ADDIS ABABA UNIVERSITY

COLLEGE OF MEDICINE AND HEALTH SCIENCES

SCHOOL OF GRADUATE STUDIES

DEPARTMENT OF RADIOLOGY

PREOPERATIVE RADIOLOGIC (CT AND MRI) STAGING OF RECTAL CANCER AS SEEN FROM TASH: A THREE-YEAR DESCRIPTIVE CROSS SECTIONAL STUDY, ADDIS ABABA, ETHIOPIA

INVESTIGATOR: GULILAT SISAY (MD, RADIOLOGY RESIDENT)
ADVISOR: DR ASSEFA GETACHEW MD, CONSULTANT RADIOLOGIST, SUBSPECIALTY IN BODY IMAGING, ASSOCIATE PROFESSOR OF RADIOLOGY, SOM, CHS, AAU
DR HAYMET SOLOMON (BODY IMAGING FELLOW)

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ABBREVIATIONS

AAU	Addis Ababa University
CRC	Colorectal cancers
GIT	Gastrointestinal tract
GIST	Gastrointestinal stromal tumors
FAP	Familial adenomatous polyposis
RSM	Retroperitoneal surgical margin
SOB	Shortness of breath
NCDs	Non communicable diseases
TNM	Tumor, node and metastasis
SEER	Surveillance, epidemiology and end results
CT	Computed Tomography
MRI	Magnetic Resonance Imaging
MDCT	Multi-detector computed tomography
MSCT	Multi-slice computed tomography
MS	Microsoft
MDT	Multidisciplinary team
SPSS	Statistical Package for social Science
TASH	Tikur Anbessa Specialized Hospital

PACS Picture archiving and communication systems

PPV Positive predictive value

NPV Negative predictive value

GLOBOCAN Global Burden of Cancer Study

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Abstract

Background: Rectal cancer is one of the most common cancers worldwide and its incidence is reported to be increasing in resource-limited countries, probably due to the acquisition of a western lifestyle. The preoperative radiological stage also has been suggested to be correlated with the prognosis of colon cancer and helps in guiding specific treatments. However, information regarding imaging of rectal cancer in Ethiopia is limited. The main aim of the study was to assess the preoperative imaging staging of Rectal cancer and correlating with pathologic stage in TASH.

Method: Institutional based descriptive cross sectional study conducted at TASH Addis Ababa, Ethiopia for the duration of 2018-2021. The Study was conducted among histologically proven rectal cancer patients at TASH and that have complete staging work up before treatment initiation during the study period. Data was collected from the operation room logbook, Oncology center cancer registry logbook, patient medical records and PACS for the images. The data was checked for clarity and completeness. Computerized data analysis was conducted by using SPSS version 25 software.

Results: A total of 247 rectal cancer patients were enrolled in the study among which males were 123 and females 124 with median age of patients at presentation of 44 years. The majority of patients (99.6%) presented late with advanced stages (stage II-IV). Lymph node and distant metastasis at the time of diagnosis was recorded in 79.3% and 21% of cases, respectively. Liver was the most common site of distant metastasis. The low rectum was the most frequent anatomical site involved and all were adenocarcinoma (100%) by histology. Mucinous and signet ring carcinomas accounted for 16 (6.5%) and 18 (7.3%) patients, respectively. Overall accuracy, sensitivity and specificity of MRI was better than MDCT in local staging of rectal cancer.

Conclusions: Rectal cancer is not uncommon in our country and shows a trend towards a relative young age at diagnosis and the majority of patients present late with advanced stage. There is a need for screening of high-risk populations, early diagnosis and appropriate staging work up for a patient, which guides treatment options. Promoting the use of MRI for local staging than MDCT that has high accuracy, sensitivity and specificity.

CHAPTER ONE

Introduction

Background of study

The colon and rectum create up the large intestine, which is portion of the digestive system, also called the gastrointestinal (GI) system. Most of the large intestine is made up of the colon, a muscular tube about 5 feet (1.5 meters) long. The colon has four sections:[1]

- The ascending colon starts from the cecum (a pouch which receives undigested food from the small intestine) and extends upward on the right side of the abdomen.[1]
- The transverse colon is the one, which crosses the body from the right to the left side. The ascending and transverse colon together are called the proximal colon.[1]
- The descending colon descends on the left side [1]
- The sigmoid colon, which is named for its "S" shape, is the final part of the colon and joins the rectum. The descending and sigmoid colon are collectively referred to as the distal colon. The sigmoid colon joins the rectum the final 15 centimeters (6 inches) of the large intestine, which then connects to the anus.[1]

Cancer inflicts an enormous problem on society in low- and high-income countries.[2] Cancer is predicted to be an increasingly significant cause of morbidity and mortality in few decades, in all regions of the world.[3] In 2018, 18.1 million people around the world had cancer, and caused 9.6 million death from the disease. By 2040, those numbers will nearly double, with the greatest surge in low and middle-income countries, where more than two thirds of the world's cancers will occur. It is the leading cause of death in the Western while the second leading cause of death in developing countries.[4]

Colorectal cancer (CRC) is the third most common malignancy worldwide and the fifth in Sub-Saharan Africa being the common causes of cancer related death.[4] Colorectal cancer is the third most commonly diagnosed cancer in males and the second in females.[4] The lifetime likelihood of colorectal cancer diagnosis is 4.1% in women and 5% in men. The crude incidence of colorectal cancer in Sub-Saharan Africa for both sexes were found to be 4.04 per 100,000 populations (3.69 for women and 4.38 for men) with 1.2:1 male to female ratio. Tessema et al (1992-1996) reported

from Tikur Anbessa hospital, Addis Ababa, 131 cases in five-year time, which accounted for 30 % of all GI malignancies.[4] According to an estimated 5-year prevalence of cancer in Ethiopia by GLOBOCAN in 2012 colorectal cancer accounts for 5.7% of all cancers.[2]

Colorectal cancer usually begins as a polyp which is noncancerous that develops on the inner lining of the colon or rectum and grows slowly, over a period of 10 to 20 years. An adenomatous polyp, or adenoma, is the most common type of precancerous polyp progressing to CRC. Though all adenomas have the potential to become cancerous, only less than 10% are estimated to progress to invasive cancer.[1] The probability that an adenoma will become cancerous increases as it becomes larger. Cancer arising from the glandular cells, which produce mucus to lubricate the colorectum is called adenocarcinoma and accounts for approximately 96% of all CRCs. Some sub-types of adenocarcinoma, such as signet ring and mucinous, may have a worse prognosis than other subtypes of adenocarcinoma. Other, much less common types of tumors can also start in the colon and rectum including Carcinoid tumors, GIST, lymphoma and sarcomas rarely.[1]

The risk of developing colorectal cancer increases with age. The median age at diagnosis for colon cancer is 68 in men and 72 in women while for rectal cancer, it is 63 years of age in both men and women. CRC incidence rates are about 30% higher in men than in women, while mortality rates are nearly 40% higher although the reasons for this disparity are unknown. Both genetic and environmental factors also play a key role in the etiology of colorectal cancer. The majority of CRCs are sporadic; approximately 3/4th of patients have a negative family history. Positive family history has a role in only around 15–20% of patients with colorectal cancer. Indeed, a specific subgroup of the patient with CRCs is formed by those affected by a hereditary colorectal cancer syndrome such as Lynch syndrome and familial adenomatous polyposis (FAP), accounting for 5–10% of all patients. An environmental largely modifiable lifestyle factors that increase the risk of developing CRC includes smoking, alcohol intake and increased body weight. [1]

Early CRC often has no symptoms, the reasons that make screening so important. As a tumor grows, it may bleed or obstruct the intestine. In some cases, blood loss from the cancer leads to anemia, causing symptoms like weakness, excessive fatigue, and SOB. Other warning signs includes bleeding per rectum, change in bowel habits or shape of stool, cramp or discomfort in the lower abdomen, decreased appetite and unintentional weight loss.[1]

Screening can prevent CRC through the detection and removal of precancerous growths and can detect cancer at an early stage, when treatment is frequently more successful. As a result, screening reduces CRC mortality both by decreasing incidence of disease and by increasing the likelihood of survival. The appropriate age to initiate screening and rescreening intervals differs based on individual circumstances according to their level of risk. Colonoscopy is the recommended screening method for most individuals at increased risk. Other recommended screening methods includes double contrast barium enema, flexible sigmoidoscopy, CT colonography and occult blood tests. [1]

CRC is frequently diagnosed by barium studies and colonoscopy followed by biopsy. Even though these techniques provide excellent visualization of the mucosa, they cannot determine the depth of mural invasion by the tumor or the extent of metastatic disease. In patients with CRC, accurate assessment of tumor extent within and beyond the bowel wall, the presence or absence of lymphadenopathy, and distant metastases are significantly important for proper management of disease as the prognosis and outcome for patients diagnosed with colorectal cancer is unswervingly related to stage at presentation. [5] Imaging studies are frequently used to evaluate patients for screening and staging of colorectal cancer. Cross sectional imaging studies such as computed tomography (CT) and magnetic resonance imaging (MRI) provide anatomic and morphologic information about tumors and patterns of spread. The two most common cancer staging systems are the TNM system, typically used in clinical settings, and the Surveillance, Epidemiology, and End Results (SEER) summary staging system, used for descriptive and statistical analysis of tumor registry data. This research uses the TNM staging system.[1]

Among others, computed tomography (CT) has been the most widely used tool for staging of CRC owing to its advantages of being universally available and easily reproducible. The most important feature in preoperative staging using CT in patients with CRC is the detection of distant metastases.[6] In addition, preoperative CT delivers baseline findings for comparison during the postoperative period and is the modality of choice for detection of local recurrence after surgical resection. Currently, rectal MRI is the preferred imaging modality for local staging of rectal cancer.[7]

Primary surgery is accepted to be the only potentially curative treatment for localized colonic cancer. Unlike rectal cancer, where preoperative neoadjuvant therapy has been used with

considerable success, there is currently no role for preoperative therapy in colon cancer. Adjuvant radio- or chemotherapy may be offered post-surgery to patients with advanced-stage tumors, as defined by histological staging criteria.[8]

In this study, the sociodemographic characteristics and the detailed imaging patterns of CRCs along with the stage of the disease at presentations for patients having either CT or MRI image before treatment initiations was evaluated. Additionally radiologic staging was correlated with pathologic stage for those patients having pathologic staging.

