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MUQADAS MULAZIM

SU91-MSAHW-S23-225

FAHS

Comparative Analysis of CT Enterography Versus MR Enterography In Diagnosing Small Bowel Diseases



SUPERIOR UNIVERSITY

Thesis Submitted to

The Superior University, Lahore

In Partial Fulfillment of the

Requirement for the Degree of

Master of Science in Allied Health Sciences

By

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No part of this thesis has been submitted anywhere else for any other degree. This thesis is submitted to the Faculty of Allied Health Sciences, The Superior University, Lahore in partial fulfillment of the requirements for the degree of Master of Science in the field of "**Allied Health Sciences"** in Faculty of Allied Health Sciences at The Superior University, Lahore.

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LIST OF ABBREVIATIONS

(Abbreviations not explained in the text)

CTE	Computed Tomography Enterography
MRE	Magnetic Resonance Enterography
CD	Crohn’s Disease
GIT	Gastrointestinal Tract

ABSTRACT

A meta-analysis of diagnostic confounds of CTE and MRE in diagnosing diseases of the small bowel, such as Crohn's disease, small bowel tumors, and other conditions, were analyzed and compared. The multi-center study, which attracted 40 adult patients (aged 14-64 years, median age 31.45 years) who underwent CTE ((20 patients) and MRE (20 patients) in Lahore at different tertiary healthcare facilities. Both studies evaluated the performance of imaging modalities to identify small bowel features diagnostic of inflammation, strictures, fistulas, and tumors as well as assessing their contribution to clinical decision making and management. * Findings: With small-bowel enteropathy, the cutoff values for sensitivity, specificity, and predictive values of CTE and MRE were 0.088, 0.592, and 0.686; 0.0105, 0.0568, and 0.0578, respectively. CTE identified inflammation in 65% of cases compared to 72.5% for MRE. There was also a slightly better yield from MRE for the detection of bowel inflammation, while stricture and fistula were less frequently described. In comparison to CE, CTE had a better specificity for strictures and fistulas, thus it was more appropriate in patients with complex structural changes of the small bowel. In contrast, MRE was more sensitive to the detection of subtle inflammatory changes, particularly in patients who should be exposed to lower levels of radiation. Although small bowel diseases were detected well by both imaging modalities, limitations were found. While CTE depends upon ionizing radiation that can induce hazardous effects especially among pediatric patients and infant subjects, MRE may generate moderate accuracy and result in a handful of false positives. The results underscore the importance of tailoring diagnostic imaging approaches to patient-specific factors, clinical presentation, and disease features. The current study advocates for an individualized approach to test choice within the realm of medical imaging, identifying patients around whom MRE should be prioritized due to their increased risk profile related to radiation exposure, while CTE should be leveraged for high-resolution visualization of strictures and fistulas. The selection of the imaging modality also benefits from a multidisciplinary team approach involving gastroenterologists, radiologists, and surgeons to facilitate optimal decision making. In conclusion, the study raises the importance of performing long-term evaluations of the added value of each imaging method in different patient cohorts, especially in those with a different kind of inflammatory bowel disease, small bowel tumors and function disorder that may update guidelines and improve patient's management in their community.

Chapter 1

INTRODUCTION

Small bowel diseases encompass a range of conditions that affect the small intestine, including inflammatory diseases like Coeliac disease, Crohn's illness, small bowel tumours, and mysterious bleeding from the digestive tract. These conditions This may result in serious health issues like persistent diarrhea, malnourishment, and stomach pain., which significantly impact patients' quality of life. The smaller bowel's dimension, position, and and complex anatomy, is challenging to assess with traditional imaging methods (1).

Small intestine is a crucial part of the gastrointestinal (GI) tract that is involved in the metabolism of nutrients and vitamin absorption. This is the part located between the stomach and the large intestine and it performs most of the digestive activities. In anatomical terms, there are three major parts of the small intestine namely: duodenum, jejunum and ileum, which have different physiological roles to play. The small intestine is the longest of all of the digestive system and is about 6-7 meters long in adults. It is tightly wound around the abdominal cavity with most areas being located in the central and lower quadrants. This long size gives a large area of surface essential in getting the maximum absorption of nutrients. Small intestine gradually reduces in diameter to between 15 to 20 mm as it enters the ileum after starting at a diameter of 25 to 30 mm in the duodenum (2). The first and shortest part is the duodenum which is about 25 30 cm long and takes the form of a C-shape loop that surrounds the head of the pancreas. It gets partially digested food (chyme) that is released by the stomach and it is where the pancreatic enzymes and the bile that is released by the liver are added and this aids in the chemical breakdown of food. This part too is very important in neutralizing gastric acid, and here, too, the alkaline mucus of the Brunner glands is of importance in safeguarding the mucosa. The surface of the interior is covered with many villi and microvilli, which makes the surface of absorption many times greater. After duodenum comes jejunum that is around 2.5 meters in length. The absorption of macronutrients such as carbohydrates, proteins, fats and the essential vitamins and minerals is performed mainly in this area. The jejunum has a thicker wall and more prominent plicae circulares (circular folds) than the ileum, contributing to its absorptive efficiency (3,5).

