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UTILITY OF MULTIDETECTOR COMPUTED TOMOGRAPHY (MDCT) SCAN IN SURGICALLY TREATED ACUTE ABDOMEN AT KENYATTA NATIONAL HOSPITAL- KENYA
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UTILITY OF MULTIDETECTOR COMPUTED TOMOGRAPHY (MDCT) SCAN IN SURGICALLY TREATED ACUTE ABDOMEN AT KENYATTA NATIONAL HOSPITAL- KENYA

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ABSTRACT

Background: **Acute abdomen is the leading cause of exploratory laparotomies in the emergency department. While clinical and laboratory examinations remain important, imaging plays a vital role in the diagnosis and management of acute abdomen. In the more developed economies, Multidetector Computerized Tomography (MDCT) is the main imaging modality in acute abdomen and has a well-established role. This study reports on the use of MDCT in surgically treated acute abdomen at a tertiary centre in Kenya.**

Objective: **To assess the utility of MDCT in surgically treated acute abdomen at Kenyatta National Hospital.**

Design: **Prospective cross-sectional analytic study**

Subjects: **A total of 253 consecutive patients with surgically treated acute abdomen were recruited following ethical approval and informed consent from June 2017-June 2018.**

Results: **Pre-surgery MDCT was performed in only 63 patients (25%) as per the institutional protocol. The median age of 31 (IQR 11) with male to female ratio of 3:1. The most common findings at MDCT for trauma were left diaphragmatic rupture with herniation (23.1%), perforated hollow viscera (19.2%) and bladder injury (15.4%); while the most common findings in non-traumatic acute abdomen were acute appendicitis (32.4%), peritonitis (29.7%) and intestinal obstruction (18.9%). MDCT findings showed strong concordance with surgical findings with the overall sensitivity, specificity, NPV, and PPV calculated as 91.5%, 100%, 44.4% and 100% respectively.**

Conclusion: **MDCT showed strong concordance with surgical findings in surgically treated acute abdomen and picked a good proportion of acute abdominal conditions which would have benefitted from interventional radiology or conservative management.**

INTRODUCTION

Acute abdomen refers to a clinical condition involving sudden onset of severe abdominal pain that requires urgent medical or surgical management. This can be due to a number of reasons ranging from insignificant disease to life threatening disease. A holistic approach in the diagnosis of the acute abdomen is therefore vital.(1)

In a study at KNH, Awori M and Jani, found that abdominal pain was the presenting compliant in 16.7% of patients that presented to the casualty department. He showed that abdominal pain accounted for 17.9% of all admissions via emergency department and 4.4% of these underwent surgery. (2)This study however did not quantify the impact of radiological imaging in the workup of patients with acute abdomen.

MDCT enables accuracy and reproducibility of diagnoses which in turn affects management and is therefore the primary imaging tool in acute abdomen except when cholecystitis is suspected (in which case U/S is preferred). (3)

Due to its multiplanar reconstructions, MDCT is able to increase the surgeon's confidence as it provides a pictorial evaluation of disorders (3). It therefore, goes to show that there needs to be good collaboration between the referring clinician and radiologist for prompt diagnosis and management of acute abdomen.

Surgical treatment of acute abdomen is usually via an emergency laparotomy. This is a high risk procedure but at the same time gives a definite diagnosis when correlated with histological findings.(4)

MDCT is an efficient and widely used imaging modality in acute abdomen but there is a scarcity of data on its utility in the acute general surgical workload. The objective of this study was to provide baseline data on the utility and accuracy of MDCT in surgically treated acute abdomen in our local setup.

