Department of Radiology, College of Health Sciences,

Addis Ababa University

Research

Title: Assessment of diagnostic accuracy of preoperative CT staging of oesophageal cancer in patients undergoing surgery with surgical and histopathology correlation at TASH, TASH affiliated hospitals

Study Design: Cros-sectional Retrospective Study

Location: Addis Ababa, Ethiopia.

By: Hanna Damtew, MD

(Cardiothoracic imaging fellow)

A research to be Submitted to Tikur Anbessa Specialized Hospital Department of Radiology in Partial Fulfillment of the Requirements for the Fellowship Program in Cardiothoracic Radiology

Title: Assessment of the Diagnostic Accuracy of Preoperative CT Staging of Esophageal Cancer in Patients Undergoing Surgery: A Correlation with Surgical and Histopathological Findings at TASH and TASH-Affiliated Hospitals

Study Design: Cross-sectional Retrospective

Study Location: Addis Ababa, Ethiopia

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Full title of the project	Assessment of the Diagnostic Accuracy of Preoperative CT Staging of Esophageal Cancer in Patients Undergoing Surgery with Surgical and Histopathological Correlation at TASH and TASH-Affiliated Hospitals: A Cross-sectional Retrospective Study, Addis Ababa, Ethiopia
Duration of the project	1 year
Study area	Tikur Anbessa Specialized Hospital (TASH) and TASH-affiliated hospital
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AKNOWLEDGMENT

My appreciation goes to AAU, College of health science for sponsoring this research and Department of Radiology for facilitating and providing resources of study.
I would like to pass my gratitude to the TASH affiliated hospital (St peter and Menelik II referral hospital) staffs and record room workers for their kind response and help
I would like to thank all my advisors Dr Azmera Gissela, Dr Amir Alwan and Dr Yimaj Abdulwahab for their support and continuous follow up throughout the research period.
I would also like to thank my friends and colleagues for their moral support and advises.
Finally, thanks to all my families who were besides me all the way here.

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Acronyms

•AAU: Addis Ababa University
•CT/MRI: Computed Tomography/Magnetic Resonance Imaging
•T staging: Tumor staging
•N staging: Nodal staging
•M staging: Metastatic staging
•PET: Positron Emission Tomography
•pT: Pathologic tumor staging
•pN: Pathologic nodal staging
•pM: Pathologic metastatic staging
•TASH: Tikur Anbessa Specialized Hospital
•MDT: Multidisciplinary Team

Definitions

•Correctly staged: Both preoperative CT T, N, or both staging confirmed by histopathology or surgical staging.
•Under staged: Preoperative CT T and/or N staging were lower than the actual pathologic or surgical staging.
•Over staged: Preoperative CT T and/or N staging were higher than the actual pathologic or surgical staging.
•TNM staging is defined based on the AJCC TNM staging for esophageal cancer, 8th edition.
•Upper Cervical esophagus to lower border of azygos vein
• Middle Lower border of azygos vein to lower border of inferior pulmonary vein
•Lower border of inferior pulmonary vein to stomach, including esophagogastric junction
•Cancers that affect the EGJ and have their epicentre within 2 cm of the gastric cardia are staged as oesophageal cancers
•Operable oesophageal cancer includes stage T4a and below.
•Inoperable/advanced oesophageal cancer includes stage T4b.

Abstract

Background: Esophageal cancer is a malignancy of the esophagus that arises from neoplastic changes in the epithelial lining. Computed tomography (CT) is recommended as an initial imaging modality, primarily to evaluate respectability and detect distant metastasis as well us guides treatment options.

The purpose of the study is to assess diagnostic Accuracy of Preoperative CT Staging of Esophageal Cancer in Patients Undergoing Surgery:

Material and methods after ethical clearance hospital based prospective cross-sectional study were conducted on CT scan reports of 121 patients who undergoes surgery. Diagnostic accuracy measured by comparing with histopathological staging.

Result - Accuracy, sensitivity, and specificity of CT for T3 and T4 diseases are 50%, 65%, 28% and 67.8 %, 50%, 69.4% respectively.. Diagnostic Accuracy, sensitivity, and specificity of CT for the presence of nodal ds is 62% ,59% and 63% respectively The sensitivity of CT for detecting tumor-free nodes was high (84.3%)

Conclusion: Preoperative CT has a high positive predictive value for correctly identifying truly operable stages. High sensitivity for correct identification of tumor free nodes. Low diagnostic accuracy in correct prediction of T3 and T2 stages. Low diagnostic accuracy in identification of tumor positive nodes. Only 23.1.0% of patients had correct preoperative T and N staging assessment.

1. Introduction

1.1. Background

Oesophageal cancer is a leading cause of cancer-related morbidity and mortality worldwide, with an estimated an estimated 511,054 people were diagnosed with oesophageal cancer globally, and 445,391 died from the disease in 2022 [1]. It is the fifth most common cause of cancer-related deaths in men and the eighth leading cause in women [2]. In Ethiopia, oesophageal cancer is a significant public health concern, with a crude incidence rate of 2.4 per 100,000 people annually, particularly affecting rural populations in the southern and eastern regions [3]. The two most common histological types are squamous cell carcinoma (SCC) and adenocarcinoma, accounting for over 90% of cases [4]. Accurate preoperative staging is critical for determining the appropriate treatment strategy, assessing resectability, and predicting prognosis [5].

CT scan is widely used as the initial imaging modality for preoperative staging of oesophageal cancer due to its ability to evaluate tumour size, local invasion, lymph node involvement, and distant metastasis [6]. However, the diagnostic accuracy of CT varies depending on the tumour stage and the experience of the radiologist. While CT is effective in assessing advanced disease, its accuracy in distinguishing early T stages (T1, T2, and T3) and detecting nodal involvement remains suboptimal [7]. Endoscopic ultrasound (EUS) and positron emission tomography (PET) are often used as complementary imaging modalities to improve staging accuracy, but their availability is limited in resource-constrained settings like Ethiopia [8].

1.2. Statement of the Problem

In Ethiopia, oesophageal cancer patients often present at advanced stages due to limited access to early diagnostic tools and specialized care [9]. Preoperative staging is primarily reliant on CT imaging, but its diagnostic accuracy in this population has not been thoroughly evaluated. Studies from other regions have shown that CT can under stage or over stage oesophageal cancer, leading to inappropriate treatment decisions [10]. For instance, CT's inability to differentiate between inflammatory and malignant lymph nodes often results in over staging, while its limited resolution for detecting micro metastases can lead to under staging [11]. These inaccuracies can significantly impact patient outcomes, particularly in settings where advanced imaging modalities like EUS and PET are not readily available.