Statement of the problem

In Ethiopia, cancer accounts for about 5.8% of total national mortality.[2] CRC (5.7%) is the third most prevalent cancers in Ethiopia among the adult population following breast cancer (30.2%) and cancer of the cervix (13.4%). According to the only oncology center in the country (Tikur Anbessa Specialized Hospital), about 80% of reported cases of cancer are diagnosed at advanced stages, when very little can be done to treat the disease. This is largely due to the low awareness of cancer signs and symptoms, inadequate screening and early detection and treatment services, inadequate diagnostic facilities and poorly structured referral.[2]

The use of imaging in CRC has significantly evolved over the past twenty years, launching important roles in surveillance, diagnosis, staging, treatment selection and follow up. The choice of imaging modalities currently available for the detection and assessment of tumors are broadly grouped into two categories: anatomical and functional. Anatomical imaging techniques remain the mainstay, in particular computed tomographic (CT) imaging for colon tumor staging and magnetic resonance imaging (MRI) for rectal tumor staging. The major goal of CT is to determine if there is direct invasion of adjacent organs, enlargement of local nodes, or evidence of distant metastases. The accuracy of CT in preoperative staging of colon cancer varies in different studies with overall ranges from 48% to 77%. Limitations of CT staging include an inability to definitively distinguish metastatic nodes and the depth of tumor invasion through the colonic wall. Currently, rectal MRI is the preferred imaging modality for local staging of rectal cancer.

Research have been conducted to assess the accuracy of cross sectional imaging like CT and MRI in staging CRC with overall low accuracy in identifying early stages of primary colorectal cancers but still it is not enough. When it comes to our country Ethiopia, no study was conducted

yet for assessing stage at diagnosis and accuracy of staging by image. Therefore, this study assessed the stage of rectal cancer at diagnosis, accuracy of CT or MRI imaging stage as compared with pathologic stage as well as imaging patterns of rectal cancer.

Significance of study

The pathological TNM (tumor–node– metastasis) stage is the gold standard for predicting the prognosis of various solid cancers and it is the most reliable prognostic factor for patients with colon cancer after curative colectomy. The preoperative radiological stage also has been suggested to be correlated with the prognosis of colon cancer and helps in guiding specific treatments. Additionally being familiar with common imaging patterns of CRC would help radiologists not to Miss CRC found incidentally on imaging done for other gastrointestinal tract disease indications. There are numerous published studies done at global level assessing the role of CT and MRI in staging of CRC at diagnosis and its accuracy by correlating with surgical /pathological findings but to our best knowledge there are no published reports done locally, Particularly in Ethiopia.

Chapter Two

Literature review

The clinical stage of the disease at diagnosis often determines the prognosis and survival rate of a patient with colorectal cancer, with the best outcomes seen in patients diagnosed at an early stage. However, the outcome of treatment of colorectal cancer in our environment has been poor because the majority of these patients present late to the hospital with advanced stage and only palliative care is possible. According to the study done on clinicopathological patterns and managements challenges of CRC in resource limited country in Tanzania by Chalya et al only 11 (3.3%) patients were identified as being in early stages (TNM stage I) and 321 (96.7%) patients were presented in advanced stages (stage II-IV). Two hundred and forty-two (72.9%) patients presented within 6 months of onset and 90 (27.1%) presented longer than 6 months.[22]

Another study done in Egypt showed majority of rectal cancer patients presented at advanced stages (78.6% stages II and III) with 46.5% lymph node metastases. [29] study done by Olesha et al had also demonstrated advanced stage on presentation of these cancers, especially the mucinous adenocarcinoma variant.[30] About 51% and 34% of cases presented at TNM stages II and III, respectively in a study done in Lagos and Sagamu southwest Nigeria.[31]

Accurate preoperative assessment of the local staging of CRC is essential to predict prognosis and to select most appropriate management. There is no guideline clearly asserting an optimal strategy for preoperative imaging. Advances in CT technology have elevated interest in the potential role of CT for detecting and staging of CRCs. With the development of MDCT thin-section images, faster scan acquisitions, improved resolution, and multiplanar reconstruction images have shown better accuracy in T and N staging. The sensitivity of CT detection depends mainly on the size of the colorectal tumor and the quality of the CT examination. The prognosis of CRC is directly related to the extent of colorectal wall invasion, lymph node involvement, and distant metastases. A prospective study was done on 44 patients in Tanta University; Tanta Egypt to assess the role of multislice computed tomography (MSCT) in preoperative evaluation of colorectal carcinoma (CRC). It showed 60% sensitivity and 83% specificity for assessment of local spread of disease, 69% sensitivity and 76% specificity for the evaluation of lymph nodal metastases, and 89% sensitivity and 96% specificity for hepatic metastases.[5]

In the era of pre- or perioperative therapy for resectable colorectal cancer, the radiological stage before preoperative treatment has become more crucial for predicting the outcome and evaluating treatment efficacy. Several investigators have found that a preoperative CT scan provides useful information for up to half of the patients and it definitely alters the clinical management in ~20% of patients with colon cancer. In a prospective, study done including consecutive 536 patients who underwent curative surgery in Chonnam National University Hwasun Hospital and Medical School, in Korea the overall accuracy of T staging was 79.1% with overstaging occurring in 9.9% of the patients and understaging occurring in 11.0%. The overall accuracy of N staging was 73.7% with overstaging occurring in 16.0% of the patients and understaging occurring in 10.3%.[11]

A retrospective as well as prospective study carried out at CMC, Ludhiana, Punjab from November 2011 to May 2014 in India that enrolled 31 biopsy proven CRC patient to assess the usefulness and accuracy of CT scan findings to state the extent and spread of colorectal malignancy and to correlate these findings with histopathological diagnosis. The result of the study showed a sensitivity of 83.3%, specificity of 92%, and positive predictive value of 71.4% and a negative predictive value of 95.8% in the diagnosis of T1 and T2 lesions. CT had a sensitivity of 88.2%, specificity of 93.8%, and positive predictive value of 93.8% and a negative predictive value of 86.7% in the diagnosis of T3 lesions as well as a sensitivity of 100%, specificity of 100%, and positive predictive value of 100% and a negative predictive value of 100% in the diagnosis of T4 lesions.[9]

A retrospective study done at Srinagarind hospital Khon Kaen University, Thailand to evaluate the role of CT scan in preoperative staging of colorectal carcinoma by comparing it with the surgical-pathologic staging and pathologic findings. The study involved 24 patients with biopsy proven CRC and the result showed that CT imaging had 100% sensitivity, 57% specificity, 87.5% accuracy for evaluating serosal and/or pericolic fat invasion, 93.2% sensitivity, 54% specificity, 75% accuracy for evaluating involvement of the lymph nodes. [12] Another retrospective study done on 312 patients in Mayday Hospital, UK aimed to determine if clinical outcome could be predicted from radiological features of the primary tumor showed that T-stage and nodal status was correctly predicted in only 60 and 62%, respectively.[8]

MDCT is a promising technique in detection of extramural invasion, lymph node metastases, and RSM involvement in colon carcinomas. A retrospective study was done on 141 patients in Turkey

aimed to evaluate preoperative T and N staging and retroperitoneal surgical margin (RSM) involvement in colon cancer using multidetector computed tomography (MDCT). In determining extramural invasion, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy of MDCT were 81%, 50%, 95%, 26%, and 81% for observer 1 and 87%, 75%, 97%, 27%, and 84% for observer 2, respectively. Moderate interobserver agreement was observed (κ=0.425). In determining T stage of the tumor, accuracy of MDCT was 55% for observer 1 and 51% for observer 2. In the detection of lymph node metastasis, sensitivity, specificity, PPV, NPV, and accuracy of MDCT were 84%, 46%, 60%, 74% and 64% for observer 1 and 84%, 56%, 65%, 78%, and 70% for observer 2, respectively. Interobserver agreement was substantial (κ=0.650). In the detection of RSM involvement, sensitivity and specificity of MDCT were 33% and 81% for observer 1 and 50% and 80% for observer 2. Interobserver agreement was moderate (κ=0.518).[13] Another prospective study was done on 73 patients in Turkey to evaluate tumor invasion (T staging) and lymph node metastasis (N staging) of colorectal cancer preoperatively by using multi-detector computerized tomography (MDCT) and to compare with the histopathological findings. In this study, the best accuracy results had been acquired for T1 and T2 tumors as 90.4% and 73.9%, respectively. For both histopathologically staged N0 and N1 patients, the accuracy results were 61.6%. The distant metastases were not detected in this study. [10]