MATERIALS AND METHODS

A prospective cross-sectional institutional based study was conducted at Kenyatta National Hospital (KNH) radiology department, theatres and the general surgical wards from June 2017-June 2018. Ethical approval was granted by KNH-UoN Ethics and Research Committee. A total of 253 consecutive patients above the age of 18, with surgically treated acute abdomen were enrolled with or without an MDCT examination. MDCT scans were obtained using a Siemens SOMATOM Sensation 128 CT scanner (Munich, German). Interpretation of results was done by the principal investigator under the supervision of two consultant radiologists with a composite experience of 28 years (PCM, BNM). Patients were followed up and surgical and /or histological findings were compared with MDCT findings. Conditions of "complete concordance", "partial" or "incorrect diagnosis" were considered. "Partial concordance" was considered when MDCT missed out some significant associated surgical findings but correctly identified the main condition. Data collected was analyzed using the Statistic Package for Social Science (SPSS) version 20.0 for Windows® and Chi square tests performed to determine statistical significance ($p<0.05$) of the results obtained in relation to the demographic data. To determine the correlation, cross tabulation between MDCT and surgical findings was done.

RESULTS

A total of 253 study participants were recruited into the study. The overall age range was 51with a median of 30 (IQR12.5). Out of these study participants, 25% (63/253) had MDCT studies before surgery for acute

abdomen. The age range of the MDCT group was 18 to 62 years with a median age of 31 years (IQR 11). The Male-to-Female ratio was approximately 3:1. All participants were further categorized according to the presence or absence of trauma.

Traumatic acute abdomen: There were 88 patients with abdominal trauma who were treated surgically. MDCT examinations were conducted in only 30% (26/88) of these patients. The Male: Female ratio was 12:1. Table 1 gives a summary of MDCT findings in traumatic acute abdomen classified using the American Association for the Surgery of Trauma (AAST) guidelines).

Table 1

MDCT findings in traumatic acute abdomen

MDCT diagnoses	Frequency	Percent
AAST grade 1 hepatic / ASST grade 1 splenic injury	1	3.8
AAST grade 1 hepatic injury	1	3.8
AAST grade 1 splenic injury	1	3.8
AAST grade 2 hepatic / ASST grade 2 splenic injury	1	3.8
AAST grade 3 Hepatic injury	1	3.8
AAST grade 4 hepatic injury	1	3.8
AAST grade 4 splenic injury	1	3.8
Bladder injury	4	15.4
Mild isolated hemoperitoneum	3	11.5
Left diaphragmatic perforations without thoracic herniation	1	3.8
Left diaphragmatic rupture with herniation	6	23.1
Pancreatitis	1	3.8
Perforated bowel	4	15.4
Total	26	100.0

The leading findings seen in the 26 study participants undergoing MDCT for traumatic acute abdomen were left diaphragmatic injury with herniation 6 (23%), perforated bowel 4 (19%) and bladder injury 4 (15%). Representative cases are illustrated in figures 1 and 2.

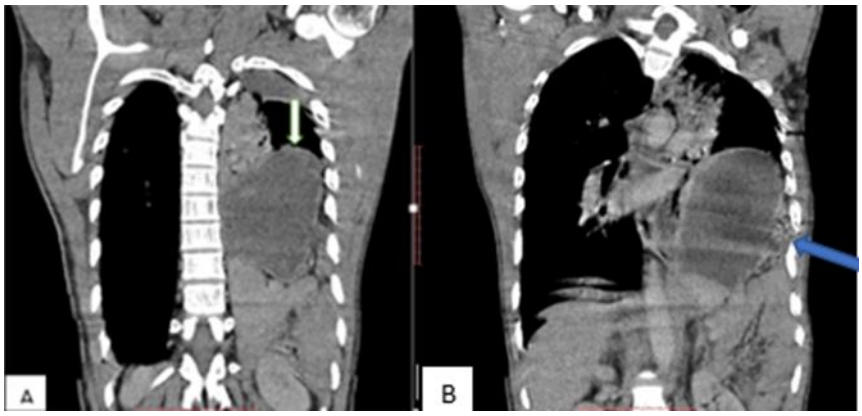

Figure 1*. left diaphragmatic Injury. Images (A) and (B). Coronal CECTs in a 21yr. old Male patient with history of blunt abdominal trauma showing gastric and omental herniation through a large left diaphragmatic tear (arrows). The gastric wall appears hazy suggestive of gastric injury (Curved arrow) confirmed as gastric perforation at surgery.*