At Tikur Anbessa Specialized Hospital (TASH) and its affiliated hospitals, CT is the primary imaging modality for preoperative staging of oesophageal cancer. However, there is a lack of local data on the diagnostic accuracy of CT staging compared to surgical and histopathological findings. This gap in knowledge hinders the optimization of treatment strategies and limits the ability to provide evidence-based recommendations for improving

patient care. Therefore, there is an urgent need to assess the diagnostic accuracy of preoperative CT staging in this setting to guide clinical decision-making and improve patient outcomes.

1.3. Rationale of the Study

The rationale for this study stems from the critical role of accurate preoperative staging in the management of oesophageal cancer. Accurate staging is essential for determining resectability, planning surgical interventions, and selecting appropriate neoadjuvant or adjuvant therapies [5]. In resource-limited settings like Ethiopia, where advanced imaging modalities are scarce, CT remains the cornerstone of preoperative staging. However, its limitations in early T staging, nodal involvement, and distant metastasis detection necessitate a thorough evaluation of its diagnostic accuracy in this context [7].

This study aims to address the gap in local data by assessing the diagnostic accuracy of preoperative CT staging of oesophageal cancer at TASH and its affiliated hospitals, with correlation to surgical and histopathological findings. The findings of this study will provide valuable insights into the strengths and limitations of CT in this setting, guiding clinicians in optimizing treatment strategies. Additionally, the study will contribute to the global body of knowledge on oesophageal cancer staging, particularly in low-resource settings, and may inform future research on the integration of complementary imaging modalities to improve diagnostic accuracy [8]. Ultimately, this study seeks to improve patient outcomes by ensuring that preoperative staging is as accurate and reliable as possible.

2. Literature Review

Oesophageal cancer remains a significant global health burden, with a high mortality rate and varying incidence across different regions. Accurate preoperative staging is crucial for determining the appropriate treatment strategy and assessing resectability [1]. Computed tomography (CT) is widely used as an initial imaging modality for staging oesophageal cancer, but its diagnostic accuracy varies depending on the tumor characteristics and the experience of the radiologist [2]. This literature review explores the role of CT in preoperative staging of oesophageal cancer, its correlation with surgical and histopathological findings, and its limitations.

CT is a cornerstone in the preoperative evaluation of oesophageal cancer, primarily used to assess tumor size, local invasion, lymph node involvement, and distant metastasis [3]. According to Kim et al., CT is particularly useful for evaluating the preservation of fat planes between the oesophageal tumor and adjacent structures, which helps differentiate between operable and non-operable cases [1]. However, CT has limitations in distinguishing between early T stages (T1, T2, and T3), where endoscopic ultrasound (EUS) is considered more accurate [1]. This limitation is particularly significant because early-stage tumor often require different treatment approaches compared to advanced-stage tumor [4].

Several studies have evaluated the diagnostic accuracy of CT in oesophageal cancer staging. Sultan et al. reported that Accuracy, sensitivity, and specificity of CT for T2 and T3 are 66%, 61%, 68% and 63%, 67%, 56% respectively. Accuracy, sensitivity and specificity of CT for presence of nodal disease are 65%, 59% and 75% [3]. CT had a sensitivity of 85% and specificity of 80% for detecting T4 tumor, but its accuracy decreased for early-stage tumor [5]. Similarly, Onbaş et al. found that CT had a diagnostic accuracy of 78% for T staging and 72% for N staging, highlighting its limitations in detecting nodal involvement [6]. These findings suggest that while CT is valuable for assessing advanced disease, its accuracy for early-stage tumor and nodal staging remains suboptimal [5, 6].

The correlation between preoperative CT staging and surgical/histopathological findings is critical for validating imaging accuracy. Imaz et al. conducted a study comparing CT staging with postoperative histopathology and found that CT correctly staged 65% of cases, under staged 20%, and over staged 15% [7]. This demonstrates the need for complementary imaging modalities, such as EUS and positron emission tomography (PET), to improve staging accuracy [7]. Pongpornsup et al. also emphasized that CT's ability to detect mediastinal invasion was limited, with a diagnostic accuracy of 70%, further highlighting the importance of multimodal imaging approaches [8].

Despite its widespread use, CT has several limitations in oesophageal cancer staging. Ali et al. noted that CT's inability to differentiate between inflammatory and malignant lymph nodes often leads to over staging [9]. Additionally, Rice et al. highlighted that CT's resolution is insufficient for detecting micro metastases, which can significantly impact treatment planning [2]. Cheng et al. also reported that CT's accuracy in detecting distant metastases was lower than that of PET, particularly for small lesions [11]. These limitations highlight the need for integrating CT with other imaging modalities to improve diagnostic accuracy [10, 11].

In conclusion, CT plays a vital role in the preoperative staging of oesophageal cancer, particularly for assessing advanced disease and resectability [1, 3]. However, its limitations in early T staging, nodal involvement, and distant metastasis detection necessitate the use of complementary imaging modalities [5, 6, 7]. Future studies should focus on integrating CT with EUS and PET to improve diagnostic accuracy and optimize treatment strategies [7, 10].

3. Objectives

3.1. General Objective

- To evaluate the diagnostic accuracy of preoperative CT staging of esophageal cancer in patients undergoing surgery, with correlation to surgical and histopathological findings.

3.2. Specific Objectives

- To determine the accuracy of preoperative CT staging in patients with esophageal cancer undergoing surgical intervention.
- To evaluate the intra and post operative finding of esophageal cancer in patients undergoing surgery.
- To assess the histopathologic staging of esophageal cancer in patients who have undergone esophagectomy.

4. Methods and Materials

4.1. Study Setting

The study is conducted at Tikur Anbessa Specialized Hospital (TASH) and its affiliated hospitals in Addis Ababa, Ethiopia. Tikur Anbessa Specialized Hospital (TASH) is Established in 1974, is the largest tertiary hospital in the country and is administered by Addis Ababa University. It serves as the oldest and largest teaching hospital in Ethiopia, providing training for approximately 300 medical students and 350 residents annually. TASH diagnoses and treats around 500,000 patients each year.

The radiology department at TASH provides a wide range of imaging services, including approximately 840 chest imaging studies per month. The cardiothoracic imaging unit is staffed by three senior cardiothoracic radiologists and two cardiothoracic radiology fellows, who actively provide services. Additionally, the unit holds multidisciplinary team (MDT) meetings every other week, involving oncologists, cardiothoracic surgeons, and radiologists and a joint discussion with the cardiothoracic surgeons every week . During these meetings, a minimum of three oesophageal cancer cases are discussed per session.