The hallmark of Chronic Crohn's disease (CD) is a frequent infection of the gastrointestinal (GI) tract.8. North America and Europe have the greatest availability, with 145–199 instances per 100,000, or 400–600,000 victims in North America solely (2–4). With the highest prevalence between the ages of 15 and 25, the majority of CD patients appear while they are young. According to estimates, CD costs the US economy $10.9–15.5 billion, whereas in Europe it costs €2.1–16.7 billion (3,5).
Additionally, CD patients have an approximately 50% higher age-adjusted risk of dying than the rest of the population, in addition to causing significant morbidity.9. With two prominent peaks as far as of the age of incidence—the first occurring between the ages of 20 and 30 and the second peak occurring at the age of 50—the average beginning of the illness occurs at the age of 30. Disease is becoming more common across every age group 10. From surface ulceration of the mucosal surface to transmural inflammatory conditions, inflammatory and fibrotic structure, and penetration disease with sinus, fistulae, and abscess development, the illness presents with a broad range of digestive symptoms.(8,9).The occurrence of the illness is similarly diverse, with 50% of patients having ileocolitis, 25% having ileitis, and 25% having colitis alone (10). These differences are substantial and often connected. For instance, pure colonic illness with an inflammatory behavior is more common in elderly-onset CD (11). Therefore, classifying patients according to the combined effect of all of these variables is crucial for controlling patient expectations, determining the prognosis of the illness, and ensuring optimum care (12). It is difficult to diagnose and classify CD, and there isn't a single diagnostic test that can do so (16,17). Rather, a combination of endoscopic, histological, radiographic, and biochemical analysis is used to make the diagnosis (13). This intricacy partially reflects the gut's relative inaccessibility to diagnostic scrutiny. Endoscopy is the most effective method for evaluating luminal function and is essential for both diagnosing and monitoring CD. However, up to 25% of patients may not be able to have ileocolonoscopy because of their terminal ileum, which is the most frequently impacted bowel segment, affecting 75% of patients (18). Additionally, CD frequently impacts the most proximal smaller intestine, which is unquestionably beyond the colonoscope's reach, and endoscopic may also fail to detect extraluminal problems like fistulae.[15] In any event, data progressively demonstrates an exceptionally weak association with objective indicators of biologic functioning, such as endoscopy, and Clinical indices with validation, like the Crohn's an illness Action Index

(CDAI), are losing favour because they provide minimal information about the disease's anatomical pattern or any related extra-luminal issues (16). The treatment of CD now heavily relies on radiology because to the shortcomings of both endoscopic and diagnostic grading methods. CT enterography, MR enterography, small bowel ultrasound, and barium follow-through (BaF) are many frequently used small intestinal radiology examinations, each with unique characteristics. BaF and CTE remained the most often utilized of these in the fairly recent history; according to a UK study conducted in 2010 to evaluate patients with probable or confirmed CD, 80% of radiology departments used CT and 90% using BaF on a regular basis (17). BaF has a long history and is widely used in certain areas of the globe, but longitudinal imaging is quickly replacing it in numerous additional locations. Although it is very accurate in identifying abnormalities of the mucosa, its ability to assess both mural and extra-mural diseases is restricted (18). Since the introduction of multidetector-row scanners, which provide superior abdomen scanning in just one breath-hold, CTE has surely grown in importance. It is quick, easily accessible, and several studies have shown its therapeutic value (15, 30). Comparable with other imaging modalities, it can accurately diagnose diseases and measure their activity. Inevitably, sufferers are expose to radiation from ions from both BaF and, more specifically, CTE.[20] Throughout the duration of their illness, CD patients who are often young—need recurrent imaging. According to a 2007 audit, CT was the primary cause of the cumulative radiation dosage that 15.5% of CD patients received, which raised their chance of developing cancer by 7.3% (33). Physicians and patients alike are becoming more aware of these dangers and, appropriately, are concentrating on reducing their exposure to radiation There is little question that new CT methods, incremental rebuilding for CTE, will significantly reduce radiation exposure; nonetheless SBUS and MRE remain the only two completely radiation-free methods that are often used in clinical settings. Effective intestinal illness diagnosis is essential for appropriate disease treatment and better results for patients (21). However, due to its deep location within the abdomen and its extensive length, the small bowel has been historically difficult to visualize, making diagnostic imaging techniques essential. Traditional methods, such as small bowel follow-through, had limited sensitivity and specificity, often leaving subtle disease undetected. This limitation spurred the development of advanced imaging techniques, especially magnetic resonance imaging (MR) and computed tomography (CTE), which allow detailed

evaluation of small bowel diseases (22).