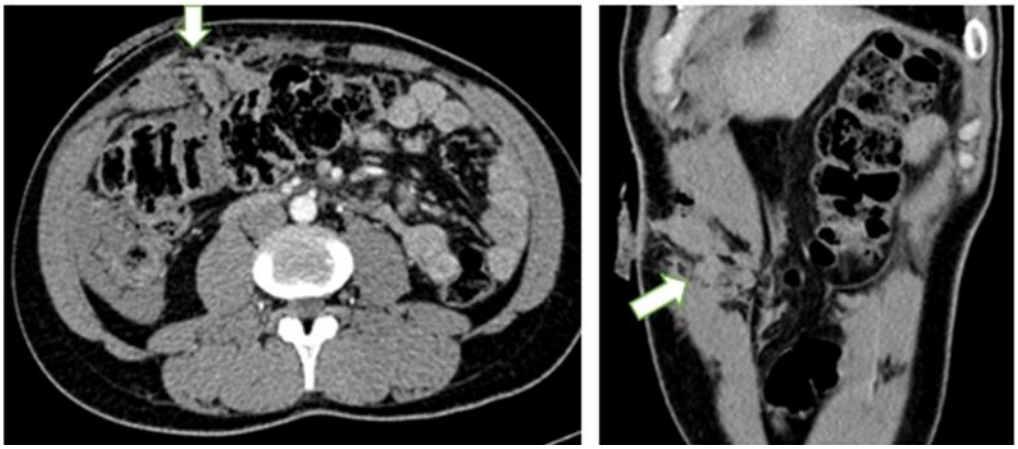

***Figure 2**. Penetrating abdominal injury. 26yr. old Male patient with history of penetrating abdominal injury; Axial (A) and coronal (B) CECT shows a right anterior abdominal wall injury with disruption of the overlying muscles fibers and injury to the adjacent small and large bowel.*

As per the AAST guidelines (5)there were 8 (31%), cases with surgical findings that suggested that these patients would have benefited from a less invasive management. These included hepatic / splenic injuries of AAST grade 1 and 2 (n = 4), Mild isolated hemoperitoneum (n=3) and pancreatitis (n = 1). Table 2 gives the surgical findings in traumatic patients without an MDCT. It shows that the pattern of findings was similar as that seen in the MDCT group. As per AAST guidelines 23% (14/62) patients without MDCT may not have required an emergency laparotomy had MDCT been performed.

Table 2

Surgical findings in traumatic patients without an MDCT

Diagnosis	Frequency	Percent
Bladder injury	5	8.1
Grade 1 AAST hepatic injury	4	6.5
Grade 2 ASST hepatic injury	2	3.2
Grade 3 ASST hepatic injury	2	3.2
Grade 4 ASST hepatic injury	1	1.6
Grade 4 ASST splenic injury	1	1.6
Hemoperitoneum	3	4.8
Ischemic bowel	1	1.6
Left diaphragmatic injury with herniation	2	3.2
Left diaphragmatic injury without herniation	2	3.2
Left diaphragmatic rupture with herniation	2	3.2
Negative laparotomy	3	4.8
Pancreatitis	2	3.2
Perforated bowel	27	43.5
Peritonitis	4	6.5
Retroperitoneal haematoma	1	1.6

Total	62	100.0

Non-traumatic acute abdomen: Only 22 % (37/165) in the non-traumatic acute abdomen group had an MDCT study prior to surgery. The Male: Female ratio was 3:2 in this group. The MDCT findings are illustrated in Table 3 and include acute appendicitis (32%), peritonitis (30%) intestinal obstruction (19%).