TASH's affiliated hospitals, such as St. Peter Referral Hospital and Menelik II Hospital, also contribute to the study by expanding the scope of patient data and providing additional training opportunities for residents and fellows.

4.2. Study Population

The source population were all patients with confirmed oesophageal cancer through endoscopic biopsy who underwent preoperative CT imaging for staging and surgery at TASH and its affiliated hospitals between January 2021 and December 31, 2024.

4.3. Study Design and Study Period

This study was employed at a hospital-based, retrospective, cross-sectional design. It was conducted at TASH and its affiliated hospitals, covering the period from January 2021 to December 31, 2024. Patients with confirmed oesophageal cancer through endoscopic biopsy and preoperative CT imaging for staging are included. The CT scan imaging reports at initial diagnosis will be collected and analysed for its completeness with TNM staging then post-surgical pathologic results collected from patients data and hospital PACS system . Additionally patients status regarding post-surgical recurrence are also assessed and their current status whether they are active in follow up or has lost has been checked as well

4.4. Sample Size Determination

A non-probability sampling technique used. All patients with oesophageal cancer who underwent preoperative CT staging and surgery at TASH and its affiliated hospitals and who had post operative histopathologic result during the specified study period (January 2021 to December 31, 2024) enrolled in the study.

4.5. Sampling Technique

Study participants are selected using a convenience sampling method to achieve the maximum attainable sample size. Data collection commenced immediately after the approval of this proposal.

4.6. Inclusion and Exclusion Criteria

Inclusion Criteria

- All patients with esophageal cancer who underwent preoperative CT staging and subsequent surgery (including intraoperative staging).
- Patients who had preoperative chest CT staging performed at TASH or facilities outside TASH but underwent surgery at TASH or its affiliated hospitals.
- For patients with multiple preoperative CT staging studies, the most recent preoperative CT staging will be used.

Exclusion Criteria

- Patients with esophageal cancer who lack preoperative CT staging reports or whose CT images were not evaluated by a radiologist.
- Patients who did not undergo surgery.
- Patients with distant metastases who did undergo neoadjuvant treatment.
- Patients with undocumented post operative histopathologic staging

4.7. Study Variables

Independent Variables

- Age and sex of the patient.
- Types of surgery performed
- Tumor location and size of the mass within the esophagus.
- Smoking history.
- History of alcohol consumption.

Dependent Variables

- Preoperative CT imaging with TNM stage .
- Endoscopic biopsy results.
- Postoperative histopathology result
- Pathologic TNM staging (pT, pN, pM) based on histopathology.

4.8. Data Collection Strategy

Patient medical records accessed using patient identification numbers through the hospital's Med Web system and patient's hospital card. CT scan images of patients with endoscopically proven oesophageal cancer will be identified and evaluated. Key data, including the site of the lesion, endoscopic biopsy, preoperative and post operative TNM staging, type of surgery performed, and postoperative histopathologic results, recorded in an Excel spreadsheet for further analysis.

4.9 Data Management

The primary investigator has ensured data cleanliness and completeness. The collected data are prepared for analysis, and backup copies are stored on a separate secure drive to prevent data loss.

4.10. Data Quality Assurance

To ensure the accuracy and reliability of the data, the primary investigator conducted regular and periodic supervision during the data collection process. This includes checking for completeness, consistency, and quality of the data.

4.11. Data Analysis

The collected data are coded, cleaned, and thoroughly examined for completeness. It then entered into the Statistical Package for Social Sciences (SPSS) version 27 software for analysis. Descriptive statistics, including frequency distributions, percentages, means, and standard deviations, are used to characterize the variables. The analysed data are presented using tables, graphs, and figures as appropriate.

4.12. Ethical Considerations

Ethical clearance for this study has obtained from the Radiology Department's Research and Publications Committee of the School of Medicine, College of Health Sciences, and Addis Ababa University. Confidentiality of patient information has strictly maintained throughout data collection, analysis, and dissemination of results.

4.14. Conflicts of Interest

The primary investigator declares that there are no conflicts of interest related to this study.

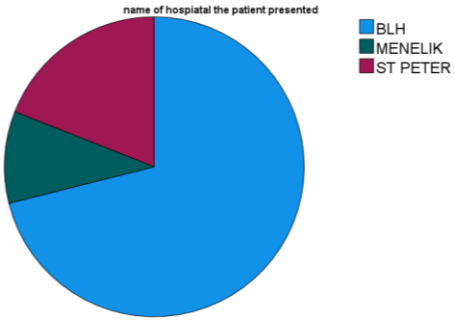
4.15. Dissemination of Findings

The findings of this study have been presented to the Department of Radiology at TASH. A formal report submitted in both soft and hard copies. Additionally, the research output are published in local or international peer-reviewed scientific journals to contribute to the broader body of knowledge on oesophageal cancer staging.

5. Result

Total of 121 patients has full filled the inclusion criteria among that a total of 86 patients were from TASH , 12 patents were from Menelik II referral hospital and 23 patients were from ST peter hospital (figure 1).

69 (57.02%) were female and 52 (42.98%) were male (figure 2)



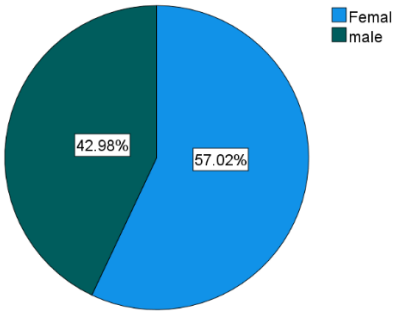


Figure 1 patient hospital distribution

Figure 2 patients gender distribution

Majority of patients come from Oromia region (55%) followed by Addis Ababa (42%) and Amhara (9%) (figure 3)

