Validity of Linear Endoscopic Ultrasound in Rectal lesions Evaluation

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Abstract

Background: Rectal examinations utilize radial and linear EUS probes for specific areas. Linear probes offer deep visualization but pose challenges in pelvic anatomy. Rectal lesion evaluations use CT, MRI, and EUS, with EUS and MRI are often complementary. Linear EUS is gaining popularity for GI tract lesions' assessment.

Objectives: To assess the accuracy of linear –array Endoscopic Ultrasound in rectal lesions evaluation.

Patients and methods: Cross-sectional study in 40 Egyptian patients with rectal lesion. Linear EUS (Fuji EG-580UT) was compared to CT/MRI. Colonic prep, clinical assessments, sedation, FNA procedures were conducted. EUS examined lesions, layers, lymph nodes, and extend were evaluated. Samples were processed by cytopathologists. Outcomes were assessed including EUS diagnoses, CT/MRI/EUS comparisons and impact on patient management.

Results: The research comprised 40 rectal lesions patients. Patient age, gender, BMI, symptoms, and history were documented. CT, MRI, and EUS had 70%, 68%, and 65% malignancy diagnosis accuracy, respectively. EUS had the best sensitivity, specificity, PPV, NPV, and accuracy. EUS matched pathological T and N staging. Perfect AUCs demonstrated EUS advantage in T and N staging in ROC analysis.

Conclusion: CT had the highest diagnosis rate for rectal lesion malignancy, followed by MRI and then EUS. EUS was associated with the highest diagnostic, T staging, and N staging accuracy. CT had the highest diagnostic accuracy for early T and N stages, followed by MRI, while EUS had higher diagnostic accuracy for late T and N stages, suggesting that EUS could be the most reliable tool for preoperative diagnosis of rectal lesion staging.

Keywords: Linear Endoscopic; Ultrasound; Rectal lesions**.**

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Introduction

In Egypt, colorectal cancer (CRC) represents the seventh most common cancer and the third most common male neoplasm and fifth most common female neoplasm. CRC is more common among male patients aged above 50 years old. CRC can also affect individuals between ages 45 and 49 years with positive family history **(Elhadidy and Haydara, 2022).**

The examination of the rectum involves the use of flexible endoscopic ultrasound (EUS) probes, which come in two types: linear and radial. These probes serve different purposes and are applied based on anatomical regions, visualization capabilities, and intervention requirements. For instance, the radial probe is particularly useful for assessing the anal canal, while the linear probe is employed for evaluating the rectal and pararectal regions **(Shalaby et al., 2021).**

Some endosonographers opt to start with a radial probe for the initial examination and then switch to a linear probe when interventions like EUS-guided biopsy or drainage are needed. In cases of short-segment benign strictures, such as anastomotic or Crohn disease-related strictures, the linear EUS can be introduced to place a lumen apposing metal stent for symptom relief. The linear probe also offers advantages in visualizing tumors and deeper layers within the same image, although it may present challenges in assessing pelvic anatomy and the sphincter complex **(van-der-Valk et al., 2018).**

When evaluating patients with rectal lesions, various imaging methods are employed, including computerized tomography (CT), magnetic resonance imaging (MRI), and endoscopic ultrasound (EUS) **(Marone et al., 2015).** EUS and MRI are commonly used in combination as complementary tools during pre-treatment workup **(Scharitzer et al., 2021).** Typically, radial EUS is preferred for staging gastrointestinal wall conditions due to its ease of maneuverability and comparability to CT and MRI scans **(Nuernberg et al., 2019).** However, over the last decade, linear-array EUS has gained popularity and is increasingly used as the primary diagnostic approach for both pancreato-biliary and luminal diseases **(Ki and Napoleon, 2019).**

Some medical centers, especially those with a focus on pancreato-biliary conditions, may exclusively utilize linear array scopes, even when dealing with GI tract lesion staging **(Vaezy and Zderic, 2009).** Despite this trend, there remains a need for a comprehensive evaluation of the accuracy and reliability of linear EUS in assessing rectal lesions **(Marone et al., 2015).**

The present study was done to assess the accuracy of linear –array Endoscopic UltraSound in rectal lesions evaluation.