There is universal agreement that endoluminal assessment of the entire large bowel should be performed with either colonoscopy or air-contrast barium enema. Staging for distant metastatic disease is routinely performed with a combination of chest radiograph and liver chemistries. Although CT scan has the capacity to demonstrate both local extension and metastatic disease, it has not been proven to consistently alter clinical management in this group of patients. One study was done in seattle USA to assess the clinical utility of routine preoperative computed tomography (CT) scanning in patients with cancer of the intraperitoneal colon and showed that the preoperative CT scan provided information that was useful for treatment planning in 37% of these patients.[14]

As mentioned earlier in patients with colorectal cancer, preoperative staging using various imaging technologies is important for establishing the treatment plan and predicting the prognosis. Although computed tomography (CT) has been used most widely, the versatility of CT accuracy was primarily because of the lack of specialization. A retrospective study was done in Korea that

aimed to identify whether any advancement in abdominal CT accuracy in the prediction of local staging has occurred. 285 patients were included in the study and the result showed that the overall prediction accuracy of the T stage as 55.1%, with over staging occurring in 63 (22.1%) and under staging in 65 patients (22.8%). The sensitivity and specificity were 90.0% and 68.4%, respectively. The overall prediction accuracy of the N stage was 54.7%, with over staging occurring in 89 (31.2%) and under staging in 40 patients (14.1%). The sensitivity and specificity were 71.9% and 63.2%, respectively. The CT accuracies by pathologic stage were 0%, 62.2%, 25.3%, and 81.2% for stages 0 (Tis N0), I, II, and III respectively. [6]

MRI examination of the rectum has evolved as the standard technique in the assessment of rectal cancer because of its multiplanar capabilities and high tissue contrast imaging. [15,16] One study was done in Tanta oncology center in Egypt which aimed to evaluate the role of MRI in assessment of rectal neoplasm involving 42 patients known to have or highly suspected clinically to have rectal neoplasms. Assessment was done by MRI using pelvic phased array coil with IV contrast (Gadolinium) and rectal gel administration. MRI was proved to have high accuracy in the assessment of the rectal wall infiltration and pelvic organ involvement, which is about 93% and has high accuracy in the assessment of perirectal lymph nodes involvement, which is about 91% as compared to the post-operative pathological results. Another study done in Yale University, USA on 28 patients showed Sensitivity of MRI in detecting invasion through the bowel wall was 89% (16/18), specificity was 80% (8/10), and accuracy was 86% (24/28). Sensitivity for malignant lymphadenopathy was 67% (8/12); specificity was 71% (10/14), and accuracy 69% (18/26).[16]

The treatment of rectal cancer depends on the stage, and whether patients need to receive neoadjuvant therapy is based on the depth of infiltration and the lymph node metastasis.[15,17] MRI shows precise anatomy of the rectum and mesenteric fascia, and predicts circumferential resection margin and tumor stage accurately.[17] It also predicts the risk of local recurrence and simultaneous metastasis or heterochronous metastasis. A retrospective study that included 377 patients of rectal cancer was done in China to investigate the accuracy of magnetic resonance imaging (MRI) in preoperative staging diagnosis for rectal cancer with multidisciplinary team (MDT) discussion. The result showed that for direct surgery group, 21 out 97 (21.6%) patients changed their therapy strategy due to the change of the stage assessment after MDT. The accuracy of MRI for the diagnosis of preoperative N stage with MDT was significantly higher than those

without MDT (56.2% vs. 42.1%, P=0.021). Moreover, for those without lymph node metastasis, the accuracy of MRI was higher after MDT (61.2% vs. 37.8%, P=0.009). For neoadjuvant therapy group, 7 out of 36 (19.4%) patients altered their therapy after MDT because of the changed stage. MDT improved the accuracy of restaging N stage with MRI (70.0% vs. 33.3%, P=0.003). The accuracy of MRI in staging T stage seemed not improved after MDT in both groups.[17]

Chapter Three

Objective of the study

General Objectives

- To assess radiological stage of Rectal Cancer at Diagnosis in Tikur Anbessa Specialized Hospital (TASH) and correlation with pathologic stage.

Specific Objectives

- To assess sociodemographic distribution of Rectal cancer patients
- To assess the role of CT and MRI in staging of rectal cancer
- To assesss the imaging patterns(CT and MRI) of the rectal cancer
- To correlate radiological TNM stage with pathologic stage
- To assess the histologic distribution of rectal cancer

Chapter Four

Methods and materials

Study Area

This study was conducted in Tikur Anbessa Specialized Hospital (TASH), Addis Ababa Ethiopia. TASH is under college of health sciences campus of Addis Ababa University (AAU), which is one of the pioneer universities in the country. The hospital is a tertiary level referral and teaching hospital providing service to people from all corners of the country in its various departments. It gives undergraduate, postgraduate and several subspecialty-training programs in medical and health sciences. The radiology department is equipped with high-tech radiologic devices including two x-ray machines, around ten ultrasound machines; two CT scan machines and a 1.5T MRI machine.

Study Period

This study was conducted from August 2018 to August 2021 GC.

Study Design

This is an institutional based cross-sectional study of patients with rectal cancer having full staging work up at presentation before starting any mode of treatment at TASH.

Source Population

All adult patients with rectal cancer who are on treatment and follow up at TASH.

Study Population

All adult patients with pathologically proven rectal cancer patients who are on treatment or follow up at TASH and having complete staging work up before initiation of any mode of treatment during the study period.

Inclusion and exclusion criteria

Inclusion Criteria

All adult patients (>18 years) with pathologically proven rectal cancer and having complete staging work up before initiation of any mode of treatment in the study period at TASH.

Exclusion Criteria

- Patients who have no pathology result for diagnosis
- Patients who have incomplete medical records for sociodemographic data's.

Sampling technique and sample size

The study was intended to include all adult patients with rectal cancer who are on treatment or follow up after operation as well as newly diagnosed patients having complete staging work up prior to initiation of treatment or surgery at TASH so there was no sample size calculation. Thus, all consecutive cases/rectal cancer patients that had fulfilled the inclusion criteria in the study period were enrolled into the study by non-probability sampling technique.

Data collection instruments, techniques and data collectors

All adult patients with rectal cancer was searched for from the operation room logbook and oncology center cancer registry logbook and then patients' medical records were traced and accessed. The sociodemographic and histopathologic parts of the data were filled on the standard questionnaire prepared from the charts and radiological data were filled on the questionnaire by reviewing the images downloaded from PACS (MedWeb) after confirmed by senior radiologist having subspecialty in body imaging with more than 5yr of experience. For those cases having no image available in TASH Medweb radiological report on MDT were taken from the patients chart. Data was collected after receiving ethical clearance to conduct this study from the ethical review committee of TASH. The data was collected and filled into the SPSS version 25 by the Principal Investigator.

Data analysis

The data were checked for clarity and completeness. All statistical analysis were performed using SPSS (Version 25), and statistical significance was set at $P< 0.05$.

Ethical considerations

In order to respect patients' right, and the regulation of the hospital where the study was conducted, Permission to undertake the study was obtained from Ethical Review Committee of Radiology department to access the medical records of the patients.

Variables

Independent variables

Sex

Age

Time of presentation

Symptoms of the patient

Anatomic location of rectal cancer

Histopathologic diagnosis

Dependent Variables

Cross sectional imaging (CT and MRI) TNM staging

Pathological staging

Operational definitions

- Rectal tumors are divided into upper, middle, and lower rectal tumors based on the distance of the lower end of the tumor from the anal verge
- Lower rectum is defined as when lower end of the tumor is within 5 cm from the anal verge
- Mid rectum is when lower end of the tumor is 5 to 10 cm from the anal verge, and
- Upper rectum is when lower end of the tumor is 10 to 15 cm far from the anal verge.

TNM staging definition

TNM staging is the universal staging system used for rectal cancer, where "T" stands for primary tumor, "N" stands for nodal status, and "M" stands for distant metastasis.

For Nodal, staging size criteria of 5mm was taken as a cutoff. Morphologic criteria like Irregular margins, heterogeneous signal intensity or enhancement, was taken as an indicators of a malignant lymph node

Early stage of rectal cancer is defined as a primary rectal cancer with T1 or T2 stage with no regional nodes and distant metastasis (stage I)

Advanced stage of rectal cancer is defined as rectal cancer with T3 and above staging and having either regional nodal metastasis or distant metastasis (Stage II, III and IV)

Table 1: TNM staging definition according to the 8th edition of AJCC

TNM Category	TNM Criteria
T1	Involvement of the submucosa
T2	Tumor invades the muscularis propria
T3	Tumor invades through the muscularis propria into perirectal tissues
T4	Tumor invades the visceral peritoneum or invades or Adheres to adjacent organ or structure
N0	No regional LN metastasis
N1 N1a N1b N1c	One to three regional lymph nodes are positive One regional lymph node is positive Two or three regional lymph nodes are positive No regional lymph nodes are positive, but there are tumor deposits in the • subserosa • mesentery • or nonperitonealized pericolic, or perirectal/ mesorectal tissues.
N2 N2a N2b	Four or more regional nodes are positive Four to six regional lymph nodes are positive Seven or more regional lymph nodes are positive
M0	No distant metastasis by imaging
M1 M1a M1b M1c	Metastasis to one or more distant sites or organs or peritoneal metastasis is identified Metastasis to one site or organ is identified without peritoneal metastasis Metastasis to two or more sites or organs is identified without peritoneal metastasis Metastasis to the peritoneal surface is identified alone or with other site or organ metastases

CHAPTER FIVE

Results

Sociodemographic characteristics of rectal cancer patients at TASH

Out of 247 patients analyzed 123(49.8%) are males and 124(50.2%) are females. The age ranged from 19 to 80 with median of 45 years and range of 61. The modal age group was between 31 to 40 years old and 57.9% are above age of 40 while 104 patients were aged 40years and less.