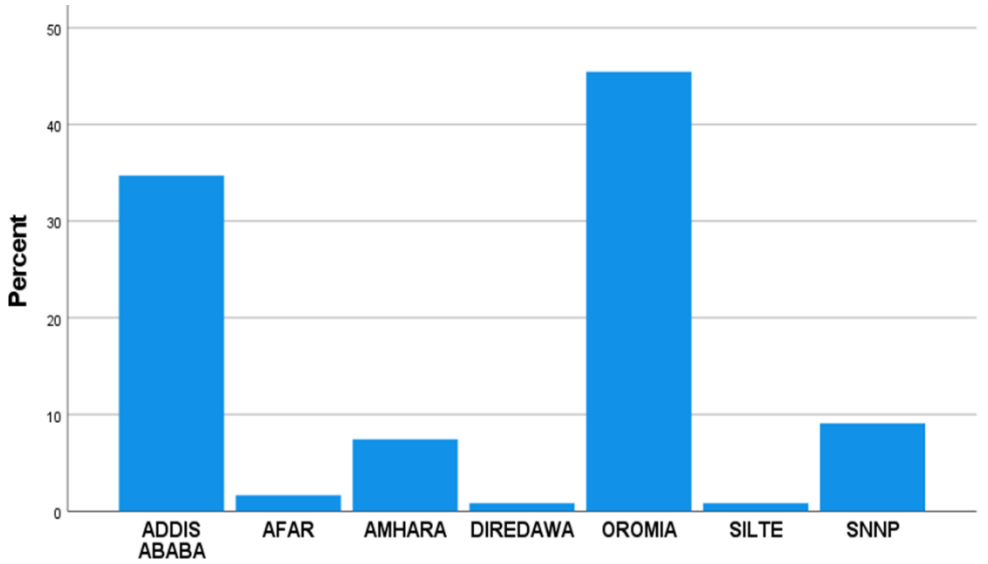


Figure 3 Regional distribution

Patients of age group ranges between 16 to 91 years were included in the study with Median age at presentation is 54 .15 yr

All patients had dysphagia at presentation, followed by vomiting, weight loss and vomiting as a frequent presentation.

Among 121 patients only 3 patients (2.5 %) admitted having past history of alcohol intake and 4 (3.3%) patients admitted having past history of smoking

Time gap between Preoperative CT scan imaging date and surgery date was 27.3 ± 11.1 days.

Regarding post-surgical histopathologic result 102 (84.3 %) had confirmed SCC and 19 (15.7%) had Adeno carcinoma (figure 4)

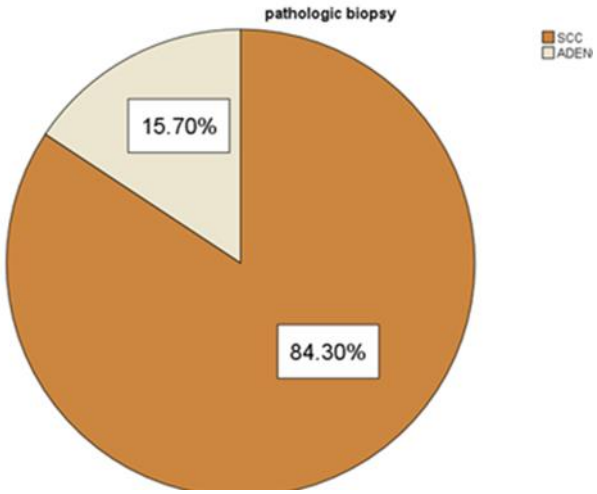


Figure 4 Histopathologic distribution

Concerning about the location of the mass at presentation from endoscopic biopsy with histologic grading and differentiation 76 (82.8 %) patients had mid oesophageal ca while 23 (19%) patients had GEJ oesophageal ca and 22(18.2%) patents has mid oesophageal ca (figure 5)

Among the patients presented with SCC majority 47.1 % had KSCC while 37.1% of patents had poorly differentiated or NKSCC. poorly differentiated or Grade 3 adenocarcinoma was the commonest (6.1%) histologic finding among the adenocarcinoma oesophageal ca (figure 6)

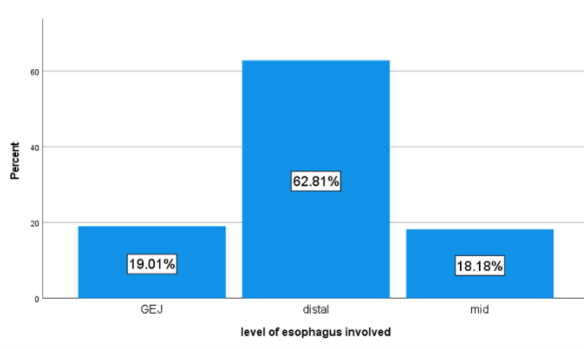


Figure 5 Frequency of tumor location

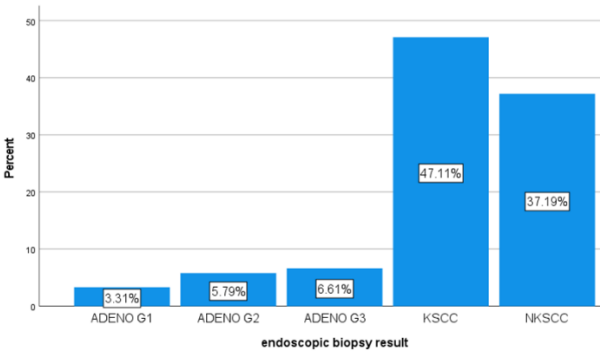


Figure 6 Frequency of histologic biopsy

Total of 47(38.8%) patients had an endoscopic evaluation of oesophageal ca locating 36- 40 cm from incisor and 38(31.4%) patients had 31-35 cm from the incisor mass (figure 7)

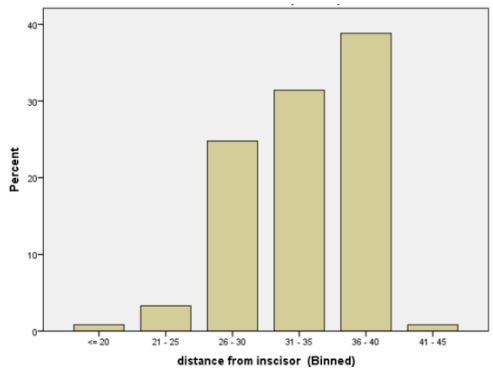
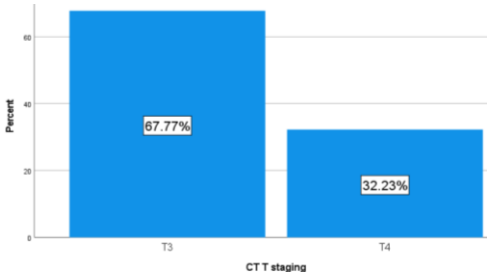


Figure 7 Endoscopic evaluation oesophageal mass location from incisor

Among 121 pts with confirmed oesophageal ca had a preoperative CT report of TNM staging -- 82 were of T3 (67.8%) and 39 (32.2%) were stage T4 diseases
Regarding nodal ds 94 (77.7%) patents had no nodal involvement (N0) at presentation and 15(12,4%) , 9(7.4%) and 3(2.5%) patients had N1,N2 and N3 diseases at presentation respectively. All patients had no record of distant metastasis (figure 8a and b)