Table 3

MDCT findings in non-traumatic acute abdomen

Diagnosis	**Frequency**	**Percent (%)**
Acute appendicitis	12	32
Intestinal obstruction	7	19
Large left bleeding suprarenal mass	1	3
Pelvic abscess	3	8
Perforated viscus	1	3
Peritonitis	11	30
Sigmoid volvulus	1	3
Sub phrenic abscess	1	3
Total	37	100

Representative cases are given in Fig 3 and 4. Intrabdominal abscesses, n = 4 (10.8%) found at MDCT may have benefited from non-surgical management such as interventional radiology rather than laparotomy. This means the overall number of patients who would have benefited from non-surgical management in patients with MDCT examination was 19% (12/63).

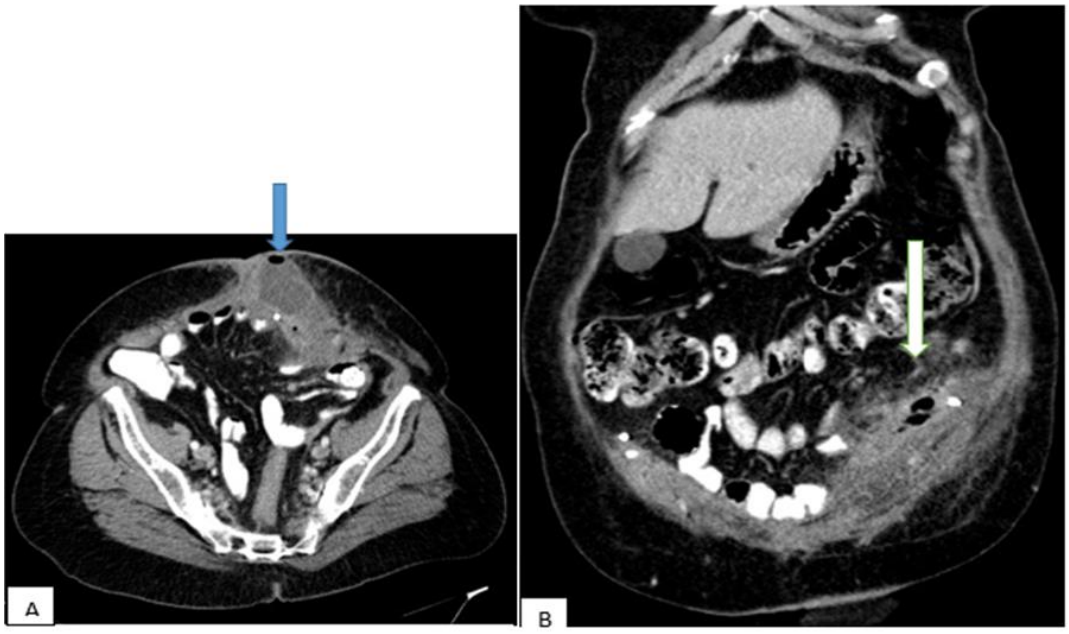

Figure 3. *Anterior wall abscess. Axial (A) and coronal (B) CECT showing an anterior wall abscess (blue arrow) in a 40yr. old female with peritoneal extension (white arrow).*

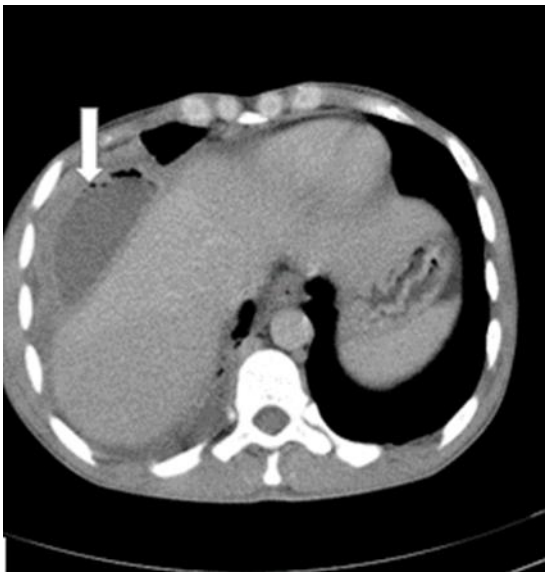

Figure 4. *Right subphrenic abscess. Axial CECT in a 34-yr. old woman showing a right subphrenic ring enhancing fluid collection with air locules within it consistent with a right subphrenic abscess*