Patients and methods

The Tropical Medicine and Gastroenterology Departments at Qena University Hospital in Egypt and Shefaa Elorman Hospital in Luxor, Egypt collaborated on this cross-sectional research under ethical code: **SVU-MED-GIT023-2-21-12-296.** The research focused on individuals with rectal lesions and followed strict inclusion and exclusion criteria. All patients with rectal lesions were included, but exclusion criteria included lesions more than 20 cm from the anal margin and individuals with considerable morbidity that might possibly interfere with endoscopy.

The research included a multimodal strategy, with a particular emphasis on the use of linear probe endoscopic ultrasonography (EUS). Rectal EUS was performed for patients with rectal cancer (up to 25 cm from the anal margin) utilizing a Fuji EG-580UT Ultrasonic Endoscope (Fujifilm, Japan) with a curved linear array in this context. For preoperative staging and

comparison to CT and MRI staging, several frequencies (5MHz, 7.5MHz, 10MHz, and 12MHz) and a dynamic range of 40-100 were used. The gold standard for final pathological staging was taken into account. Importantly, the MRI and CT findings were kept hidden from the EUS endoscopists. A reduced fiber meal the day before the colonoscopy was combined with a split-dose bowel preparation containing 2 liters of Polyethylene Glycol+ Ascorbate and Enema.

CT scans were acquired with a 64-slice detector row CT of the abdomen and pelvis following intravenous administration of contrast medium (350 mg iodine/mL). Portal venous phase imaging was performed typically after a 70-s delay (parameters: 120 kVp, 170-350 mA; collimation, 0.6 mm). Routine data set reconstructions at 5.0 mm thickness were used for evaluation. CT images were evaluated prospectively with respect to lymph node involvement and distant metastases. Lymph nodes were considered positive for metastases when the diameter exceeded 5 mm.

MRI images were acquired using a 1.5 T system using phased array surface coils. Spin-echo T1-weighted images in sagittal and axial planes, and variable-echo proton-density and T2-weighted images were obtained, with the patient in a supine position. The section thickness was 7 mm with an interslice gap of 2mm.

A thorough assessment protocol was implemented for all enrolled patients, which included detailed history taking to identify relevant symptoms, thorough clinical examinations with a focus on abdominal and per rectal assessments, abdominal ultrasound examinations, and comprehensive examinations of recent abdominopelvic CT or MRI scans. Prior to the EUS operation, patients fasted for at least 8 hours and received preparations that included polyethylene glycol and repeated enemas. Additional medical examinations included assessing coagulation profiles and administering Propofol sedative when required, especially for agitated individuals. Before the EUS-FNA operations, third-generation cephalosporin intravenous antibiotic injections were given.

Patients were placed in a left lateral decubitus posture during the operation, using an EUS linear array machine (Pentax EG-3830UT Echoendoscope, Pentax medical company, USA) coupled to a suitable ultrasound machine (Hitachi EUB 7000, Hitachi medical corporation, Japan). A skilled endosonographer performed EUS exams, and fine needle aspiration (FNA) was done under EUS supervision using fine needles (Cook Echotip needles) in sizes 22 or 19G. To measure lesion hardness and guide needle paths, elastography and Doppler were used.

Within the scope of EUS, all lesions were meticulously examined, including the evaluation of all layers of the rectal wall beneath the lesions. The existence of perirectal lymph nodes, the depth of wall invasion, and the amount of invasion into perirectal fat or neighboring organs were all evaluated. If practicable and with sufficient wall thickness for aspiration, the FNA needle was moved via the linear array echoendoscope instrument channel, puncturing the gut wall, and collecting tissue samples by back-and-forth reciprocation with negative suction. Before withdrawing the needle from the scope, the internal stylet was retracted. The removed tissue material was then deposited onto a slide using a syringe to introduce air. To guarantee adequate samples, the technique was done 1-4 times.

Cytological samples were processed and interpreted by expert cytopathologists. The sufficiency of specimens was assessed using representative cell populations. Smears were created when the aspirated

materials were discharged onto slides. The remaining specimens from later passes were processed for cell-block analysis.

The study outcome measures included the proportion of patients who received correct diagnoses using EUS and cytopathological examination from EUS-FNA samples. Prior to obtaining EUS, presumptive diagnoses were established based on imaging and colonoscopy data. Final diagnoses for individuals who had surgery were based on cytopathological findings from resected material. In situations where surgery was not performed, the definitive diagnosis was made based on the long-term clinical course (at least six months) in combination with the EUS-FNA data.

