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The diagnostic accuracy of triphasic abdominal CT in detecting esophageal varices

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Abstract

Background In Tanzania, triphasic abdominal Computed Tomography (CT) is a more accessible and non-invasive alternative for diagnosing esophageal varices, though its accuracy has not been thoroughly evaluated, therefore this study aimed to determine the diagnostic accuracy of triphasic abdominal CT in detecting esophageal varices using esophagogastroduodenoscopy (OGD) as the gold standard among patients with upper gastrointestinal bleeding at Muhimbili National Hospital (MNH).

Methods This cross-sectional study was conducted at MNH from January 2021 to May 2023. We sampled upper gastrointestinal bleeding patients who underwent both OGD and triphasic abdominal CT using non-probability consecutive sampling. The sensitivity, specificity, negative predictive value (NPV), positive predictive value (PPV), and accuracy of triphasic abdominal CT were assessed against OGD findings.

Results In a study of 200 participants, esophageal varices were detected in 54% by OGD and 53.5% by CT. We observed 105 true positives, 2 false positives, 90 true negatives, and 3 false negatives. Triphasic abdominal CT demonstrated a sensitivity of 97.2%, specificity of 97.8%, PPV of 98.1%, NPV of 96.8%, and an accuracy of 97.5%. Extraluminal findings included portal venous thrombosis in (22%), splenic collateral (51.5%), ascites (32%), hepatocellular carcinoma (13%), and periportal fibrosis (32%).

Conclusion Triphasic abdominal Computed Tomography can be used as a reliable and non-invasive alternative modality for diagnosing and screening esophageal varices in resource-limited settings.

Keywords Esophageal varices, Triphasic abdominal CT, Oesophagoduodenoscopy

Background

Upper gastrointestinal bleeding (UGIB) is a serious global emergency, with esophageal varices being a significant cause, especially in Tanzania where it accounts for 57% of cases [1–3]. Esophageal varices, from portal hypertension, affect up to 40% of cirrhotic patients, with

a 10–30% annual hemorrhage risk and a 20–35% mortality rate at first bleeding [4–7]. Liver cirrhosis from Hepatitis B, alcohol, and schistosomiasis are major risk factors for portal hypertension [2, 3, 8–11].

Oesophagoduodenoscopy (OGD) is a gold standard tool for diagnosing and treating esophageal varices in upper gastrointestinal bleeding [12–14]. However, restricted access to OGD correlates with unfavorable disease outcomes [3, 15, 16]. Several studies have reported that triphasic abdominal CT showed a non-invasive alternative diagnostic modality to detect esophageal varices and other related pathologies that may impact patient management [6, 17–19].

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Esophageal varices are a major cause of morbidity and mortality in patients with upper gastrointestinal bleeding, particularly in regions like Tanzania where liver cirrhosis is prevalent [1, 2]. In Tanzania, where CT is widely available from Regional Referral Hospitals to the National Hospital level, the accuracy of triphasic abdominal CT has yet to be evaluated. Demonstrating high diagnostic accuracy of triphasic abdominal CT can improve patient outcomes, enhance resource utilization and guide clinical practice.

This study is innovative in several key aspects including its comprehensive evaluation in resource limited settings, blinded assessment ensuring objective comparison of the two imaging modalities and paving way for further prospective, multi-center studies, and contribute to the global body of knowledge on non-invasive diagnostic techniques for esophageal varices, potentially influencing international clinical practices.

Materials and methods

This diagnostic accuracy study was part of a broader study on UGIB profiles at MNH. We included 200 participants aged 20 to 90 years, with UGIB history who underwent both OGD and triphasic abdominal CT. On average, the interval between OGD and triphasic abdominal CT scans was 4 weeks. Exclusion criteria included patients without retrievable CT or endoscopic records. Ethical approval was obtained from the MUHAS Institutional Review Board (MUHAS-REC-04-2023-1617).