The surgical findings of patients without MDCT in the non-traumatic group showed a similar trend as those with MDCT. Table 4 shows that the leading findings included acute appendicitis (39%), peritonitis (27%) and intestinal obstruction (22%). Diagnoses of intrabdominal abscesses n = 7 (6%) would have benefitted from a lesser invasive percutaneous drainage than invasive laparotomy.

Table 4

Surgical findings in non-traumatic acute abdomen without MDCT

Diagnosis	**Frequency**	**Percent (%)**
Acute appendicitis	50	39
Cholecystitis	3	2
Hepatic abscess	1	1
Intestinal obstruction	28	22
Mesenteric ischemia	1	1
Ovarian torsion	3	2
Pelvic abscess	5	4
Perforated viscus	1	1
Peritonitis	35	27
Psoas abscess	1	1
Total	128	100

The overall total number of patients without MDCT with collections or diagnoses which would have benefited from non-surgical or conservative managements was 21 (11%). It is worth noting that abdominal USS was the single most frequently used imaging modality (55%) inpatients without MDCT.

Accuracy of MDCT: The accuracy of MDCT when compared to surgical findings was 92% (58/ 63) having complete concordance where the MDCT findings completely correlated with surgical findings. There was partial concordance in 5 (8%) patients. In this group MDCT was able to identify the most important findings but missed out on some findings seen on surgery. The overall accuracy of MDCT if partial concordance was considered was 100%. In other words, MDCT was able to accurately diagnose the most important findings in all our patients which was confirmed at surgery. There was statistically significant correlation between MDCT and surgical findings (Chi Squared and Fishers exact test p value was <0.01. The overall sensitivity, specificity, NPV, and PPV for MDCT to identify surgically treated acute abdomen were calculated as 91.7%, 100%, 37.5% and 100% respectively.

DISCUSSION

This is the first study, to our knowledge, done at KNH showing the utility and accuracy of MDCT in surgically treated acute abdomen. Generally, there was a high male: female ratio in both the traumatic (12:1) and non-traumatic (3: 2) groups which was comparable to other studies. Musau et al, in a study at KNH for traumatic acute abdomen found the ratio to be slightly higher at 12.3:1(6) while Edino in Kano, Nigeria, in his study on the pattern of abdominal injuries had an all-male sample of 67(7).

This study showed that there was a small percentage of study participants, 25% (n= 63) that were subjected to a MDCT examination before surgery. Abdominal USS was the single most commonly used imaging study presurgery. Nagurney et al, in his study of patients who presented with non - traumatic acute abdomen in an urban university hospital in the United States of America, found a slightly higher proportion (39%) having a MDCT scan. They concluded that MDCT was the most useful imaging test presurgery (8).

In our study, patients who had no MDCT showed a similar surgical pattern as those who had MDCT for both trauma and non-trauma group. The infrequent unavailability of the CT scanner due to mechanical problems could have contributed to the low MDCT use. The other reason for low MDCT usage could have been due to the fact that patients who were hemodynamically unstable were not subjected to MDCT as per protocol. In our setup, the reliance on conventional radiography, ultrasound and clinical skill seems to be quite high and could be the leading cause of low MDCT use. The cost effectiveness of MDCT and various imaging modalities was beyond the scope of this study.

