

Abdominal Trauma Imaging in a Nigerian Tertiary Hospital—Our Experience with 87 Adult Patients

Abstract

Introduction: Abdominal trauma is a major cause of morbidity and mortality in low- and medium-income countries (LMICs). Abdominal trauma imaging is important in determining the location and severity of organ injury, the need for surgery, and the identification of complications. The choice of imaging in abdominal trauma in LMICs is influenced by peculiar problems, which include the availability of imaging modality, expertise, and cost. There are few reports on options of trauma imaging in LMICs, and this study aimed to identify and characterise the type of imaging done for patients presenting with abdominal trauma at the University of Ilorin Teaching Hospital. **Materials and Methods:** This was a retrospective observational study of patients with abdominal trauma who presented at the University of Ilorin Teaching Hospital from 2013 to 2019. Records were identified, and data were extracted and analysed. **Results:** A total of 87 patients were included in the study. There were 73 males and 14 females. The abdominal ultrasound was the commonest modality done in 36 (41%) patients, whereas abdominal computed tomography was done in five (6%) patients. Eleven patients (13%) had no imaging done, and 10 of these patients proceeded to having surgery. In patients with intraoperative finding of perforated viscus, the sensitivity of radiography was 85% and specificity was 100%, whereas that of the ultrasound was 86.7% and 50% for sensitivity and specificity, respectively. The ultrasound scan was the commonest imaging done for patients who presented with features of haemorrhage ($P = 0.04$), odds ratio (OR) = 1.29 (95% confidence interval [CI] = 1.08–1.6), and patients with severe injury, $P = 0.03$, OR = 2.07 (95% CI = 1.06–4.06). Gender ($P = 0.64$), shock at presentation ($P = 0.19$), and mechanism of injury ($P = 0.11$) did not influence the choice of imaging. **Conclusions:** Abdominal trauma imaging in this setting was majorly via ultrasound and abdominal radiographs. Factors suggested to influence the pattern of abdominal trauma imaging in LMICs include the availability of specific imaging modality, cost, lack of standardisation and definite abdominal trauma protocols.

Keywords: Abdominal injury imaging, abdominal trauma imaging, trauma imaging in Nigeria

Introduction

Up to six million people die each year as a result of trauma, and about 90% of these deaths occur in low- and middle-income countries (LMICs).^[1] The global burden of injury is inversely proportional to income, and it is not surprising that LMICs suffer the largest volume of injuries.^[2] Compared with high-income countries (HICs), the outcome of abdominal trauma has been poor with high morbidity and mortality.^[3] Abdominal injuries are common and are the leading cause of mortality for people under 45 years.^[4] Medical imaging refers to different technologies using ionising (x-rays, computed tomography [CT], and nuclear medicine) and nonionising radiation

(ultrasound and magnetic resonance imaging [MRI]) to diagnose, monitor, or treat medical conditions.^[5] Imaging in the setting of abdominal trauma is important in determining the diagnosis of specific organ injury, severity, need for surgery, and planning for surgical procedure as well as the identification of complications. The huge shortage of imaging equipment is underlined as there is less than one CT scanner per million inhabitants in LMICs compared with 40 scanners per million in HICs.^[5] This gap is far wider for MRI and nuclear imaging.^[5] The choice of imaging in abdominal trauma depends on various factors such as the haemodynamic stability of the patient, the availability of imaging equipment, and expertise. Important considerations in the choice of imaging in LMICs include cost, as most healthcare

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Adenuga AT, Adeyeye A. Abdominal trauma imaging in a Nigerian tertiary hospital—Our experience with 87 adult patients. *J West Afr Coll Surg* 2023;13:23-7.

Adedire Timilehin Adenuga, Ademola Adeyeye¹

Department of Surgery,
Cedarcrest Hospitals, Abuja,
¹Department of Surgery,
University of Ilorin Teaching
Hospital, Ilorin, Kwara, Nigeria

Received: 01-Nov-2022

Accepted: 23-Nov-2022

Published: 20-Mar-2023

Address for correspondence:

Dr. Adedire Timilehin Adenuga,
Department of Surgery,
Cedarcrest Hospitals, Abuja,
Nigeria.

E-mail: timiadenuga@gmail.com

Access this article online

Website:

www.jwacs-jcoac.com

DOI: 10.4103/jwas.jwas_273_22

Quick Response Code:



financing is mainly out of pocket, deficiency in personnel training, ineffective system organisation and clinical protocols, shortage of imaging equipment, lack of specialist availability, and brain drain.^[6]

It is odd that although most injuries occur in LMICs with subsequent higher numbers of morbidity and mortality, most trauma care research and guidelines come from HICs often with no consideration for the distinct and unique trauma care practices associated with resource constraints and the peculiarity of our local patients. There are few reports on options of trauma imaging in LMICs,^[2,5] and this study aimed to identify and characterise the pattern of imaging done for patients presenting with abdominal trauma at the University of Ilorin Teaching Hospital.