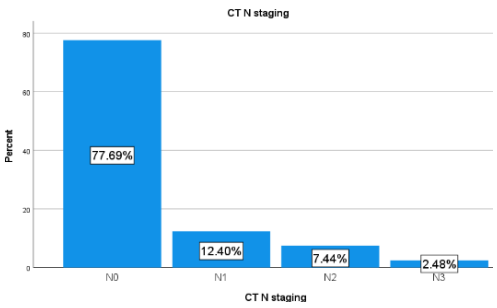


Figure 8 Distribution of preoperative oesophageal ca TNM CT staging for T(a) and N (b) diseases at presentation

Regarding about the size of the oesophageal mass total horizontal (rt to left) diameter of the mass ranges from 0.8 cm to 6 cm with mean diameter of 1.8 cm and total vertical (craniocaudal) diameter of the oesophageal mass ranges from 2 cm up to 9 cm with mean diameter of 5.5 cm . A total of 113 (93.4cm) patients had a total vertical length of >/= 3 cm

81 patients (66.9%) underwent trans hiatal esophagectomy (THE) type of surgery followed by McKeown esophagectomy in 22 (18.2)pts (figure 9)

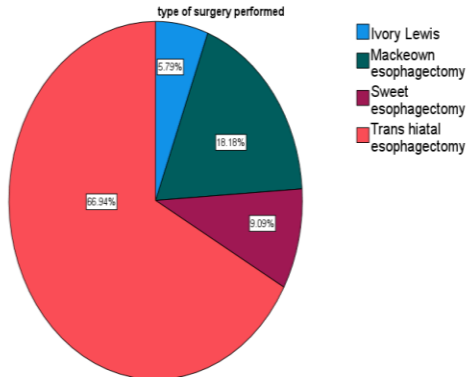


Figure 9 Types of surgery performed.

Post surgical histopathologic biopsy result showed 69 patents (57%) had stage PT3 diseases, 42 patients (34.7%) had stage PT2 diseases ,5 patients (4.1%) had stage PT4A diseases and other 5 (4.1%) had also stage PT4B diseases (figure 10 a)

Regarding pathologic N staging among 121 patent who underwent esophagectomy for confirmed oesophageal ca total of 70 patients (57.9%) had no nodal involvement (PN0) and 30 patients(24.8%) showed PN1 diseases ,18 patients (14.9 %) pts showed PN2 diseases and only 3 patients (2.5 %) had PN3 diseases (figure 10 b)

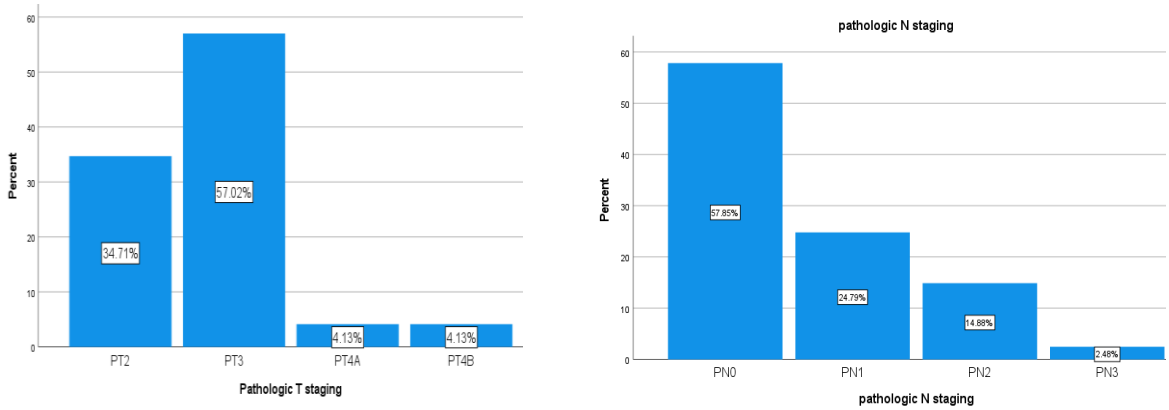


Figure 10 Distribution of postoperative CT pTNM staging for T (a) and N diseases (b)

Post surgical pathologic evaluation of the mass revealed that 76 (62.8%) patients had a free surgical margin in proximal , distal and radial margins while 45 patients (37.2%) exhibits positive radial margin (figure 11) .
Among 76 patients who confirmed to have a free surgical margin 21 of them underwent post-surgical chemotherapy and the rest 25 does not need the adjuvant treatment (figure 12)

Regarding current status of our patents included in the study , among 121 pts only 19 (15.7 %) patients has documented to have recurrence (figure 13)
Adjuvant chemotherapy after esophagectomy is given for 62 patients (51.2 %) and 28 (23.1%) patients don't need the adjuvant chemotherapy 31(25.6 %) pts have not documented whether they are given post-surgical chemotherapy or not.

Figure 11

		Frequency	Percent	Valid Percent
Valid	free surgical margins	76	62.8	62.8
	postive surgical margin	45	37.2	37.2
	Total	121	100.0	100.0

figure 12

surgical margin * post surgical chemo given Crosstabulation

Count

		post surgical chemo given			Total
		Given	Not Documented	Not Given	
surgical margin	free surgical margins	21	30	25	76
	postive surgical margin	41	1	3	45
Total		62	31	28	121

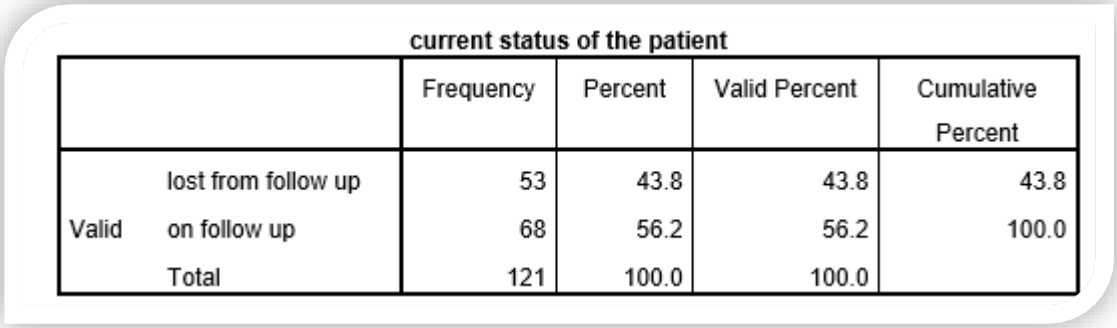
post surgical recurrence

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	suspicious recurrence	19	15.7	15.7	15.7
	not docu	102	84.3	84.3	100.0
	Total	121	100.0	100.0	