Statistical analysis

IBM SPSS version 22.0 was used to analyses computer-generated data. To express quantitative data, percentages and numbers were employed. We used the (0.05) significance threshold to establish the significance of the findings. The Chi-Square test is used to compare two or more groups. The Monte Carlo test may be used to adjust for any number of cells with a count less than 5. Fischer Chi-Square adjustment was applied to tables demonstrating non continuous data. The Kappa statistic was used to measure the agreement between different diagnostic methods. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy were calculated for each diagnostic method. Receiver Operating Characteristic (ROC) analysis was performed, and the area under the curve (AUC) was reported. Pairwise comparison of AUCs for different diagnostic methods was done.

Results

A total of 40 patients undergoing EUS for rectal lesions were enrolled in our study. Table 1 demonstrates the basic characteristics of enrolled patients, including age, gender, BMI, presenting symptoms, past history, and family history. In this study of 40 patients, the mean age was 52.4 years, with participants grouped into three age categories: less than 50, between 50 and 60, and over 60 years. The gender distribution showed 22.5% were female and 77.5% were male, while the mean BMI was 32.5 kg/m2, classified into four BMI groups. The most common presenting symptom was rectal pain (70%), followed by changes in bowel habits (50%) and rectal bleeding (55%), with 10% reporting unexplained weight loss and 45% presenting other symptoms. A small percentage had a history of cancer (5%), and 10% had a positive family history of cancer (**Table.1**).

Table 1. Demographic data for all patients (N = 40)

Variables	No.	%	Mean ± SD	Range
Age, years			52.4 ± 10.5	35 – 70
Gender				
Female	9	22.5		
Male	31	77.5		
BMI, kg/m^2			32.5 ± 4.8	25 – 42
Presenting Symptoms				

Rectal Pain	28	70		
Changes in Bowel Habits	20	50		
Rectal Bleeding	22	55		
Weight Loss	4	10		
Anaemia	18	45		
Past History of Cancer				
No	38	95		
Yes	2	5		
Family History of Cancer				
No	36	90		
Yes	4	10		

BMI: Body mass index; SD: Standard deviation.

Regarding the pathology of rectal lesions, 35% were benign, and 65% were malignant, with mucoid carcinoma accounting for 7.7% and Gastrointestinal stromal tumor were found in 3.8% of cases. Among benign lesions, proctitis was the most common tumor affecting 64.3%, followed by rectal adenoma in 21.4% and rectal ulcer in 14.3% of patients. Malignant Adenocarcinoma lesions were found 88.5% of all malignant rectal lesions.

CT scan found that 12 patients (30%) had benign tumor and 28 patients (70%) had malignant tumors compared to 14 patients (35%) with benign tumor and 26 patients (65%) with malignant tumors with pathological examination indicating a moderate agreement between pathology and CT, while a substantial agreement was observed between pathology in which 14 patients (35%) had benign tumor and 26 patients (65%) had malignant tumors and MRI which indicated that 13 patients (32.5%) had benign tumors and 27 patients (67.5%) had malignant tumor. Notably, a perfect agreement was discerned between pathology and EUS with both modalities showing that 14 patients (35%) had benign tumor and 26 patients (65%) had malignant tumors, indicating a high level of alignment between the pathological assessment and the results obtained through endoscopic ultrasound (**Table.2**).

Table 2. The degree of agreement of Diagnosis (N = 40)

Variables	**Benign**		**Malignant**		**Kappa**	**P value**
	No.	**%**	**No.**	**%**		
Pathology	14	35	26	65	-	-
CT	12	30	28	70	0.545	.001[x]

MRI	13	32.5	27	67.5	0.832	.000[x]
EUS	14	35	26	65	1.000	.000[x]

x: Chi square test. CT: Computed tomography; MRI: Magnetic resonance imaging; EUS: Endoscopic ultrasound.

A receiver operating characteristic (ROC) analysis was carried out to compare the value of CT, MRI, and EUS in diagnosis of rectal malignancy. The CT was found to be a good diagnostic test where the area under the curve (AUC) was equal to 0.764 ± 0.086 (CI, 0.594; 0.933), and P value was .006. The MRI was found to be a very good diagnostic test where the area under the curve (AUC) was equal to 0.909 ± 0.060 (CI, 0.792; 1.000), and P value was < 0.001. The EUS was found to be an excellent diagnostic test where the area under the curve (AUC) was equal to 1.000, and P value was < 0.001. As shown in (**Table.3)**, EUS had the highest values for sensitivity, specificity, PPV, NPV, and accuracy in comparison to CT and MRI.