Table 2. Frequency of Rectal Cancer patients by sex and age category at TASH in 2018-2021

		Age Category							
		20 years and less	21 - 30yrs	31 to 40yrs	41 to 50yrs	51 to 60yrs	61 to 70 yrs	71 to 80 yrs	Total
Sex	Male	3	16	28	19	24	24	9	123
	Female	5	21	31	27	27	12	1	124
Total		8	37	59	46	51	36	10	247

The duration of symptoms at presentation ranged from 1 month to 5 years with median time of presentation being 12 months. Majority of the patients were presented to the hospital after 1 year of their symptoms onset accounting for 102(41.3%) cases while 75(30.3%) of the cases presented within 7 to 12 months of symptoms onset and only 70(28.3%) of patients presented to the hospital in a period of 6 months and earlier after symptoms onset.

The most common presenting symptoms are rectal bleeding seen in 207(83.8%) of cases followed by tenesmus 130(52.6%) and bowel habit changes 119(48.2%). Only 19(7.7%) patients were presented with symptoms of obstruction 18/247 of the by emergency and one with elective presentation with partial obstruction. Abdominal mass and symptoms of anemia are the rare presentations of rectal cancer in our study that were seen in only seven (1.2%) of cases.

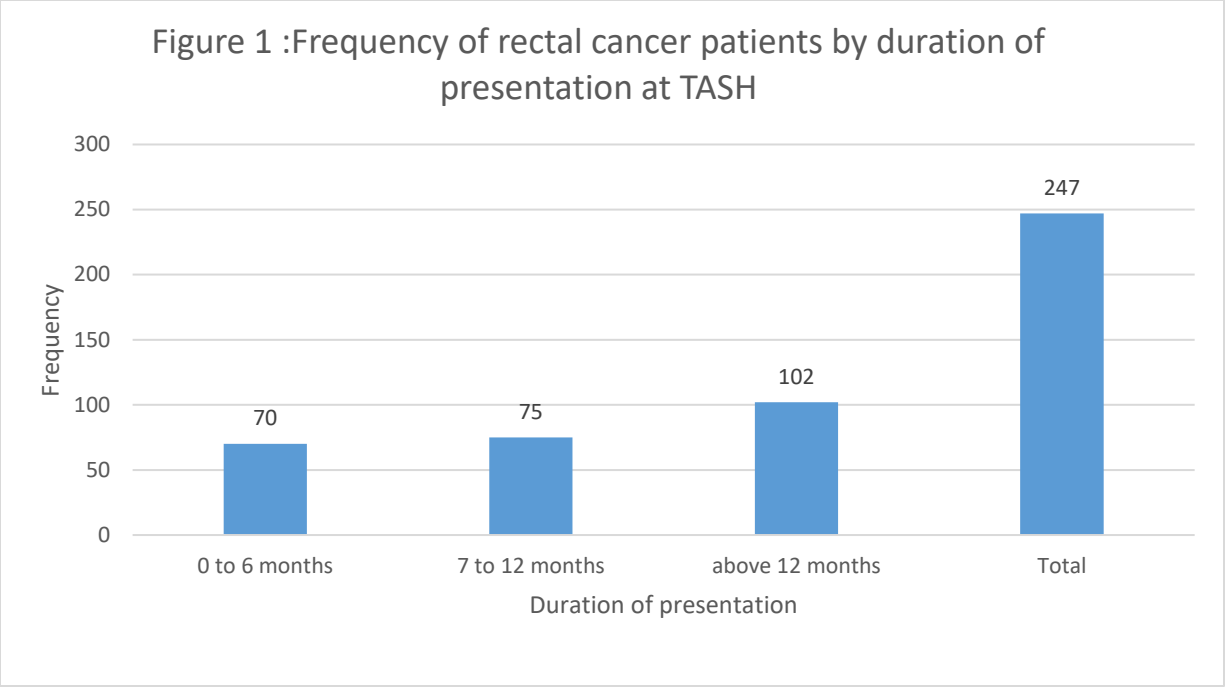


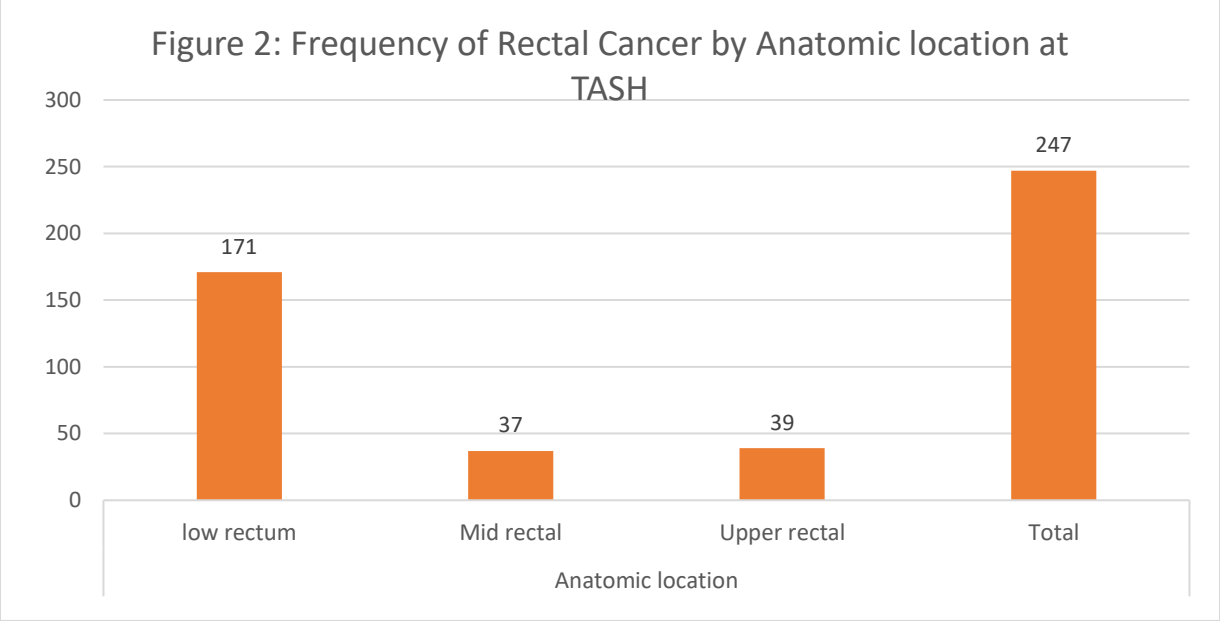
Table 3: Frequency of Rectal cancer patients by Symptoms of Presentation

		Responses		
		N	Percent	Percent of Cases
Presenting symptoms[a]	Bowel habit change	119	19.6%	48.2%
	Abdominal pain	48	7.9%	19.4%
	Obstruction	19	3.1%	7.7%
	Bleeding perrectum	207	34.0%	83.8%
	Weight loss	53	8.7%	21.5%
	Tenesmus	130	21.4%	52.6%
	Abdominal mass	4	0.7%	1.6%
	Symptom of anemia	3	0.5%	1.2%
	Others	25	4.1%	10.1%
Total		608	100.0%	246.2%

Imaging Findings of Rectal cancer patients at TASH

The most common anatomic location involved by the tumor was the lower third of the rectum accounting for 171(69.2%) of the cases with 46(18.6%) having anal canal extension. Only around

30% was located in the upper and mid rectal segments with 39(15.8%) cases located in upper third of the rectum with 15(6.1%) having sigmoid colon extension and the remaining 37(15%) in mid rectum.



The gross appearance of the tumor was also evaluated and majority of rectal cancer appear as an asymmetric circumferential wall thickening seen in 152(61.5%) and a symmetric circumferential wall thickening without annular stenosis in 28(11.3%). Rectal mass with an exophytic growth was seen in 26(10.5%) and an intraluminal polypoid mass was seen in 22(8.9%) while the remaining 19(7.7%) appear as a symmetric wall thickening with annular stenosis. From total 135 patients that have post contrast image 74(54.8%) showed homogeneous post contrast enhancement while the remaining 61(45.2%) demonstrated heterogeneous post contrast enhancement.

The length of rectum involved by the cancer were also evaluated in our study and it showed a wide range of rectal length involvement ranging from minimum of 3cm to maximum 17cm with median value of 7.2cm and range of 14. Majority of the cases have involved length of the rectum between 5 to 10cm accounting for 158(64%) patients, in 59(23.9%) short segment of rectum (<5cm) was involved and in the remaining 30(12.1%) >10cm rectal segment was involved.