Diagnostic triphasic abdominal CT and OGD

Axial triphasic abdominal CT scans were reviewed in consensus by the principal investigator, who has over 3 years of experience in clinical research, and an experienced radiologist with over 5 years of expertise in CT imaging, specifically in hepatic and gastrointestinal conditions. Both were blinded with the endoscopy findings. Varices were identified as linear or nodular enhancing lesions near or within the esophageal lumen [20]. Assessments were blinded to endoscopic results, which served as the gold standard. Triphasic abdominal CT scans were performed using a standard protocol that included non-contrast, arterial, and portal venous phases. The scans

were acquired using a multi-detector CT scanner with thin-slice reconstruction to enhance the detection of esophageal varices and related abnormalities. Endoscopy was performed by an experienced gastroenterologist with a minimum of five years of experience who was blinded with the CT findings. Esophageal varices defined as the presence of dilated submucosal veins in the distal esophageal lumen. These veins may appear as red or bluish streaks or as distinct, raised, and worm-like structures [21–23].

Data Management and Analysis

Data were collected using structured forms and analyzed using SPSS version 26. Sensitivity, specificity, PPV, and NPV of triphasic abdominal CT were calculated against OGD results. A P-value of <0.05 was considered statistically significant.

Results

A total of 200 participants were included, with males being more predominant than females (120 [60%] vs. 80 [40%]). A wide range of patient age was seen and it varied between 20 and 90 years with a median age of 47 years. In our patient cohort, esophageal varices were significantly associated with hepatitis B virus (OR=6.07, 95% CI: 2.162–17.085, $p<0.001$), alcoholic liver disease (OR=5.95, 95% CI: 2.559–13.835, $p<0.001$), non-alcoholic fatty liver disease (OR=3.66, 95% CI: 1.780–7.467, $p<0.001$), and hepatic schistosomiasis (OR=3.77, 95% CI: 1.830–7.788, $p<0.001$).

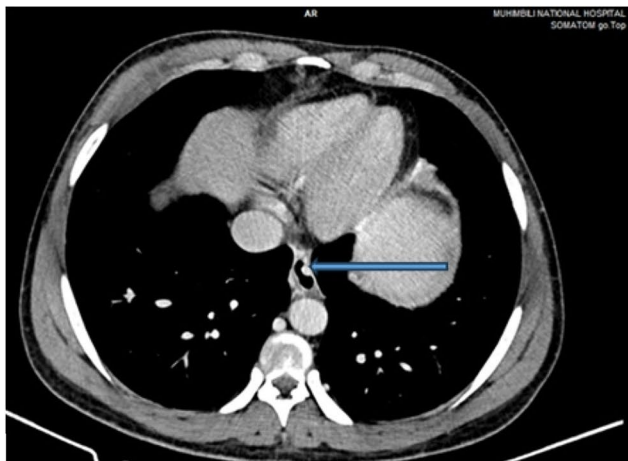
Among the 200 participants, esophageal varices by OGD were found in more than half of them 108(54%). Triphasic abdominal CT neared the OGD findings where it revealed esophageal varices in patients 107(53.5%) and absent in 93(46.5%) of the studied participants. In addition to esophageal varices, triphasic abdominal CT also showed evidence of gastric varices in 53 patients (26.5%), liver cirrhosis in 49(24.5%), portal venous thrombosis in 44(22%), para esophageal varices in 39(19.5%), and splenic varices in 103 (51.5%), Periportal fibrosis in 64(32%) and Hepatocellular carcinoma (HCC)26(13%).

There were 105 true positives had both endoscopy and CT signs of esophageal varices, 2 false positive on CT scan, 90 true negatives on both modalities, and 3 false negative cases which had positive signs on endoscopy only with endoscopy taken as a gold standard for the diagnosis of esophageal varices. (Table 1).