By measuring the Cohen Kappa statistic (**Table.4**), a statistically significant agreement was detected between pathology and MRI, and EUS as regards stages T1 (P = 0.001 and P < 0.001 respectively), T2 (P = 0.007 and < 0.001 respectively), T3 (P = 0.012 and < 0.001 respectively), and T4 (P < 0.001 and P < 0.001 respectively). However, CT showed a statistically significant agreement with pathology as regards stages T3 (P = 0.029) and T4 (P = 0.017) only. Unlike CT and MRI, EUS had demonstrated a perfect agreement with pathological T staging. The diagnostic accuracy of CT, MRI, and EUS in identifying malignancy within the lesions yielded rates of 70%, 68%, and 65%, respectively.

Table 3. Diagnostic Accuracy of CT, MRI and EUS (N = 26 patients)

Variables	**CT**	**MRI**	**EUS**
Sensitivity	88.5%	96.2%	96.15%
Specificity	64.3%	85.7%	100%
Positive Predictive Value	82.1%	92.6%	100%
Negative Predictive Value	75%	92.3%	93.33%
Accuracy	80%	92.5%	97.5%

CT: Computed tomography; MRI: Magnetic resonance imaging; EUS: Endoscopic ultrasound.

Table 4. Agreement of T Staging between CT, MRI and EUS (N = 26)

Variables	**T-Stage**				
	T0	**T1**	**T2**	**T3**	**T4**
Pathology	0 (0)	5 (19.2)	6 (23.1)	6 (23.1)	9 (34.6)

CT	3 (11.5)	8 (30.8)	3 (11.5)	5 (19.2)	7 (26.9)
Kappa	-	0.295	0.343	0.425	0.462
P value	-	0.115[k]	0.057[k]	0.029[k]	0.017[k]
MRI	1 (3.8)	6 (23.1)	4 (15.4)	7 (26.9)	8 (30.8)
Kappa	-	0.655	0.509	0.488	0.738
P value	-	0.001[k]	0.007[k]	0.012[k]	< 0.001[k]
EUS	0 (0)	5 (19.2)	6 (23.1)	6 (23.1)	9 (34.6)
Kappa	-	1.000	1.000	1.000	1.000
P value	-	< 0.001[k]	< 0.001[k]	< 0.001[k]	< 0.001[k]

k: Kappa test. T: tumor size; CT: Computed tomography; MRI: Magnetic resonance imaging; EUS: Endoscopic ultrasound.

By measuring the Cohen Kappa statistic (**Table.5**), a statistically significant agreement was detected between pathology and MRI, and EUS as regards stages N0, N1, and N2. However, CT showed a statistically significant agreement with pathology as regards stage N2 only. Unlike CT and MRI, EUS had demonstrated a substantial agreement with pathological N staging.

Table 5. Agreement of N Staging between CT, MRI and EUS (N = 26)

Variables	**N-Stage**		
	N0	**N1**	**N2**
Pathology	7 (26.9)	11 (42.3)	8 (30.8)
CT	10 (38.5)	9 (34.6)	7 (26.9)
Kappa	0.225	0.193	0.532
P value	0.235[k]	0.320[k]	0.006[k]
MRI	9 (34.6)	10 (38.5)	7 (26.9)
Kappa	0.641	0.601	0.719
P value	0.001[k]	0.002[k]	< 0.001[k]
EUS	8 (30.8)	10 (38.5)	8 (30.8)
Kappa	0.719	0.761	0.819
P value	< 0.001[k]	< 0.001[k]	< 0.001[k]

k: Kappa test. N: lymph mode metastasis; CT: Computed tomography; MRI: Magnetic resonance imaging; EUS: Endoscopic ultrasound.

Receiver Operating Characteristic (ROC) analysis was performed to evaluate the diagnostic efficacy of computed tomography (CT), magnetic resonance imaging (MRI), and endoscopic ultrasound (EUS) in both T and N staging of rectal malignancy, as depicted in Figures 2 and 3, respectively. In T staging, CT demonstrated satisfactory to good performance, with respective area under the curve (AUC) values of 0.681, 0.642, 0.700, and 0.719 for stages T1, T2, T3, and T4. MRI exhibited good to very good diagnostic ability, yielding AUCs of 0.852, 0.725, 0.758, and 0.859 for the same T stages. Remarkably, EUS excelled in T staging, achieving a

perfect AUC of 1.000 across all T categories. Furthermore, as indicated in Table 6, EUS had better sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy compared to CT and MRI (**Table.6**, **Fig.1**).