In a study of non-traumatic acute abdomen Laal et al, showed a similar pattern of findings as our study where appendicitis, peritonitis and intestinal obstruction where the leading causes for acute abdomen(9). A Nigerian study differed slightly and found that the commonest cause of non-traumatic acute abdomen was appendicitis (30.3%) followed by intestinal obstruction (27.9%), perforated typhoid ileitis 14.9% and peptic ulcer disease (7.6%), respectively(10).

MDCT showed complete concordance in solid viscera as well as in bladder injuries. Diaphragmatic injuries showed a 13% incidence at surgery in keeping with other studies which show them to have an incidence of approximately 0.8 to 15 % (11). Complete concordance for diaphragmatic injuries was recorded in 5 cases while 2 cases showed partial concordance. This was because in our study, MDCT was unable to detect underlying gastric injury in the two cases while clearly showing the diaphragmatic injury. This is a well-known limitation of diaphragmatic injuries in relation to perforations involving the gastric wall and duodenum (12). Our study also

found that all the cases of diaphragmatic injuries were on the left side. This could be partly due to the relatively few numbers of patients with these injuries but also due to the fact that left diaphragmatic injuries are the commonest (11).

Partial concordance was also seen in two patients with bowel perforation in which MDCT was able to suggest bowel injury due to free peritoneal air but unfortunately unable to correctly localize it. It is well understood that even though MDCT is the main imaging modality in determining the site of perforation, it has only an accuracy of 86% (13). MDCT was able to correctly diagnose small bowel ileus but failed to identify adhesions in the one case we had. A study with a large number of patients with adhesive small bowel obstruction would be more objective in quantifying the impact of MDCT in such patients in our region.

Overall, the accuracy of MDCT in surgically treated acute abdomen was 92% with 58 of the 63 patients having complete concordance. There was partial concordance in 5 (8%) patients. In other words, MDCT was able to accurately diagnose the most important finding in all our patients which was confirmed at surgery and histology where applicable.

Low numbers within specific diagnoses hindered the study from analyzing specific MDCT diagnoses in comparison to surgical findings. However, overall sensitivity, specificity, NPV, and PPV for MDCT to diagnose surgically treated acute abdomen were calculated as 91.7%, 100%, 37.5% and 100% respectively,

Lamaris et al found that the sensitivity and specificity were 89 % and 77 % respectively with a significantly higher number of non-traumatic patients (1021)(14). Priola et al, with 181 patients, found that the overall sensitivity in the detection of the main condition and the associated findings to be 87.3% but this increased to 95.6% when partial concordance was considered (15).

In our study there were 12 patients (19%) with MDCT who had diagnoses which may have benefited from non-surgical management. These included intrabdominal abscesses and pancreatitis were less invasive management has been shown to have better outcomes(16). It has been shown that complications, inadequate drainage and duration of drainage are much less in percutaneous drainage compared to major operative procedures (17). Therefore it has been suggested that these two approaches should not be looked at as competitors but as complementary, giving the patient and hospital the best possible outcome (18). A healthy collaboration between the radiologist and the surgeon is therefore indispensable.

Isolated mild hemoperitoneum can be easily and objectively quantified using MDCT and used as a parameter for surgical intervention. In the absence of other solid and hollow visceral injuries and in a stable patient, hemoperitoneum of less than 250ml is not an indication for surgical intervention. Studies have shown that conservative management has excellent outcomes in these patients(19). In our study, we found three of such patients. Low-grade visceral injuries such as AAST grades 1 and 2 have been shown to benefit from conservative management as well. However, the overall clinical picture and the presence of hemoperitoneum must be taken into account. A low grade injury in the presence of hemoperitoneum may require surgery(20).

This study has shown that overall, 13% patients would have benefited from non-surgical or conservative managements such as interventional radiology or laparoscopic surgery. This study therefore highlights the need for a multidisciplinary approach in treating acute abdomen so that every patient gets the best possible treatment and avoids unnecessary long hospital stay that may come from more invasive procedures.

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