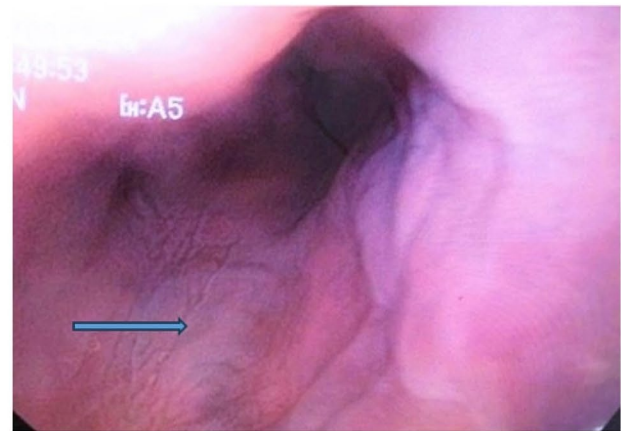
Based on these findings, triphasic abdominal CT has a sensitivity of 97.2%, specificity of 97.8%, PPV of 98.1%, and NPV of 96.8% in the detection of esophageal varices. The overall diagnostic accuracy of triphasic abdominal CT in detecting esophageal varices was 97.5%.

Table 1 Cross tabulation of triphasic abdominal CT in detecting esophageal varices using OGD as a gold standard. (N=200)

Triphasic Abdominal CT findings	Oesophagoduodenoscopy (OGD) findings		Total
	Esophageal varices(+ve)	Esophageal varices (-ve)	
Esophageal varices (+ve)	105	2	107(53.5%)
Esophageal varices(-ve)	3	90	93(46.5%)
Total	108(54%)	92(46%)	200

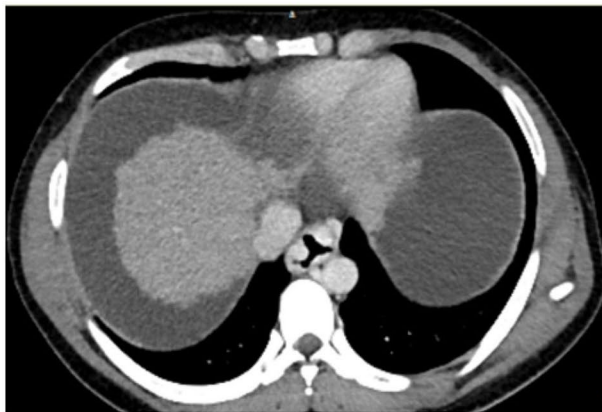


A



B

Case 1; Esophageal varices were seen on axial post-contrast CT scan in the portal venous phase (arrow in image A) as an enhancing dot-like submucosal structure and on endoscopy as tortuous linear intraluminal structures (arrows in image B).



A



B

Case 2: Triphasic abdominal CT images axial(A) and coronal reformatted(B) planes, portal venous phase, showing esophageal varices, ascites, and liver cirrhosis.

Discussions

Our study demonstrated that triphasic abdominal CT has a high diagnostic accuracy in detecting esophageal varices. These findings are in line with a study conducted at Kot Khawaja Saeed Teaching Hospital, Lahore in Pakistan, which reported similar findings with high sensitivity (98.4%), specificity (97.6%), and accuracy (98.1%) [6]. The similarity in sampling technique and imaging protocol could explain the observed performance. However, these findings were slightly lower than those reported at Aga Khan University Hospital, in Pakistan and Egypt and in Pakistan where abdominal CT has an accuracy of range of 99% to 100% [5, 17, 19]. The variations observed could be clarified by the inclusion of exclusively cirrhotic patients in the studies mentioned, alongside the utilization of CT

esophagography in the Egyptian study, which is a highly effective protocol for detecting esophageal varices.

Also, our study findings were higher than those reported in the United States, Iran, and China where the sensitivity, specificity and diagnostic accuracy ranged from 63.49 to 90%; 50–72.58% and 72.58 and 83.5% respectively [13, 24, 25]. The observed differences could be attributed to the small sample sizes and the exclusive inclusion of cirrhotic patients in the abovementioned studies.