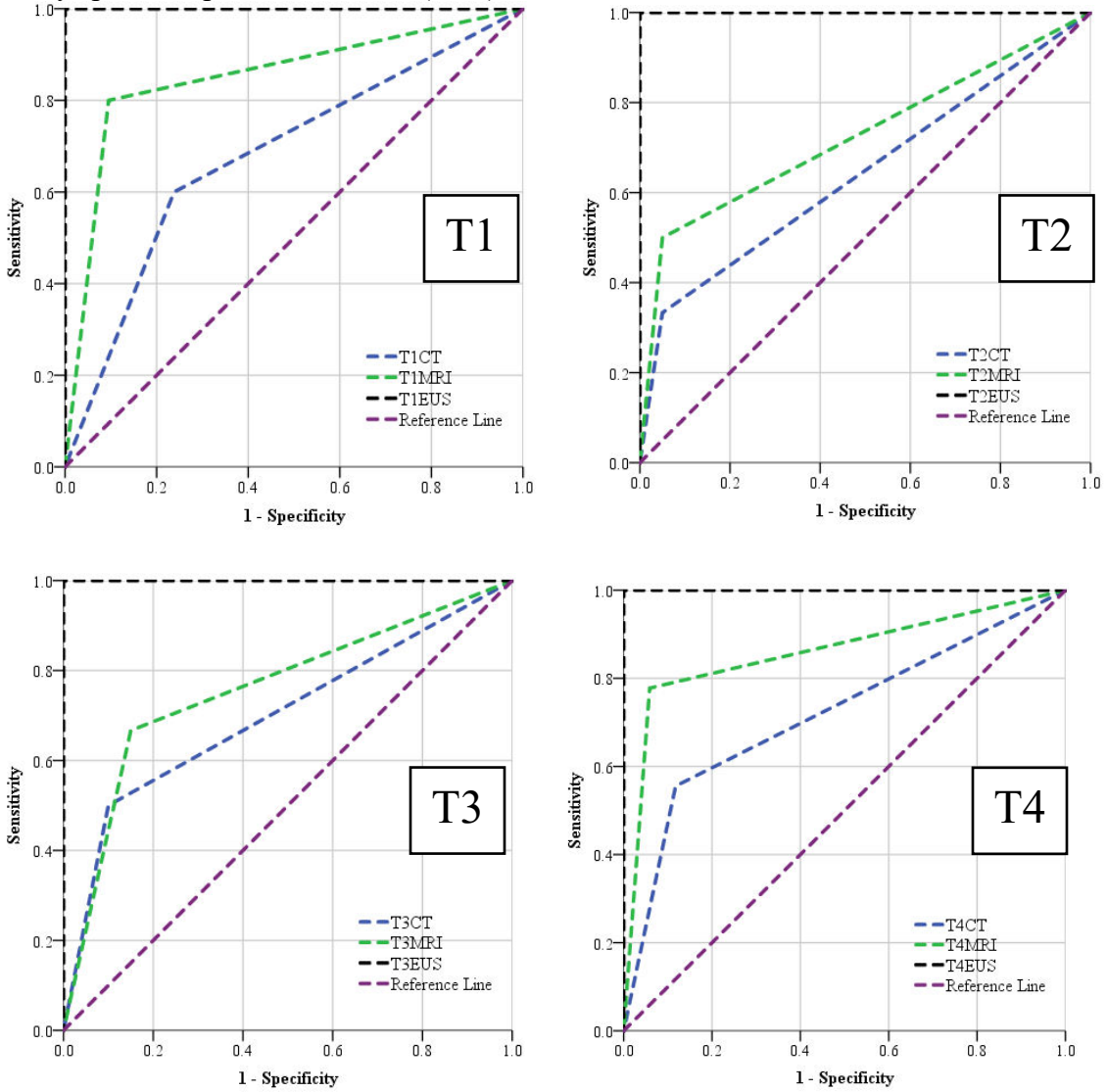

Fig.1. ROC Analysis (T Staging). CT demonstrated represented area under the curve (AUC) values of 0.681, 0.642, 0.700, and 0.719 for stages T1, T2, T3, and T4 respectively. MRI represented AUCs of 0.852, 0.725, 0.758, and 0.859 for stages T1, T2, T3, and T4 respectively. EUS represented AUC of 1.000 across all T categories.