TNM Staging

Out of total 247 patients evaluated 120(48.6%) have T3 stage, followed by T4b stage seen in 92(37.2%), T4a stage in 25(10.1%) and only 10(4%) had T2 stage by imaging. From the total

patients about 167(67.6%) have mesorectal fascia involved by the cancer while the remaining 80(32.4%) have no involvement of MRF.

From local structures involved by a locally advanced rectal cancer prostate gland is the most frequently involved structure in males which was involved in 36(25. 5%) followed by urinary bladder that is involved in 17(12.1%) of cases. On the other hand vaginal wall is the most common locally invaded structure in females accounting for 33(23.4%) of cases followed by cervix that is involved in 18(12.8%) of cases. The least commonly invaded structures are ureters and the ovaries. From total locally, advanced rectal cancer only 34 cases have pelvic sidewalls extension and 11 cases have sacral bone involvement. In only one case, the external iliac vein was invaded by the tumor. Lavatory ani was involved by the tumor in 33 cases from the 46 cases of low rectal cancer having anal canal extension.

From the total 247 cases of 195(78.9%) have one or more suspicious lymph nodes and the remaining 52(21.1%) have no suspicious lymph node seen. Mesorectal lymphnodes are involved in 180(91.8%) of cases and extramesorectal lymph nodes are involved in 71(36.2%). The mesorectal lymph nodes involved ranges from one to nine in number with mean of 3.4. Out of 71 extramesorectal lymphnodes involved most frequently involved is internal iliac group seen in 59(53.2%) followed by external and common iliac groups seen in 13(11.7%) of the cases each. The paraaortic lymph nodes are also seen in 9(8.1%) and obturator group in 3(2.7%) as well as other lymph node groups such as peripancreatic, presacral and inguinal lymph nodes are seen in 14(12.6%) of cases.

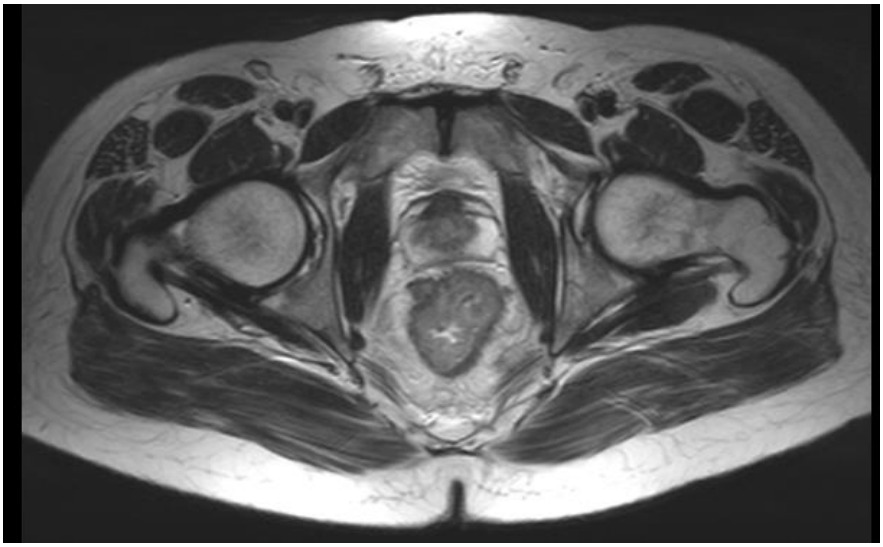
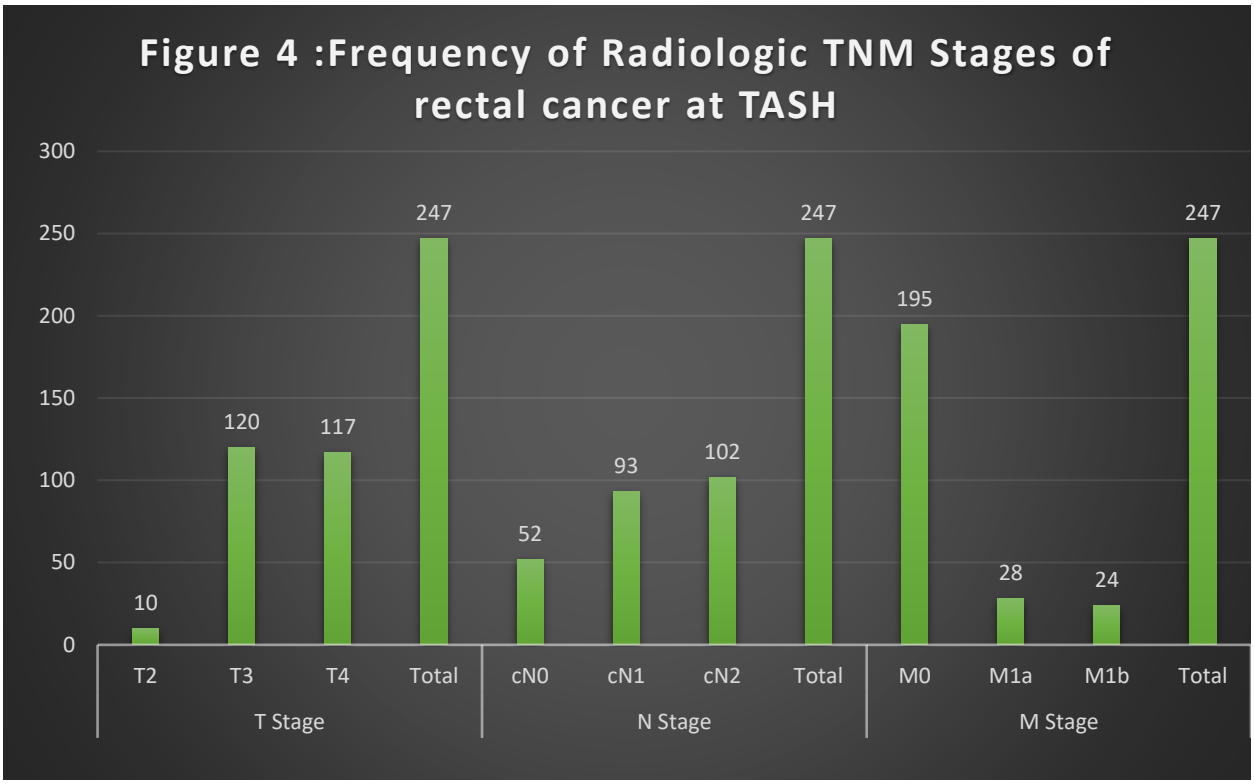


Fig 3: These is an axial T2 image of a 35yr old male patient showing a circumferential rectal wall thickening having slightly hyperintense signal as compared to the muscle and having mesorectal fat extension at 11 to 12 o'clock.(T3)



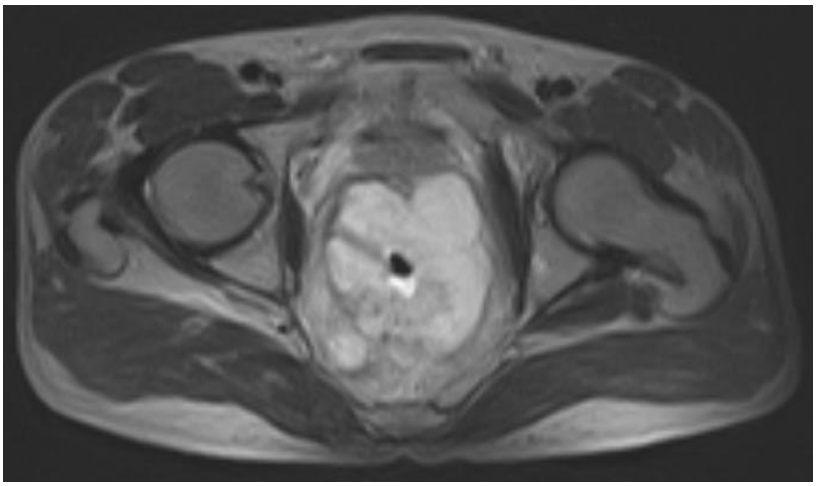


Fig 5: T2 axial image of a 30 yr old male patient showing asymmetric circumferential rectal wall thickening having lobulated outer surface and T2 heterogeneously hyper intense signal with involvement of the MRF and prostate gland as well as seminal vesicles. The presacral fat is also involved as well as pelvic sidewalls on the left side.(T4)