The challenges in diagnosing esophageal varices in low-income countries are multifaceted. The limited availability of endoscopic services poses a significant challenge in the timely diagnosis and management of esophageal varices. Additionally, the high costs and the need for

specialized training to operate and maintain endoscopic equipment further exacerbate this issue. As a result, many patients in low-income countries do not have access to adequate diagnostic services, leading to delays in diagnosis and treatment. This often results in poorer outcomes for patients, as timely intervention is crucial in managing esophageal varices and preventing complications such as bleeding. Triphasic abdominal CT offers a non-invasive, widely accessible alternative that can help bridge this gap and improve patient outcomes. In Tanzania and similar settings, enhancing the availability and utilization of triphasic abdominal CT for esophageal varices diagnosis could significantly improve patient care.

The high sensitivity and specificity of triphasic abdominal CT make it a valuable diagnostic tool, especially in resource-limited settings where OGD may not be readily available. However, the possibility of false-positive and false-negative results necessitates a cautious interpretation of CT findings. In our study, the false positive and false negative cases observed could be attributed to the inherent limitations of imaging techniques and interpretation variability. For instance, small varices or those in atypical locations might be missed on CT, while CT might overcall varices due to overlapping structures or artifacts.

The prevalence of esophageal varices in our study cohort was 54%, which led to a high positive predictive value (PPV) and a low negative predictive value (NPV). This prevalence is lower compared to other studies conducted in Pakistan, which could be explained by differences in the sample population, as those studies included only patients with chronic liver disease [6, 17, 18]. This comparison supports the reliability of our PPV and NPV calculations.

Our study also identified portosystemic collaterals, liver cirrhosis, periportal fibrosis, and hepatocellular carcinoma, consistent with other studies [5, 6, 26]. Triphasic abdominal CT, unlike OGD, detects these extra-esophageal abnormalities, highlighting its additional benefit, especially in chronic liver disease which helps guide treatment and projecting the prognosis in the managed patients.

Our study has a limitation. It was a retrospective design of the study hence selection bias. A single-center study at a tertiary hospital. This limits its generalizability.

Conclusions

Triphasic abdominal Computed Tomography demonstrated high diagnostic accuracy in detecting esophageal varices, with a sensitivity of 97.2%, specificity of 97.8%, PPV of 98.1%, NPV of 96.8%, and an overall accuracy of 97.5%. These findings suggest that triphasic abdominal CT can be a reliable and non-invasive alternative for

diagnosing and screening esophageal varices in resource-limited settings.

Abbreviations

CT	Computed Tomography
OGD	Oesophagoduodenoscopy
MNH	Muhimbili National Hospital
PPV	Positive predictive value
NPV	Negative predictive value
UGIB	Upper gastrointestinal bleeding
HCC	Hepatocellular carcinoma

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Author contributions

SL: Designed the study, acquired and analyzed the data, interpreted the data and did manuscript drafting; BM: assisted in designing the study, data interpretation, and critically reviewed the manuscript for its intellectual content; GM & LS: assisted in acquiring the data and critically reviewed the manuscript for its intellectual content; AJ: assisted with data analysis, and critically reviewed the manuscript for its intellectual content. All Authors read and approved the final Manuscript.

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Data availability

Dataset used in this analysis are available from the corresponding author on a reasonable request.

Declarations

Ethics approval and consent to participate

The research proposal underwent a comprehensive review and obtained ethical approval from the MUHAS Institutional Review Board (MUHAS-REC-04-2023-1617). Due to the retrospective design of the study, a waiver for informed consent was requested. Permission to collect data was also obtained from the director-general of MNH. The confidentiality of all information and data was strictly upheld throughout the study. Patient identities were not collected or utilized, and no identifying information was included in the data analysis. Furthermore, access to the data was restricted to the investigators alone.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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