Moving on to N staging, CT displayed satisfactory to good discriminatory capability, with AUCs of 0.628, 0.594, and 0.757 for stages N0, N1, and N2, respectively. MRI exhibited good to very good performance, with AUCs of 0.850, 0.797, and 0.847 for N0, N1, and N2 stages. EUS, once again, stood out as an excellent diagnostic tool in N staging, achieving AUCs of 0.876, 0.876, and 0.910 for stages N0, N1, and N2, respectively. Similar to the T staging results, EUS consistently displayed superior diagnostic performance compared to both CT and MRI,

as delineated in Table 6, with the highest values for sensitivity, specificity, PPV, NPV, and overall accuracy (**Table.6**, **Fig.2**).

Table 6. T and N staging accuracy in MRI, CT and EUS (N = 26)

Variables	Sensitivity	Specificity	PPV	NPV	Accuracy
T Stages					
T1					
CT	60	76.2	37.5	88.9	73.1
MRI	80	90.5	66.7	95	88.5
EUS	100	100	100	100	100
T2					
CT	33.3	95	66.7	82.6	80.8
MRI	50	95	75	86.4	84.6
EUS	100	100	100	100	100
T3					
CT	50	90	60	85.7	80.8
MRI	66.7	85	57.1	89.5	80.8
EUS	100	100	100	100	100
T4					
CT	55.6	88.2	71.4	78.9	76.9
MRI	77.8	94.1	87.5	88.9	88.5
EUS	100	100	100	100	100
N Stages					
N0					
CT	57.1	68.4	40	81.3	65.4
MRI	85.7	84.2	66.7	94.1	84.6
EUS	85.7	89.5	75	94.4	88.5
N1					
CT	45.5	73.3	55.6	64.7	61.5
MRI	72.7	86.7	80	81.3	80.8
EUS	81.8	93.3	90	87.5	88.5
N2					
CT	62.5	88.9	71.4	84.2	80.8

MRI	75	94.4	85.7	89.5	88.5
EUS	87.5	94.4	87.5	94.4	92.3

T: tumor size; N: lymph node metastasis; CT: Computed tomography; MRI: Magnetic resonance imaging; EUS: Endoscopic ultrasound

