

3. Is there renal injuries YES____ NO____

If yes, grading

Grade I	
Grade II	
Grade III	
Grade IV	
Grade V	

4. Is there bowel injuries YES____NO_____

If yes, grading

Grade I	
Grade II	
Grade III	

Grade IV	
Grade V	

5. Is there pancreatic injuries YES_____NO_____

If yes, grading

Grade I	
Grade II	
Grade III	
Grade IV	
Grade V	

FAST serial no: ___________

6. What are the results of the FAST Negative : ________ Positive : _________

If positive:

1. Is there free fluid: YES__ NO __

2. Is there visceral injury: NO__ YES__

If yes, what organs are injured: Liver__ Renal__ Splenic__ pancreatic__ Diaphragm?