Figure 13

Among 121 patients included in the research 68 (56.2%) patients are still on strict follow up on their respective referral hospitals and 53 (43.8%) patients are lost from follow up(figure 14)

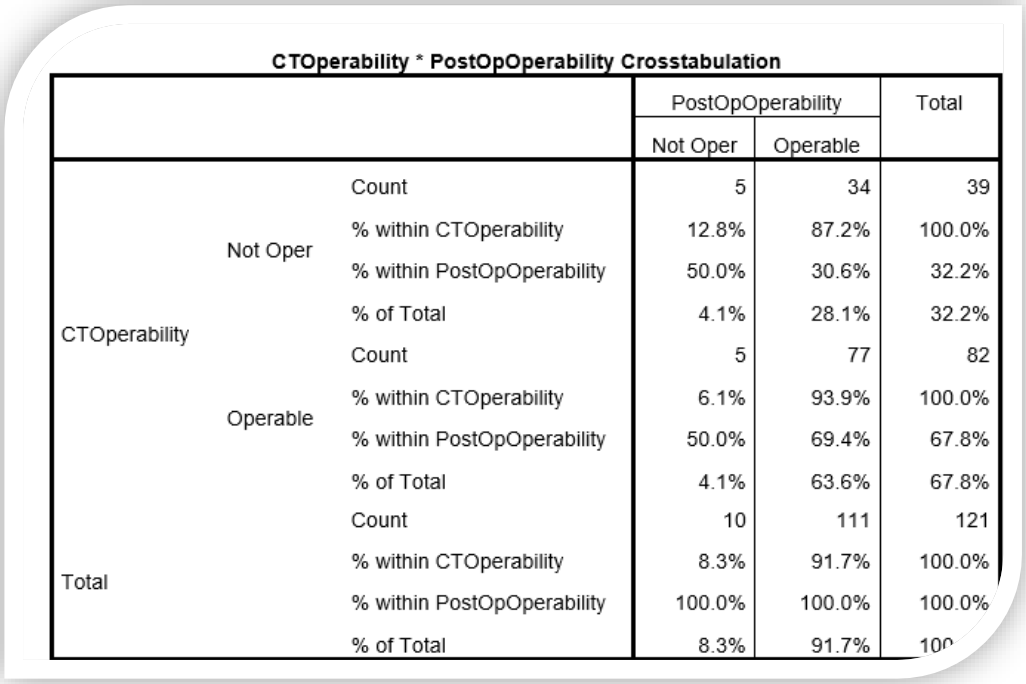
Figure 14



current status of the patient

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	lost from follow up	53	43.8	43.8	43.8
	on follow up	68	56.2	56.2	100.0
	Total	121	100.0	100.0	

Generally, among 121 patients who were confirmed as operable cases by pre operative CT TNM staging a total of 111 (93.9%) were actually operable and 10 (6.1%) inoperable/ post-surgical --of which 5 was staged as T4 and 5 was staged as T3 on preop CT staging .which suggests preop CT staging has 93.9 % PPV in detecting operability with 69.3 % and 50% sensitivity and specificity respectively (figure 16)



CTOperability * PostOpOperability Crosstabulation

			PostOpOperability		Total
			Not Oper	Operable	
CTOperability	Not Oper	Count	5	34	39
		% within CTOperability	12.8%	87.2%	100.0%
		% within PostOpOperability	50.0%	30.6%	32.2%
		% of Total	4.1%	28.1%	32.2%
	Operable	Count	5	77	82
		% within CTOperability	6.1%	93.9%	100.0%
		% within PostOpOperability	50.0%	69.4%	67.8%
		% of Total	4.1%	63.6%	67.8%
Total		Count	10	111	121
		% within CTOperability	8.3%	91.7%	100.0%
		% within PostOpOperability	100.0%	100.0%	100.0%
		% of Total	8.3%	91.7%	100

Figure 16

Comparing pre op T staging and post-surgical pathologic T staging a total of 66 pts (54.5%) are Over staged, 50 pts (41.3 %) correctly staged and 5 pts (4.1%) under staged (Figure 17)

Regarding T3 Staging ----From preoperative CT staging of T3 oesophageal ca diseases 32 (26.4%) patients had a PT2 stage and 5 (4.1%) patients had PT4 stage. Only 45 (37.2%) patients have correctly staged T3 diseases which indicates that Diagnostic accuracy of preoperative CT staging for T3 diseases is 50% with Sensitivity of 65.2%
And Specificity= 28.8% (PPV = 54.9% and NPV =38.5%) (figure 18)

Regarding T4 staging -- From preoperative CT staging of T4 oesophageal ca diseases 10 (8.3%) patients was found to have PT2 diseases and 24 (19.8 %) patients had PT3 diseases on post-surgical biopsy. Only 5 patients had correctly staged preoperative T4, which reveals Diagnostic accuracy of pre operative CT staging for T4 oesophageal diseases is =67.8% with Sensitivity=50%and Specificity=69.4% (PPV =12.8% and NPV =93.9%) (figure 19)

	FREQUENCY	PERCENT
T3--PT2	32	26.4
T3--PT3	45	37.2
T3--PT4	5	4.1
T4--PT2	10	8.3
T4--PT3	24	19.8
T4—TP4	5	4.1
TOTAL	121	100

figure 17 frequency distribution for T staging

			Pathologic Staging T3		
			Negative	Positive	
CT Staging T3	Negative	Count	15	24	39
		% within CT Staging T3	38.5%	61.5%	100.0 %
		% within Pathologic Staging T3	28.8%	34.8%	32.2%
	Positive	Count	37	45	82
		% within CT Staging T3	45.1%	54.9%	100.0 %
		% within Pathologic Staging T3	71.2%	65.2%	67.8%
Total		Count	52	69	121
		% within CT Staging T3	43.0%	57.0%	100.0 %
		% within Pathologic Staging T3	100.0%	100.0%	100.0 %

Figure 18 CT Staging T3 VS Pathologic Staging T3 correlation

figure 19 CT Staging T4 VS Pathologic Staging T4 correlation

			Pathologic Staging T4		
			Negative	Positive	
CT Staging T4	Negative	Count	77	5	82
		% within CT Staging T4	93.9%	6.1%	100.0%
		% within Pathologic Staging T4	69.4%	50.0%	67.8%
	Positive	Count	34	5	39
		% within CT Staging T4	87.2%	12.8%	100.0%
		% within Pathologic Staging T4	30.6%	50.0%	32.2%
Total		Count	111	10	121
		% within CT Staging T4	91.7%	8.3%	100.0%
		% within Pathologic Staging T4	100.0%	100.0%	100.0%