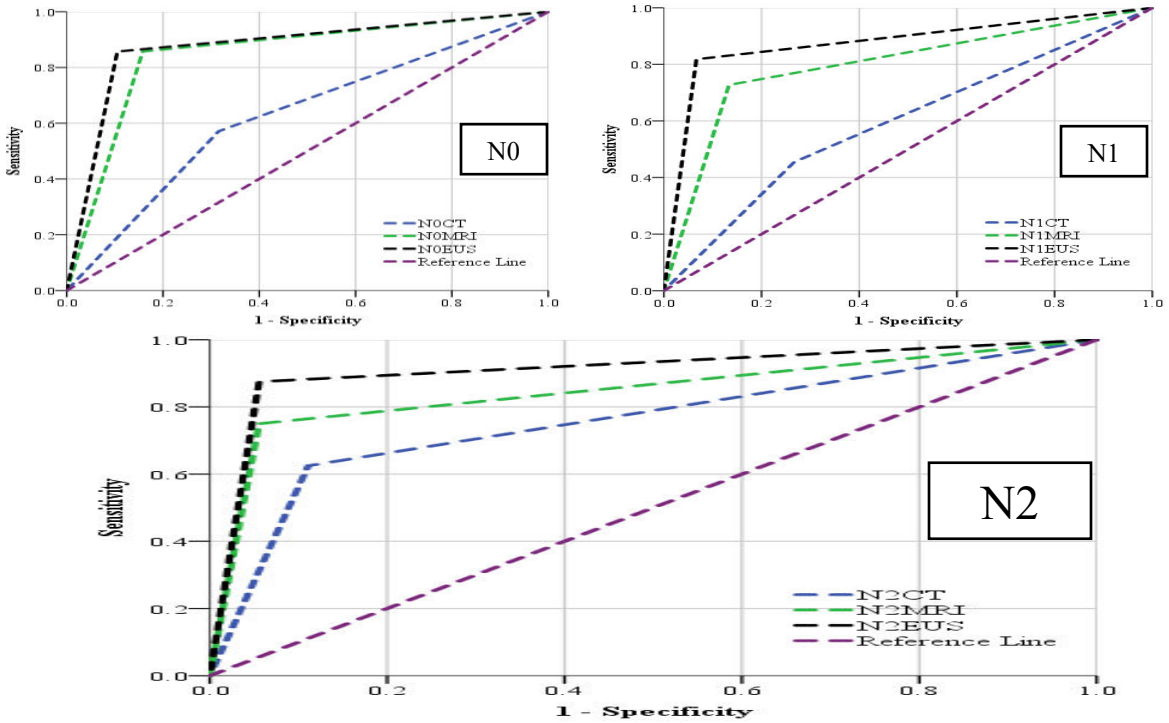

Fig.2. ROC Analysis (N Staging). CT represented AUCs of 0.628, 0.594, and 0.757 for stages N0, N1, and N2, respectively. MRI represented AUCs of 0.850, 0.797, and 0.847 for N0, N1, and N2 stages, respectively. EUS represented AUCs of 0.876, 0.876, and 0.910 for stages N0, N1, and N2, respectively.

Discussion

The linear echoendoscope is a versatile tool utilized for fine needle aspiration (FNA) of lesions in the gut wall and surrounding luminal gastrointestinal tract areas. Additionally, it serves as an exceptional imaging instrument **(Conway et al., 2010).** Accurate staging holds paramount importance in rectal cancer (RC) management, as prognosis closely correlates with both the T and N stages at diagnosis **(Avallone et al., 2013).** Traditional staging, as defined by **Byrd et al., (2010),** encompasses the depth of local invasion (T stage), lymph node involvement (N stage), and the presence of distant metastases (M stage). Neoadjuvant chemotherapy with irradiation (NAT) is often administered to high-risk locally advanced RC (LARC) patients before surgery, while preoperative short-course radiation therapy is given to low-risk LARC cases **(Avallone et al., 2013).** Various imaging modalities, including computed tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET), and endoscopic ultrasonography (EUS), are employed for RC staging. EUS stands out for its exceptional accuracy in locoregional staging, particularly in measuring mural infiltration (T stage), especially in early RC **(Glimelius et al., 2010).** However, EUS

exhibits reduced accuracy in restaging RC post-neoadjuvant chemotherapy and radiotherapy (post-NAT) and before surgery, and its applications extend to clinical trials exploring less invasive treatments and post-surgical monitoring **(Marone et al., 2015).**

In the current study, rectal lesions were assessed in 40 patients. The mean age was 52.4±10.5 years. 31 patients (77.5%) were male, and 13 patients (32.5%) were overweight and other 13 patients (32.5%) were class I obese.

These findings align with earlier studies, such as the investigation by **Soh et al. (2015),** which explored the clinical value of endoscopic ultrasound-guided fine needle aspiration and biopsy (EUS-FNA/B) for rectal and perirectal diseases. Their study involved 30 individuals, with a median age of 56 years with a male predominance. Similarly, **Fernández et al., (2015),** examined the performance characteristics of EUS-guided fine needle aspiration for diagnosing perirectal recurrence of colorectal cancer in 58 patients, the majority of whom were men with an average age of 64.2 years.

The main compliant was rectal discomfort followed by rectal bleeding and bowel changes. **Kongkam et al., (2014)**, evaluated the use of a forward-viewing radial-array echoendoscope for staging colon cancer beyond the rectum and found similar results to ours. During the EUS technique, they discovered a positive family history of colon cancer in two individuals and distant metastases in one. **Wang et al., (2017),** also reported on 12 patients with primary anorectal melanoma. These patients, who had a mean age of 54.5 years, had symptoms such as hematochezia (9 patients), anal prolapse (2 patients), and anal pain (1 patient) within 3.2 months of symptom start. Four individuals in their group were male, whereas eight were female.

Rectal lesions were malignant in 65% of cases, with adenocarcinoma being the most prevalent (57.5%). Proctitis (64.3%) and rectal adenoma (7.5%) were among the benign abnormalities. A diagnostic agreement study revealed that CT, MRI, and EUS correctly identified malignancy in 70%, 68%, and 65% of cases, respectively.