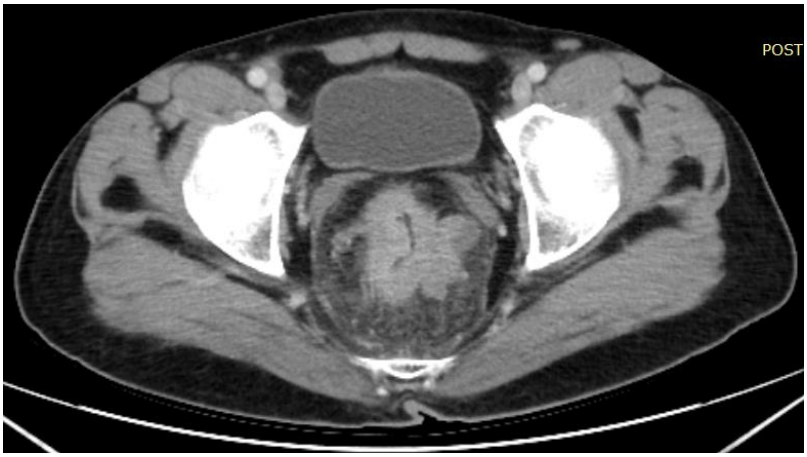


Fig 6: a post contrast abdominopelvic CT of a 55y old male patient showing an asymmetric circumferential rectal wall thickening showing homogeneous enhancement with extension into the mesorectal fat and adjacent fat stranding. There is also homogeneously enhancing mesorectal LAP seen on the left side. (T3) histology turned signet ring cell carcinoma

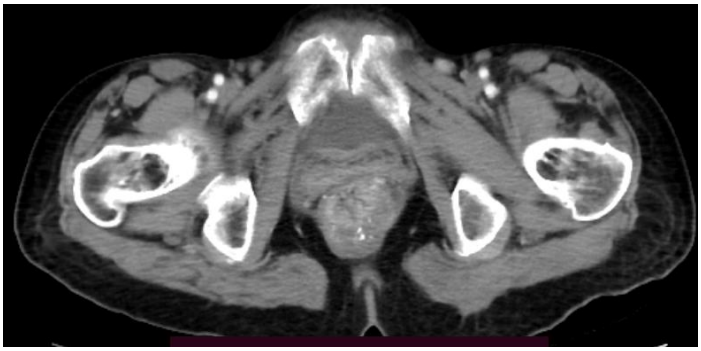


Fig 7: post contrast abdominopelvic CT scan of a 60yr old female patient showing an asymmetric low rectal wall thickening with internal areas of hypoattenuation and foci of calcifications seen. The mass has extension to the levator ani and external anal sphincter suggesting stage T4(histology turned out to be mucinous adenocarcinoma)

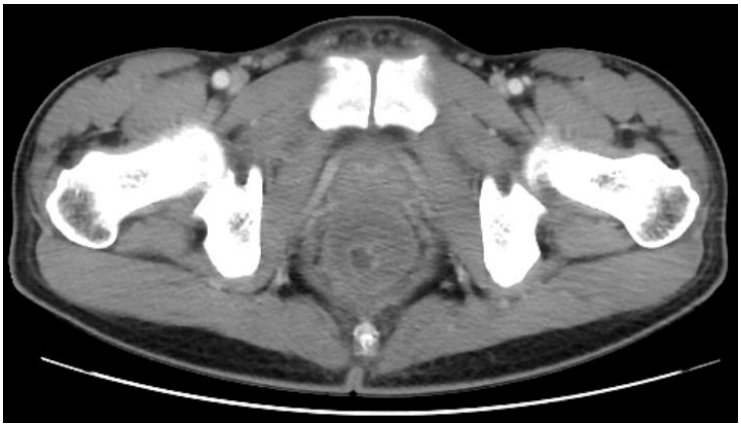


Fig 8: post contrast axial abdominopelvic CT of a 23yr old male patient showing a symmetric circumferential rectal wall thickening with mural stratifications and internal hypo attenuation with hyper enhancing inner mucosa and outer serosa. The mass has no fat plane with prostate gland suggesting invasion.(T4)

Table 4: Frequency of Local structures invaded by an advanced rectal cancer

Local structures invaded		Responses		Percent of Cases
		N	Percent	
	Prostate	36	25.9%	39.6%
	Seminalvesicle	16	11.5%	17.6%
	Uterus	17	12.2%	18.7%
	Bladder	17	12.2%	18.7%
	Vagina	33	23.7%	36.3%
	Cervix	18	12.9%	19.8%
	Left ureter	1	0.7%	1.1%
	Both ureters	1	0.7%	1.1%
Total		139	100.0%	152.7%

Distant metastasis was also evaluated and from 247 cases 52(21%) have distant metastasis with 28(11.3%) involve only one distant site and 24(9.7%) more than one distant site or non-regional lymph nodes without peritoneal involvement. The most common site of distant metastasis was liver accounting for 45.5 %(35/50) followed by the lungs 29.9 %(23/50) and distant lymph nodes in 14.3 %(11/50). Other rare sites of distant metastasis observed was bone, adrenal glands, ovaries, pancreas and omentum.

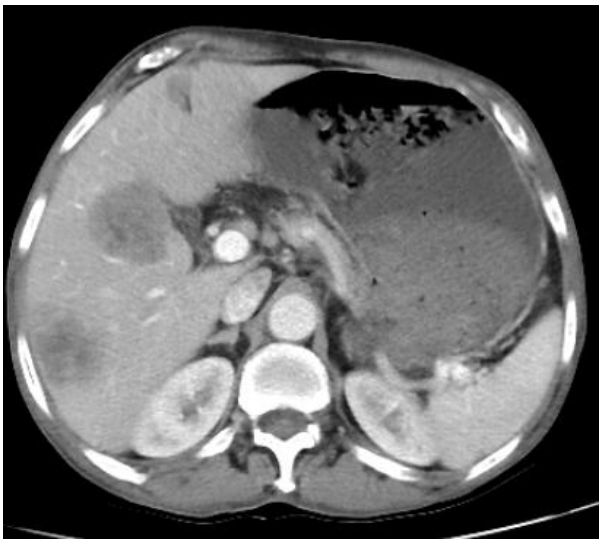


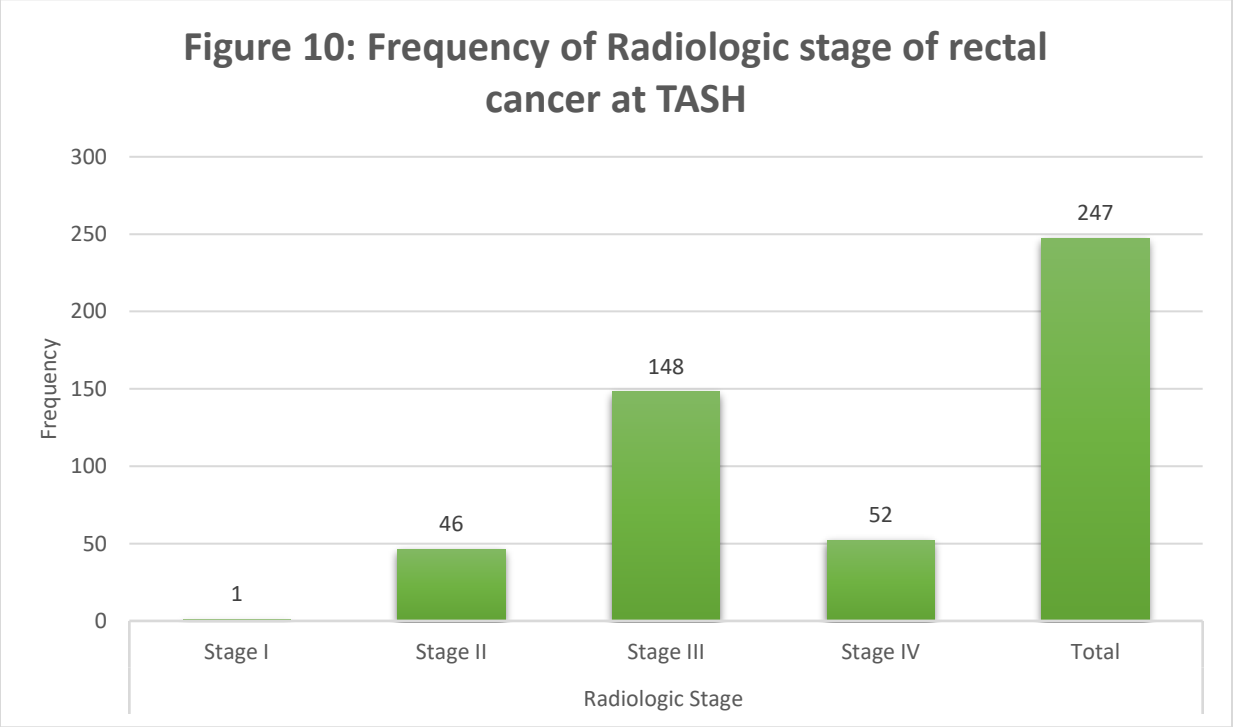
Fig 9: two ill-defined hypo enhancing liver lesions in a known Rectal adenocarcinoma patient suggesting liver metastasis on presentation

Table 5: Frequency of distant sites of rectal cancer metastasis

		Responses		
		N	Percent	Percent of Cases
Sites of distant Mets[a]	Liver	35	44.3%	67.3%
	Lung	23	29.1%	44.2%
	Distant LN	11	13.9%	21.2%
	Bone	1	1.3%	1.9%
	Other site mets	9	11.4%	17.3%
Total		79	100.0%	151.9%