Materials and Methods

Study design and study area

This was a 7-year retrospective observational study (2013–2019) on patients presenting with abdominal trauma at the Accident and Emergency Department of the University of Ilorin Teaching Hospital located in North-Central Nigeria. Institutional ethical approval was obtained for this study from the ethical board of the University of Ilorin Teaching Hospital with ethical approval number ERC PAN/2020/12/0106.

Study participant characteristics

We retrieved records of patients with clinical and/or radiological evidence of abdominal trauma. Patients who were less than 16 years and pregnant patients were excluded from the study.

Handling of imaging reports

For chest radiography, a report and/or documentation of the presence of free air under the diaphragm is taken as pneumoperitoneum. The findings on ultrasound and abdominal CT are noted as well and are used to classify patients on positive or negative imaging findings. The report of imaging was correlated to findings at surgery using intraoperative findings as the point of reference. Sensitivity, specificity, and diagnostic accuracy of ultrasound and radiographs in detecting perforated viscus preoperatively were calculated.

The injury severity score (ISS) was obtained from the patient documentation, imaging studies, and intraoperative finding. The ISS is defined as the sum of the squares of the highest abbreviated injury scale grade in the three most severely injured body regions. Six body regions are defined, which includes: the thorax, abdomen and visceral pelvis, head and neck, face, bony pelvis, and extremities and external structures. The ISS ranges from 1 to 75, and an ISS of 75 was assigned to anyone with an abbreviated injury scale of 6.

$$ISS = (A)^2 + (B)^2 + (C)^2.$$

Data analysis

Data were analysed using Statistical Package for Social Sciences (SPSS version 23.0) software (2015 SPSS Inc., Chicago Illinois, USA). For categorical variables, data were summarised in proportions and frequency tables. Analyses were performed using Students T-test for continuous data, whereas Chi-square was used for categorical variables. OR was calculated using logistic regression. Differences were considered statistically significant when *P* value was less than 0.05 (*P* < 0.05).

Results

A total of 87 patients fit the inclusion criteria and were included in the study. There were 73 males and 14 females with a male to female ratio of 5.2:1. Other baseline information is as seen in Table 1.

Management of patients

A total of 64 (73.6%) patients had immediate laparotomy and 17 (19.5%) patients with 19 solid organ injuries were managed conservatively, whereas six (6.9%) patients had failed nonoperative management and required laparotomy (three patients with splenic injury and three patients with liver injury). Two patients had negative laparotomy. The median length of hospital stay was 8 days (6–12).

Pattern of imaging for abdominal trauma patients

The abdominal ultrasound alone was the sole imaging used in deciding for surgery or no surgery in 36 (41%) patients. A total of 11 (12.6%) patients did not have any imaging done with 10/11 of them proceeding straight to surgery, eight patients (80%) due to haemodynamic instability and two (20%) due to evisceration. None of the patients in the time period had abdominal MRI done. Other information is as seen in Table 2.

Table 1: Characteristics of patients at presentation

Characteristic	Data (n = 87)
Age (years), mean ± SD	34.2 ± 11.9
Range	16–65
Sex	
Male	73 (83.9%)
Female	14 (16.1%)
Mechanism of injury	
Motor vehicular	32 (36.8%)
Motorcycle	15 (17.2%)
Pedestrian	2 (2.3%)
Falls	4 (4.6%)
Gunshot	26 (29.9%)
Stabs	8 (9.2%)
Type of injury	
Blunt	53 (60.9%)
Penetrating	34 (39.1%)

SD = standard deviation

Table 2: Imaging executed in patients with abdominal injury

Imaging	Number of patients	Percentage
Abdominal ultrasound alone	36	41
Standard abdominal radiograph* + abdominal ultrasound	14	16
No imaging	11	13
Abdominal ultrasound + chest radiograph (frontal view alone)	10	12
Abdominal ultrasound + abdominal radiograph (supine and erect only)	5	6
Abdominal CT alone	5	6
Standard abdominal radiograph* alone	3	3
Chest radiograph (frontal view) alone	3	3

*Standard abdominal radiographs include supine abdominal view, upright abdominal view, and an erect chest radiograph

Table 3: Performance of imaging modalities in preoperative detection of perforated viscus

Diagnostic test	Ultrasound (%)	Chest radiograph (%)
Sensitivity	86.7	85
Specificity	50	100
Diagnostic accuracy	78.9	87

Sensitivity, specificity, and diagnostic accuracy of imaging modalities

A total of 45 patients were operated on an account of perforated viscus. Pneumoperitoneum (described as air under the diaphragm) was seen on erect chest radiograph in 23 patients, whereas this was absent in four patients despite intraoperative confirmation of bowel perforation. There were no false positives. The sensitivity of this radiograph in detecting perforated viscus using the presence of pneumoperitoneum was 85%, whereas the specificity was 100%. The diagnostic accuracy of this imaging modality was 87%.