Our study agreed with **Mahran et al., (2022),** who reported a strong association between EUS elastography patterns and final diagnoses, with a soft pattern predominantly observed in benign cases (67.60%) and an aggressive pattern linked to malignant cases (78.70%). Remarkably, there was complete agreement (Kappa Agreement = 1) with significant differences between EUS diagnosis, EUS-FNA diagnosis, and the final diagnosis, demonstrating EUS diagnostic precision. Additionally, there was a substantial Kappa Agreement of 0.97 between the presumptive diagnosis and the final diagnosis.

Similarly, **Soh et al., (2015),** reported an overall diagnostic accuracy of 67% for EUS-FNA/B in rectal and perirectal lesions. While subepithelial tumors (SETs) showed a diagnostic accuracy of 50%, non-SET lesions achieved a higher accuracy of 75%. The extent of the lesion was found to influence diagnostic accuracy, and two notable complications following EUS-FNA/B were moderate fever and asymptomatic pneumoperitoneum.

Hara et al., (2003), observed a diagnostic accuracy of 90% for EUS-FNA in patients with rectal and sigmoid lesions, emphasizing its diagnostic reliability. Additionally, **Sasaki et al., (2005),** reported a diagnostic yield of 95.5% when using EUS-FNA for submucosal and extrinsic masses in the colon and rectum. **Boo et al., (2011)**, highlighted the efficacy and safety of EUS FNA and Trucut biopsy in rectal and

perirectal lesions, with a diagnostic accuracy of 91.7%. Similarly, **Maleki et al., (2013),** found favorable results for evaluating perirectal lesions using endorectal endoscopic ultrasound fine-needle aspiration (ERUS FNA), with EUS FNA showing 87% sensitivity, 100% specificity, a diagnostic accuracy of 90%, and positive and negative predictive values of 100% and 77%, respectively.

In our study, compared with CT and MRI, EUS showed better sensitivity, specificity, PPV, NPV, and overall accuracy. EUS also exhibited similar results to pathological T staging.

Our findings are congruent with **Fernández et al., (2015),** who reported malignancy in 67% of rectal lesion cases and benign features in 30%, achieving exceptional sensitivity, specificity, PPV, NPV, and accuracy with EUS-guided fine needle aspiration (EUS-FNA). Similarly, **Gao et al., (2020),** identified a 90.8% agreement between EUS-based staging and pathological staging in rectal cancer, particularly across tumor stages. **Kongkam et al., (2014),** highlighted the efficacy of EUS, particularly in obstructive lesions, with T staging accuracy rates ranging from 60.0% to 100%. **Puli et al., (2009),** reported sensitivity and specificity ratings ranging from 80.5% to 98.3% for trans-rectal EUS in rectal cancer staging. Our study findings regarding CT limited specificity in differentiating early and advanced stages of colon cancer are consistent with **Dighe et al., (2012),** observations. Lastly, **Marone et al., (2015),** underscored EUS superior accuracy in T staging for rectal cancer compared to CT and MRI.

Our research extended to N staging in rectal cancer, with EUS demonstrating superior diagnostic performance (AUC = 0.876-0.910) and higher sensitivity, specificity, PPV, NPV, and overall accuracy compared to CT and MRI.

Our results, however, contradict with those of **Puli et al., (2009),** who demonstrated reduced sensitivity (73.2%) and specificity (75.8%) for ERUS in determining nodal involvement. ERUS was better at ruling out nodal invasion than it was at confirming it.

Cârţână et al., (2011), on the other hand, showed that ERUS efficiently detects the local extent of rectal cancer but has limits in identifying lymph node metastases, which is consistent with our findings. In identifying the N category, **Kauer et al., (2004),** discovered less than adequate results for ERUS.

The disparities might be due to reactive inflammatory nodes that are difficult to differentiate from malignant nodes based on echo characteristics, resulting in false positives. Size requirements, such as nodes larger than 5 mm in diameter, might also influence findings **(Cârţână et al., 2011).**

Conclusion

CT had the highest diagnosis of rectal lesion malignancy followed by MRI then EUS. EUS was associated with the highest diagnostic, T staging and N staging accuracy. CT had the highest diagnosis accuracy of early T and N stages followed by MRI while EUS had higher diagnosis accuracy of late T and N stages suggesting that EUS was proven to be the most reliable tool for preoperative diagnosis of rectal lesion staging.

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