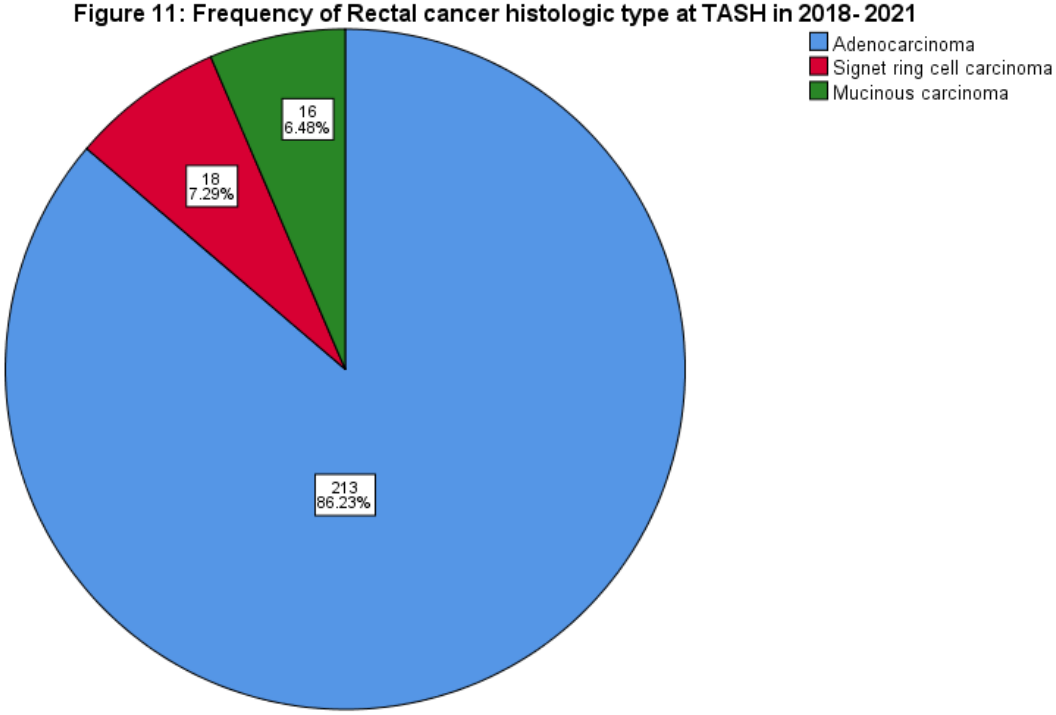
a. Dichotomy group tabulated at value 1.

According to the TNM stages only 1/247(0.4%) patients are identified as being in early stage (TNM stage I) and 246/247(99.6%) patients were presented in advanced stages (II-IV).



Out of total 247 cases studied 213(86.2%) are glandular adenocarcinoma ranging from well differentiated to poorly differentiated one by histology, 18(7.3%) are signet ring cell carcinoma, 16(6.5%) are mucinous carcinomas.

Figure 11: Frequency of Rectal cancer histologic type at TASH in 2018- 2021



Associated factors with stage of rectal cancer at diagnosis

The association between different sociodemographic data and stage of rectal cancer was done by a chi-square and fishers exact test with level of significance of ($P<0.05$). Accordingly, duration of patient presentation since onset of symptom and length of the bowel segment involved were found to have significant association with stage of rectal cancer at diagnosis with p value of 0.000 and 0.03 respectively. Other factors like sex, age, location of the tumor and histologic types have no statistically significant association with rectal cancer stage at diagnosis.

Radiologic-Pathologic correlation of rectal cancer Staging By CT and MRI

Out of 247 patients 50 have pathologic staging and among them 25 of them were staged by MRI while the remaining 25 staged by a MDCT. The imaging T and N stage was correlated with a pathologic T and N stage. MRI staged 2 patients as T2, 13 as T3 and 10 as T4 while the corresponding pathology stage was 3 as T2, 11 each as T3 and T4 respectively. The MRI staging over staged 1 case of T2 as a T4, 1/11 case of T3 as T4 and under staged 3/11 cases of T4 as T3.

This showed MRI has a sensitivity and specificity of 66.7% and 100% respectively for T2 staging. It has also sensitivity and specificity of 90.9% and 78.6% for T3 staging and 72.7% and 85.7% for T4 staging respectively. Regarding the CT scan, it has staged 3 patients as T2, 16 as T3 and 6 as T4 while the pathologic stage turned to be 6, 15 and 4 patients as stage T2, T3 and T4 respectively. This showed that the CT has over staged 1/6 patients as stage T4 and 3/6 patients as T3 that are actually staged as T2 by pathology. It has also under staged 1/15 T3 as T2 and over staged 3/15 as T4. In addition CT has also under staged 2/4 patients as T3 which were T4 by pathology. The overall sensitivity and specificity for T2, T3 and T4 were 33.3% and 50%, 73.3% and 80% and 50% and 81% respectively.

Table 6: T stage by MDCT versus Pathologic T stage Crosstabulation

		Pathologic T stage			
		T2	T3	T4	Total
CT T stage	T2	2	1	0	3
	T3	3	11	2	16
	T4	1	3	2	6
Total		6	15	4	25

Table 7: MRI T stage versus Pathologic T stage Crosstabulation

		Pathologic T stage			
		T2	T3	T4	Total
MRI T stage	T2	2	0	0	2
	T3	0	10	3	13
	T4	1	1	8	10
Total		3	11	11	25

Regarding the Nodal staging the MRI staged 13 patients as N1, 5 as N2 and 7 as having no suspicious node (N0) while the corresponding pathologic stage showed 16 of the patients to be negative for nodal involvement (N0), 7 as N1 and only 2 was staged as N2. It showed a sensitivity and specificity of 37.5 and 88.9 for N0 staging while 71.4 and 55.6 for N1 staging respectively. The sensitivity and specificity for N2 staging was 100 and 87 respectively. MDCT

staged 6 patients as N0, 11 as N1 and 8 as N2 while the pathology staged 12 as N0, 8 as N1 and 5 as N2. This showed as MDCT over staged nodal status as N1 and N2 in 3 patients each which was actually node negative on pathologic stage. The sensitivity and specificity of MDCT on nodal staging was found to be 33.3 and 84.6 for N0, 75 and 70.6 for N1 and 80 and 80 for N2 respectively.

Table 8: MDCT N stage versus Pathologic N stage Cross tabulation

		Pathologic N stage			
		N0	N1	N2	Total
CT N stage	cN0	4	1	1	6
	cN1	5	6	0	11
	cN2	3	1	4	8
Total		12	8	5	25

Table 9: MRI N stage * Pathologic N stage Crosstabulation

		Pathologic N stage			
		N0	N1	N2	Total
MRI N stage	cN0	6	1	0	7
	cN1	8	5	0	13
	cN2	2	1	2	5
Total		16	7	2	25

Table 10: Summary of MDCT and MRI Overall Accuracy for T and N staging as correlated with Pathologic stage

Overall	MDCT		MRI	
	T stage	N stage	T stage	N stage
Accuracy	73.3	70.6	86.7	68
Sensitivity	60	56	80	52
Specificity	80	78	90	76

Chapter Six

Discussion

Our study aimed at studying the stage of a rectal cancer at initial patient presentation before initiation of treatment. Accordingly, the current study found that 99.6% of rectal cancer patients present at an advanced stage ranging from stage II- IV with majority of them presenting in stage III. This study is consistent with most of the studies done in Africa like Tanzania, Sudan and South Africa which showed advanced stage of presentation for CRC overall. [22,23] The study done at TASH in 2016 showed similar finding with our current study regarding the advanced stage at presentation but with majority of the patient having distant metastasis which is not the case this time likely attributed by increased awareness of the society on cancer and improved diagnostic modalities in our country.

Regarding the sociodemographic characteristics of rectal cancer the mean age at presentation was 45.6 years with SD of 15, which is consistent with similar study done in TASH in 2016 that reported mean age of 45.9 and in Tanzania that were 46. [22] 60.7% of patients were aged 50years old and less showing an increase in the occurrence of rectal cancer in younger patients, which is consistent with a study, done 5 years back. However, it is in great dissimilarity with reports from developed world where elderly populations dominate the picture.

Majority of the patients presented after 6 months of symptom onset in our study, which is consistent with a study done in Sudan and Saud Arabia. [23,24] The reason for delayed time of presentation could be due to low awareness of cancer and lack of standard health facilities for diagnosing colorectal cancer; therefore, patients have to travel to access adequate facilities, which may also be resulting in delayed diagnosis. The detailed reasons for delayed time of presentation needs further study since it has significant association with advanced stage at presentation that further have an impact on patient prognosis.

The most common presenting symptoms were rectal bleeding in 83.8% of cases followed by tenesmus in 52.6% and bowel habit changes 48.2%. Similar results were reported in a study done in Sudan, Ghana and Tanzania. [23,25, 22]

Microscopically, approximately 95% of colorectal cancers are adenocarcinomas arising from the epithelial lining of the colorectum. In this study, glandular adenocarcinoma is the most frequent one accounting for 85.4%. Signet ring cell carcinoma and mucinous carcinoma accounts for 7.3% and 6.5% respectively. The result is in close agreement with a study done in Sudan and Tanzania.[23,22] The two later histologic tumors are known to have poor prognosis which occurs more commonly in younger (<40 years) in this study consistent with a study done in many African countries.