Comparing pre operative CT Staging and Pathologic N staging total of 17 pts (14%) are over staged ,66 pts (54.5%) correctly staged and 38 pts (31.4 %) under staged (figure 20 a)

A total of 59 (48.7%) has correctly staged as a tumor free node, 6 (4.9%) patients has correctly staged N1 oesophageal ca ds, only 1 patient had correctly staged N2 diseases and none of the patients had a correct preoperative prediction for N3 diseases

Which indicates that sensitivity and specificity of preoperative CT staging for
NO ds is Sensitivity= 84.3 %, Specificity= 31.4% and for
N1 disease Specificity= 20%and Sensitivity= 90 %
N2 disease Specificity= 5.6 % and Sensitivity=92.2% (figure 21)
In general CT has Diagnostic Accuracy, sensitivity, and specificity of CT for the presence of nodal ds is 62% ,59% and 63% respectively (figure 20 B)

Figure 20 A and B CT Staging N ds VS Pathologic N Staging correlation

CT Node Positivity * Post Op Node Positivity Crosstabulation					
			Post Op Node Positivity		Total
			No	Yes	
CT Node Positivity	No	Count	59	35	94
		% within CT Node Positivity	62.7 %	37.3 %	100.0 %
	Yes	Count	11	16	27
		% within Post Op Node Positivity	38.2 %	61.8 %	100.0 %
Total		Count	94	27	121
		% within CT Node Positivity	100 %	100 %	100.0 %

PreVs PostOp CT N Stages	Number	Percentages
N0--N0	59	48.76%
N0--N1	19	15.7%
N0--N2	13	10.74%
N0--N3	3	2.48%
N1--N0	6	4.96%
N1--N1	6	4.96%
N1--N2	3	2.48%
N1--N3	0	0%
N2--N0	4	3.3%
N2--N1	4	3.3%
N2--N2	1	0.83%
N2--N3	0	0%
N3--N0	1	0.83%
N3--N1	1	0.83%
N3--N2	1	0.83%
N3--N3	0	0%
Total	121	100%

Figure 21 CT N staging and pathologic N staging Crosstabulation

			pathologic N staging			
			N0	N1	N2	N3
CT N staging	N0	Count	59	19	13	3
		% within CT N staging	62.8%	20.2%	13.8%	3.2%
		% within pathologic N staging	84.3%	63.3%	72.2%	100.0%
	N1	Count	6	6	3	0
		% within CT N staging	40.0%	40.0%	20.0%	0.0%
		% within pathologic N staging	8.6%	20.0%	16.7%	0.0%
	N2	Count	4	4	1	0
		% within CT N staging	44.4%	44.4%	11.1%	0.0%
		% within pathologic N staging	5.7%	13.3%	5.6%	0.0%
		% of Total	3.3%	3.3%	0.8%	0.0%
	N3	Count	1	1	1	0
		% within CT N staging	33.3%	33.3%	33.3%	0.0%
		% within pathologic N staging	1.4%	3.3%	5.6%	0.0%
Total		Count	70	30	18	3
		% within CT N staging	57.9%	24.8%	14.9%	2.5%
		% within pathologic N staging	100.0%	100.0%	100.0%	100.0%

Total of 28 (23.1 %) patents among 121 patients has correct T and N staging preoperatively with combined T and N staging sensitivity of 42.4% and specificity of 46.5 % (figure 22)

			N_Correctlystaged		Total
			No	Yes	
T_Correctly Staged	No	Count	33	38	71
		% within T_CorrectlyStaged	46.5%	53.5%	100.0%
		% within N_Correctlystaged	60.0%	57.6%	58.7%
	Yes	Count	22	28	50
		% within T_CorrectlyStaged	44.0%	56.0%	100.0%
		% within N_Correctlystaged	40.0%	42.4%	41.3%
		% within N_Correctlystaged	100.0%	100.0%	100.0%

Figure 22 T_CorrectlyStaged N and Correctly staged T Crosstabulation

Generally, our research showed preoperative CT scan TNM staging had 82.6 % specificity and 19.98% sensitivity for T staging and 59 % sensitivity and 63 % specificity for N staging

The research has also showed there was correlation between patients T correctly stage and N over staged with P value of 0.008 and there was also significant correlation of T over staged, and N over staged with P value of 0.003

No correlation of risk factors like smoking or alcohol intake with diagnostic accuracy of T and N staging

No correlation has detected between diagnostic accuracy of T and N staging with the age and gender distribution

No correlation between diagnostic accuracy with level oesophagus involvement detected.

6 Discussion

Accurate preoperative staging of oesophageal cancer is essential for determining optimal treatment strategies. Our study assessed the diagnostic accuracy of preoperative CT TNM staging in predicting operability, diagnostic accuracy in T and N staging and compared it with post-surgical histopathologic findings

Our study had a total of 69 (57.02%) female and 52 (42.98%) male with Median age at presentation being 54 .15 yr. with range of 16-88 yrs. which aligns with previous research done at TASH regarding the gender and age distribution [9] which can be explained by the similar set up of the research. Other study in Switzerland on 51 patients (38 male, 13 female patients) showed median age 65 years [5] The discrepant age at presentation between the westerns and our country can be explained by consumption of hot porridge for long time which significantly associated with having oesophageal cancer s possibly due to the thermal effect, which could lead to dysplasia and later cancer [15]

Regarding T staging our study showed 66 pts (55.4%) are Over staged ,50 pts (41.3 %) correctly staged and 5 pts (4.1%) under staged and 82 were of T3 (67.8%) and 39 (32.2%) were stage T4 diseases. The results demonstrated a tendency for CT to over-stage T3 tumor while exhibiting moderate diagnostic accuracy for T4 tumor.

Diagnostic accuracy Sensitivity And Specificity of preoperative CT staging for T3 diseases is 50%, 65.2% and 28.8% respectively in our study .These findings align with previous studies that have highlighted the limitations of CT in differentiating tumor invasion depth by stating Accuracy, sensitivity and specificity of CT for T3 are 63%, 67% and 56% [1,3].