A total of 15 patients with abdominal scans had intraoperative features of perforated viscus. In 13 patients, the ultrasound scan picked the diagnosis of perforated viscus preoperatively, whereas two patients were reported as having normal scans. The sensitivity of this imaging modality was 86.7%, whereas specificity was 50%. The diagnostic accuracy of ultrasound use was 78.9% [Table 3].

For the abdominal CT, three patients had features of peritonitis and intraoperative finding of perforated viscus, and all were picked by the CT.

Choice of abdominal trauma imaging

For patients who presented with features of haemorrhage, there was more use of ultrasound scan than other modalities ($P = 0.04$), odds ratio (OR) = 1.29 (95% confidence interval [CI] = 1.08–1.6). There was no difference in the choice of imaging in patients who presented with peritonitis ($P = 0.6$). Patients with severe injuries (ISS > 15) had more ultrasound scans done than any other imaging modality ($P = 0.03$), OR = 2.07 (95% CI = 1.06–4.06). Gender ($P = 0.64$), shock at presentation ($P = 0.19$), and the type of injury (blunt or penetrating) ($P = 0.11$) did not influence the choice of imaging.

Discussion

This study set out to determine the pattern of imaging of abdominal trauma patients. The role of imaging in abdominal trauma is key, and at presentation, it gives valuable information, in addition to clinical findings, in determining patients that would be managed conservatively and those with severe injuries that would require immediate emergency laparotomy.

The commonest imaging modality done in patients in this study was the abdominal ultrasound. This modality was the sole imaging done in making the decision on whether or not to operate 41% of all patients. The abdominal ultrasound is highly effective, readily available, cheap, with no exposure to ionising radiation, and does not require the use of contrast, which is relevant in patients with associated renal injury or allergy.^[7] This is in addition to its portability (can be used during resuscitation), rapidity, and repeatability. It is highly effective in detecting solid organ injury and other features of major abdominal injury such as massive free fluid, pneumoperitoneum, and severe organ disruption. The abdominal ultrasound has been found to have a high sensitivity (79%–100%) and specificity (95%–100%) particularly in patients who are haemodynamically unstable.^[7,8] It is believed that an important reason why the abdominal ultrasound was prevalent and mostly the only imaging done was due to the relatively cheaper cost compared with other modality. Abdominal ultrasound scanning costs about \$4 when compared with the CT that costs between \$80 and \$150. In this study, more patients presenting with features of haemorrhage had abdominal ultrasound done than any other imaging modality ($P = 0.04$) and patients with severe injuries (ISS > 15), $P = 0.03$. This may be partly due to the lack of round the clock availability of the abdominal CT compared with ultrasound, as well as cost issues, preference of managing surgeon, and stability of the patients.

The diagnostic accuracy and specificity of chest radiographs were better than those of abdominal ultrasound when perforated viscus was suspected as the diagnosis, and there were relatively more radiographs done when the patient was suspected to have perforated viscus. This is understandably so as visualisation with the ultrasound is more difficult when there is extensive pneumoperitoneum, which often occurs in such cases. For patients with solid organ injury, it was difficult to calculate the diagnostic accuracy of the imaging modalities as many of these patients were not operated, and it would have been difficult to confirm the presence or not of the solid organ injury to which to measure against individual imaging modality.

The contrast-enhanced CT is the gold-standard imaging in abdominal visceral injuries.^[7] In this study, only five (6%) of all patients presenting with abdominal trauma in the period had an abdominal CT. In LMICs, a lack of widespread availability and the cost of this imaging technique when available (which can be as high as \$150) are the main limitations of use despite being the imaging of choice for abdominal trauma cases.

The standard abdominal radiograph has three views (the supine abdominal view, upright abdominal view, and erect chest view) and is highly effective in the evaluation of abdominal trauma patients.^[9] The presence of pneumoperitoneum can be seen in up to 83% of patients with visceral perforation, and this, in addition to clinical evaluation, can be used in making a decision for laparotomy when indicated.^[9] In this study, pneumoperitoneum (free abdominal air) was seen in 85% of patients with perforated viscus. The sensitivity in detecting perforated viscus, for patients who eventually had surgery, using the presence of pneumoperitoneum was 85%, whereas the specificity was 100%. The diagnostic accuracy for this imaging modality was 87%.