According to TNM staging, more than 99.6% of patients in this series presented with advanced stages and only 0.4% of cases presented with early-stage cancer. 50.6% of the cases have invasion of one or more local structures with prostate most commonly invaded organ in male while vaginal wall and cervix are the most commonly invaded organs in females. Lymph nodes are involved in 79% of the cases majority being mesorectal and regional extramesorectal LNs while distant Lymph node metastasis occurs in only 5.6%. 21% of the cases had distant metastasis with 11.3% metastasized to a single organ most frequently to the liver followed by distant LN and lung while the remaining 9.7% metastasized to more than two organs frequently to liver and lungs. This study has similar findings with a study done in Sweden, Germany, Tanzania and Nigeria.[27,26,22,28]

The correlation between cross sectional imaging including both MDCT and MRI and pathological staging was done in this study for 50 patients that have pathological staging. The result showed overall accuracy of MDCT for T and N staging of 73.3% and 70.6% while for MRI was 86.7% and 68% respectively. The overall sensitivity for T and N staging was 60% and 56% for MDCT while 80% and 52% for MRI respectively. MDCT has specificity of 80% and 78% whereas MRI has 90% and 76% for T and N staging respectively. This study shows comparable result with study done by Jung Sub So et al that showed overall accuracy for T and N staging of 55.1% and 54.7% while sensitivity and specificity of 90% and 68.4% for T and 71.9% and 63.3% for N staging respectively.

Table 11: The accuracy, sensitivity and specificity of MDCT in rectal cancer staging in published articles for comparison

		Accuracy	Sensitivity	Specificity	PPV	NPV
Jung Sub So, et al.	T	55.1	90	68.2		
	N	54.7	71.9	63.2		
	T1	37.1				

	T2	24				
	T3	67.3				
	T4	43.3				
Singla, *et al*	T1and T2		83.3	92	71.4	95.8
	T3		88.2	93.8	93.8	86.7
	T4		100	100	100	100
Aly A. et al.	T1	90.4	100	90.27	87.5	100
	T2	73.97	88	66.7	57.89	91.4
	T3	69.86	53.65	90.6	88	60.41
	T4	62.73	64	97	91.54	61.74
	N0	61.64	61.1	62.1	61.11	62.16
	N1	61.64	72.17	66	41.37	75
	N2	83.56	92.5	90.7	86.66	89.55
M Duman, S Tas, EA Mecit, et al	T1	90.4	100	90.27	12.5	100
	T2	73.97	88	66.7	57.89	91.42
	T3	69.86	53.65	90.6	88	60.41
	T4	2.73	0	97	0	91.54
	N0	61.64	61.1	62.1	61.1	62.16
	N1	61.64	52.17	66	41.37	75
	N2	83.56	12.5	90.7	16.66	89.55
Huh et al.	T	79.1				
	N	73.7				
Nittaya et al.	N	75	92.3	54	70	85
	T	87.5	100	57	85	100
Current study	T	73.3	60	80		
	N	70.6	56	78		

Table 12: **The accuracy, sensitivity and specificity of MRI in rectal cancer staging in published articles for comparison**

		Accuracy	**Sensitivity**	**Specificity**	**PPV**	**NPV**
Linzhen Yu et al.	T	84.2	93	58	87	74
	N	56.2	73	61	60	73
Giuseppe et al.	T	86	89	80		
	N	69	67	71		
A.H. Teama et al	T	93.06	91.7	100		
	N	91	95	88		
Current study	T	86.7	80	90		
	N	68	52	76		

Chapter Seven

Conclusions

In this study, we found that, rectal cancer most commonly present late after the onset of symptoms, in a younger age with an advanced stage and aggressive pattern. Low rectal cancer is the predominant rectal cancer regarding the anatomic location. The three most common presenting symptoms of the patients are bleeding per rectum, tenesmus and bowel habit changes. Majority of the patients have asymmetric circumferential wall thickening with both homogeneous and heterogeneous post contrast enhancement involving 5 to 10cm of rectal length in most of the patients.

About one fifth of the patients have already distant metastasis at the time of diagnosis making prognosis poor. The commonest site of distant metastasis is liver followed by lung.

The most common histologic diagnosis of rectal cancer in TASH is glandular adenocarcinoma followed by signet ring and mucinous carcinoma that relatively are found in higher proportion of younger patients and are in advanced stage at presentation.

MDCT has better accuracy, sensitivity and specificity in nodal staging than MRI while MRI is better than CT in T staging. They are both good in local staging of rectal cancer patients before operation with overall accuracy of around 84% and 89% for T staging in CT and MRI respectively.

Chapter Eight

Recommendations

Increasing cancer awareness among our society including the warning signs for rectal cancer like bleeding per rectum, tenesmus and bowel habit changes are very important in order to decrease the delay time of presentation since symptom onset, which has significant effect on advanced stage of the cancer at diagnosis.

We will also suggest adoption of international colorectal cancer screening programs in Ethiopia.

Training health care workers at primary care hospital about the rectal cancers so that they can detect early when patients first visit them for lower GI complaints.

We will also suggest the ministry of health to widen the cross sectional imaging across different health care services which has huge impact in diagnosing and staging curable cancers like rectal cancer when detected early otherwise which are fatal disease at advanced stage like in majority of patients at TASH.

Limitations of the study

- Small number of patients having Pathologic stage
- Poor quality of image like thick slice , low tesla MRI and inappropriate scanning techniques as well as incomplete report
- Its retrospective nature limited this study
- Non-electronic medical record keeping (retrieving patient files was difficult)
- Incomplete patient records (poor chart keeping)

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APPENDICES

STRUCTURED QUESTIONNAIRES

ADDIS ABABA UNIVERSITY, SCHOOL OF MEDICINE; COLLEGE OF HEALTH SCIENCES
RADIOLOGY DEPARTMENT

Standard questionnaire prepared for assessment of stage at diagnosis of rectal cancer patients attending treatment at BLH by CT and MRI imaging

Table 4: Standard questionnaire

Standard questionnaire prepared for assessment of stage at diagnosis of Rectal cancer patients attending treatment at BLH by CT and MRI imaging		
S. no	**Questions**	**Alternative choices for response**
PART ONE : SOCIODEMOGRAPHIC DATA		
101	Sex	1. Male 2. Female
102	Age at diagnosis	___ Years.
PART TWO: CLINICAL DATA		
103	Time of presentation(in months)	……
104	Mode of presentation	1. Emergency 2. Elective
105	Presenting symptoms	1. Change in bowel habit 2. Abdominal pain 3. Symptoms of obstruction 4. Bleeding per rectum 5. Weight loss 6. Tenesmus 7. Abdominal mass 8. Symptoms of anemia 9. Others
PART THREE: RADIOLOGIC DATA		
106	Local staging is done by.	1. CT scan 2. MRI
107	Anatomic site of rectum is involved?	1. Low Rectum 2. Mid rectum 3. High rectum
108	Imaging findings	1. Symmetric circumferential mass with Annular stenosis 2. Symmetric circumferential mass without annular stenosis 3. Asymmetric circumferential wall thickening 4. Rectal mass with exophytic growth

		5. Polypoid mass 6. Others
109	Enhancement pattern	1. Homogeneous enhancement 2. Heterogeneous enhancement 3. Non enhancing 4. Others
110	Length of the bowel involved in cm?	…….cm
111	Radiological T stage	1. T1 2. T2 3. T3a 4. T3b 5. T3c 6. T3d 7. T4a 8. T4b
112	If exam is, MRI for rectal cancer and T3 stage is mesorectal fascia involved.	1. Yes 2. No
113	If the answer for above question is no what is shortest tumor distance from MRF in mm?	……mm
114	Is there extramural vascular invasion?	1. Yes 2. No
115	If T stage is T4b which adjacent organs are involved	1. Prostate 2. Seminal vesicle 3. Uterus 4. Bladder 5. Vagina 6. Cervix 7. Ureters 8. others
116	Is there lateral pelvic wall extension?	1. Yes 2. No
117	Is there sacral bone invasion?	1. Yes 2. No
118	Is there iliac vessel encasement?	1. Yes 2. No
119	If the answer to the above question number 120 is yes, which iliac vessel is encased ?	1. RIIV 2. LIIV 3. RCIV 4. LCIV 5. REIV 6. LEIV

120	Is levator ani muscles invaded?	1. Yes 2. No
121	Is there suspicious mesorectal LN&/or tumor deposits?	1. Yes 2. No
122	Number of suspicious LN if answer to Q120 is yes	…….
123	Is there extramesorectal LN?	1. Yes 2. No
124	If answer to Q122 is yes which group?	1. Internal iliac group 2. External iliac group 3. Common iliac group 4. Obturator group 5. Paraaortic group 6. Others
125	N stage	1. N0 2. N1a 3. N1b 4. N1c 5. N2a 6. N2b
126	M stage	1. M0 2. M1a 3. M1b
127	Site of distant metastasis	1. Liver 2. Lung 3. Bone 4. Distant LN 5. Others
128	Final TNM stage	1. Stage 0 2. Stage I 3. Stage II 4. Stage III 5. Stage IV
PART FOUR: PATHOLOGIC DATA		
129	Histologic type	1. Adenocarcinoma(glandular) 2. Signet ring cell carcinoma 3. Mucinous Carcinoma 4. Squamous cell carcinoma 5. Carcinoid 6. GIST 7. Lymphoma 8. Others
130	Pathologic T stage	1. Tx 2. T0 3. Tis

		4. T1 5. T2 6. T3 7. T4
131	Pathologic N stage	1. Nx 2. N0 3. N1 4. N2