The over-staging of T3 tumor (54.5%) suggests that CT often misinterprets peritumoral inflammation or fibrosis as tumor invasion, a well-documented limitation of this imaging modality [3]. CT assessment of the oesophagus is also unable to accurately differentiate between T1, T2 and T3 stages of the primary tumor invasion [5]

However, the diagnostic accuracy of T4 staging was higher (67.8%), in our study comparing to T3 ds and has 50% and 69.4% Sensitivity and Specificity respectively reflecting its better ability to detect clear CT signs of organ invasion. CT is most useful to detect tumor invasion into adjacent structures

(T4 tumor), with reported sensitivity and specificity rates of mediastinal invasion of 85%–100%. (5)
MRI has been proposed as a superior alternative for T-staging, as it offers better soft-tissue contrast and reduces motion artifacts [4]. Recent studies indicate that 3T MRI outperforms CT in distinguishing early from advanced T stages, with a reported accuracy of up to 96% [5]. While MRI is not widely used for routine staging, its improved diagnostic performance suggests potential applications in cases where CT findings are equivocal.

Regarding N-staging, our results indicated a significant tendency for under-staging (31.4%) and over-staging (14%). The sensitivity of CT for detecting tumor-free nodes was high (84.3%), but specificity was notably low (31.4%). These findings are consistent with previous reports stating the sensitivity, specificity, for the correct identification of tumour free lymph nodes were 87.9% and 38.9% respectively (5) but preoperative CT nodal staging has a sensitivity of 20%,5.6% and 0% for N1 ,N2 and N3 ds respectively that have questioned the reliability of CT for nodal assessment due to its dependence on size criteria rather than functional or metabolic characteristics [6]. PET/CT radiomics has shown promise in improving N-staging accuracy by integrating metabolic and morphologic features, potentially addressing the limitations of size-based assessment alone [7]. Studies have reported that PET/CT-based radiomics achieves superior predictive performance compared to conventional CT [8].

The combined sensitivity and specificity of CT for T and N staging in our study were relatively low (42.4% and 46.5%, respectively), where a total of 28 (23.1 %) patents among 121 patients has correct T and N stage which suggests limitations in its ability to provide precise preoperative staging. Previous research has indicated that endoscopic ultrasound (EUS) may offer better accuracy for early T-staging, while PET/CT is advantageous for detecting nodal and distant metastases [9]. Integrating these modalities into a multimodal staging approach may improve preoperative assessment and guide treatment planning more effectively.

Histopathologic analysis in our cohort confirmed squamous cell carcinoma (SCC) as the predominant histologic type (84.3%), consistent with epidemiological data from East African and Asian populations, where SCC is

more prevalent than adenocarcinoma [10]. In western countries, including the USA, the incidence of oesophageal SCC has been declining over the last several decades, and oesophageal AC now predominates, (13) Changes in smoking and alcohol usage in Western countries has decreased the incidence of oesophageal SCC, rather obesity has highly correlated with Barrett oesophagus and resulted a higher rate of AC. Interestingly, our study found no significant correlation between staging accuracy and risk factors such as smoking or alcohol intake. This finding is consistent with prior literature suggesting that while these factors contribute to oesophageal carcinogenesis, they do not directly influence imaging-based staging accuracy [4].

Our research resulted most diagnosed case of adenocarcinoma is grade 3 (poorly differentiated adenocarcinoma) (6.6 %) and frequently diagnosed case of SCC is well differentiated squamous cell carcinoma (grade 1) (KSCC) (47%) . which aligns with National Cancer Institute in the USA study (on 37723 patients) resulted most cases of adenocarcinoma were diagnosed as poorly differentiated grade III (42%), and most cases of squamous cell carcinoma were diagnosed as moderately differentiated grade II (39.5%)

The predominance of distal location for oesophageal ca (82.8%) further supports regional trends in tumour location. From the TASH study, (on 142 patients) , 93% had SCC on histopathologic correlation and the middle third (49% of cases) and lower third (44% of cases) were where tumor formed most frequently (9) . The revised 8^{TH} edition AJCC oesophageal ca has classified location by anatomical land markings rather than upper, middle and lower locations and lower oesophageal ca can be of either distal or GEJ tumor depending of the epicentre of the mass

Tumor length could have a significant impact on both the overall survival and disease-free survival of patients with resected oesophageal carcinomas and may provide additional prognostic value to the current TNM staging system before patients receive any cancer-specific treatment (14). In our study The total horizontal (rt to left) diameter of the mass ranges from 0.8 cm to 6 cm with mean diameter of 1.8 cm and total vertical (craniocaudal) diameter of the oesophageal mass ranges from 2 cm up to 9 cm with mean diameter of 5.5 cm (27 %)

A study done in turkey among 116 pts concluded a tumor length ≥3 cm had a highly significant difference in the involvement of adventitia and lymph node stations. The patients with tumor length ≤3 cm had significantly lower rates of involvement of the adventitia and lymph node stations (14) In our study 93.4 % of patients had a total vertical length of oesophageal mass measuring >/= 3 cm .

The post-surgical margin assessment revealed a negative margin rate of 62.8%, with 37.2% having positive radial margins. This finding highlights the challenge of achieving complete resection in oesophageal cancer, particularly in advanced T stages.

The recurrence rate of 15.7% within two years further emphasizes the importance of precise preoperative staging to ensure appropriate surgical candidacy and optimize long-term outcomes. Adjuvant chemotherapy was administered in 51.2% of cases, reflecting the role of multimodal therapy in managing oesophageal cancer.

7. **Conclusion**

Preoperative CT has a high positive predictive value for correctly identifying truly operable stages. High sensitivity for correct identification of tumor free nodes. Low diagnostic accuracy in correct prediction of T3 and T2 stages. Low diagnostic accuracy in identification of tumor positive nodes. Only 23.1.0% of patients had corrected preoperative T and N staging assessment

While CT remains a widely used imaging modality for preoperative staging, its limitations in T and N staging necessitate a multimodal approach incorporating MRI, EUS, and PET/CT when available.

Future research should focus on the integration of advanced imaging techniques, including radiomics and artificial intelligence, to refine staging accuracy and improve patient outcomes.

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Annex
Information Sheet

Study Title:

Assessment of the Diagnostic Accuracy of Preoperative CT Staging of Oesophageal Cancer in Patients Undergoing Surgery: A Correlation with Surgical and Histopathological Findings at TASH and TASH-Affiliated Hospitals

Purpose of the Study:

The purpose of this study is to evaluate the accuracy of preoperative CT imaging in staging oesophageal cancer by comparing it with surgical and histopathological findings. The results will help improve diagnostic practices and treatment planning for oesophageal cancer patients.

Confidentiality:

The data collected for this study will be accessed only by the primary investigator and the research team. Your information will be kept strictly confidential and will not be shared with any unauthorized individuals.

Participation and Consent:

Your participation in this study is entirely voluntary. If you choose to participate, you may withdraw your consent at any time without any consequences. Your decision will not affect the care you receive.

Contact Information:

If you have any questions or concerns about the study, please feel free to contact the primary investigator at:

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