Although the abdominal radiograph as an imaging modality for abdominal trauma is easily performed as the equipment is readily available, the interpretation of films can be done by the surgical team and important findings such as pneumoperitoneum can be used to make decision for laparotomy; it is limited in that it cannot give further information on location and cause of pneumoperitoneum and hence cannot be used to plan surgery. The modality involves exposure to radiation and the low negative predictive value mean that negative finding on abdominal radiograph may still require an abdominal CT to confirm the absence of sinister pathology.^[10]

A total of 11 patients had no imaging done. Ten of these patients had emergency laparotomy due to haemodynamic instability (8/10) and evisceration (2/10). One patient had nonoperative management of suspected splenic injury and was discharged subsequently. Late presentation of some of these patients may be responsible for the lack of imaging and the presence of overt clinical features of peritonitis,

and haemodynamic instability and evisceration may be responsible for the urgent need to operate. The paucity of funds may mean that the managing surgeon has the difficult task of choosing either and not both of diagnostic and therapeutic options. This is not an uncommon occurrence in LMICs.

Some of the solutions suggested to improve abdominal trauma imaging in LMICs include the use of point-of-care ultrasound, procurement of advanced imaging equipment, development of emergency radiology units, the use of artificial intelligence to improve work flow, and automated detection of abdominal organ abnormalities. The development of local guidelines on imaging protocol to be used in abdominal trauma patients, creation of centres of reference, improved workforce education and training, quality management, upscaling, and financing are other suggested solutions.^[5,11,12]

There are a few limitations of this study—the retrospective nature means that data were based on documented information, which may have been incomplete or deficient in some aspect. Also, there was a lack of a standard reference for intra-abdominal injury as not all patients were operated to confirm organ injury. This study did not measure the turn-around time for imaging requests, which would, without doubt, be of importance in abdominal trauma patients.

Conclusions

The above study shows the pattern of abdominal trauma imaging in our hospital. The limitations of equipment and affordability limit the use of the abdominal CT, which is the gold standard in abdominal trauma. The lack of standardisation and imaging protocol mean that various patients have different imaging depending largely on the choice of managing surgeon. Ultrasound and abdominal radiography are the commonest imaging done for these patients.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Feldhaus I, Carvalho M, Waiz G, Igu J, Matthay Z, Dicker R, *et al.* The feasibility, appropriateness, and applicability of trauma scoring systems in low and middle-income countries: A systematic review. *Trauma Surg Acute Care Open* 2020;5:e000424.
2. Shanthakumar D, Payne A, Leitch T, Alfa-Wali M. Trauma care in low- and middle-income countries. *Surg J (N Y)* 2021;7:e281-5.
3. Bhangu A, Ademuyiwa AO, Aguilera ML, Alexander P, Al-Saqqqa SW, Borda-Luque G, *et al.* Surgical site infection after gastrointestinal surgery in high-income, middle-income, and low-income countries: A prospective, international, multicentre cohort study. *Lancet Infect Dis* 2018;18:516-25.

4. Rajai Ghafouri R, Pouraghaei M, Ghffar zad A, Shokri R, Azizkhani L. Determining prognostic value of serum levels of lactate, bicarbonate, base deficit and glucose in mortality rate of trauma patients admitted to emergency department. *Intern Med Med Investig J* 2017;2: 161-5.
5. Frija G, Blažić I, Frush DP, Hierath M, Kawooya M, Donoso-Bach L, *et al.* How to improve access to medical imaging in low- and middle-income countries? *EclinicalMedicine* 2021;38:101034.
6. Reynolds TA, Stewart B, Drewett I, Salerno S, Sawe HR, Toroyan T, *et al.* The impact of trauma care systems in low- and middle-income countries. *Annu Rev Public Health* 2017;38:507-32.
7. Jansen JO, Yule SR, Loudon MA. Investigation of blunt abdominal trauma. *BMJ* 2008;336:938-42.
8. Boutros SM, Nassef MA, Abdel-Ghany AF. Blunt abdominal trauma: The role of focused abdominal sonography in assessment of organ injury and reducing the need for CT. *Alexandria J Med* 2016;52:35-41.
9. Gans SL, Stoker J, Boermeester MA. Plain abdominal radiography in acute abdominal pain; past, present, and future. *Int J Gen Med* 2012;5:525-33.
10. Laméris W, van Randen A, van Es HW, van Heesewijk JPM, van Ramshorst B, Bouma WH, *et al.* Imaging strategies for detection of urgent conditions in patients with acute abdominal pain: Diagnostic accuracy study. *BMJ* 2009;338:29-33.
11. Patlas MN, Katz DS, Odedra D. Emergency and trauma imaging: General principles, modalities, challenges, and opportunities. *Atlas of Emergency Imaging from Head-to-Toe* 2021;11:1-7.
12. Chong ST, Robinson JD, Davis MA, Bruno MA, Roberge EA, Reddy S, *et al.* Emergency radiology: Current challenges and preparing for continued growth. *J Am Coll Radiol* 2019;16: 1447-55.