Imaging plays a pivotal role in diagnosing, staging, and monitoring small bowel diseases. Precise imaging is not only critical for an initial diagnosis but also for evaluating disease progression and response to treatment. Imaging can reveal mucosal abnormalities, sub mucosal changes, wall thickening, and other pathological features essential for accurate diagnosis (23). Historically, small bowel imaging relied heavily on contrast studies and barium follow-through. While effective to an extent, these approaches often lacked the sensitivity to detect subtle inflammation or early-stage disease. Enterography techniques, which involve ingesting a large volume of fluid contrast, were developed to optimize bowel distention and improve imaging resolution. Due to specifications like high-resolution, clear images, and cross-sectional views of the bowel, clinicians utilize CTE and MRE to enable to identify inflammation, strictures, ulcers, fistulas, and other pathological changes (24).

Specialized imaging modalities, namely CT enterography (CTE) and MR enterography (MRE), have been developed to enable detailed visualization and evaluation of the small intestine. Both techniques require the administration of oral contrast agents to adequately distend the bowel, thereby enhancing the delineation of the intestinal wall and surrounding structures (1).

Computed Tomography Enterography (CTE) has become the primary imaging modality for evaluating small bowel pathology, particularly in Crohn's disease, due to its rapid acquisition time, high spatial resolution, and widespread availability. While Magnetic Resonance Enterography (MRE) offers a radiation-free alternative that is advantageous in patients with recurrent disease, allowing for serial imaging without radiation risk.



Fig No. 1.1

CT Enterography arterial phase

CTE has a definite advantage in terms of operational efficiency. It is generally quicker and more accessible in most clinical facilities and is therefore especially applicable in emergency cases or patients who cannot endure lengthy imaging duration. Its quick acquisition of images and its availability in both secondary and tertiary care facilities make it more practical. Nevertheless, the application of ionizing radiation is a significant drawback of CTE particularly among children and those who need to be followed up frequently, through scans. Although low-dose CT protocols are being advanced, the total radiation load is an issue of clinical concern. Additionally, CTE might not be sensitive enough to discern abnormalities of the soft tissue compared to MRE and therefore have less sensitivity in early disease progression.

In comparison, MRE provides radiation-free alternative, which is especially suitable in children and adolescents, as well as in patients with chronic gastrointestinal diseases

who required serial imaging. It is very high contrast in demonstrating soft tissue structures so that one can identify features like bowel wall edema, fibrosis, and mild inflammation. Still, MRE has its limitations. The long image acquisition time can result in discomfort and the probability of motion artifacts, which is a large consideration in patients who have abdominal pain or are intolerant to standing in a supine position. Also, MRE needs special equipment that is MRI compatible and skilled staff which can be a limitation in resource-poor settings.

This paper seeks to evaluate and compare critically the diagnostic accuracy, safety, and clinical applicability of both CTE and MRE in the assessment of small bowel disorders. Under this comparison, we aim to outline the benefits and shortcomings of each modality, thus informing the clinicians to choose the most suitable imaging tool depending on any factor that may concern the patient and the intended purpose of the imaging.

The small bowel pathology is nuanced and has to be understood well in order to interpret imaging studies successfully. Diseases like Crohn s disease which is transmural inflammation with stricture and fistulization or celiac disease which is an autoimmune response to gluten that causes villous atrophy and malabsorption usually need advanced imaging to diagnose and track the disease. In the same line, non-specific symptoms of small bowel neoplasms e.g. bleeding or obstruction may have non-specific symptoms and are difficult to diagnose without high-resolution imaging whether benign polyps or malignant tumors. Both CT and MR enterography provide excellent visualization of the complex anatomy of the small intestine and allows identification of important abnormalities including wall thickening, fistulas, strictures, and mass lesions. CTE is also very useful in evaluating complications of Crohn disease such as fistulas and abscesses within the abdomen. In the meantime, MRE offers improved contrast in the soft tissues without any radiation risks, which makes it an invaluable aid in the long-term disease monitoring and detection of the tumor.

AIMS AND OBJECTIVES

- To find out the comparative analysis between MR and CT enterography for the detection of minor intestinal disorders
- To evaluate and contrast the positive predictive ability, negative forecasting value, sensitivity, and particularity using CTE and MRE in detecting small bowel diseases such as Crohn's disease, small bowel tumors, and other inflammatory conditions.

Chapter 2

LITERATURE REVIEW

A prospective research was carried to Collect preliminary information on the precision of MR enterography versus CT enterography in detecting small-bowel Crohn's illness and establish a medical standard of excellence determined by ileocolonoscopy, clinical data, and imaging. For this randomised prospective trial, the study group consisted of thirty-three individuals with diagnosed active Crohn's ileal disease who had agreed to perform MR enterography in addition to medical CT enterography and ileocolonoscopy. Two radiologists each evaluated the CT and MR enterography exams, and any disputes were settled by consensus. An intestinal surgeon assessed the results of ileocolonoscopy, whether or not mucous biopsy was performed. Following a review of all relevant data, the treating gastroenterologist's ultimate clinical determination served as the basis for the standard of care for the existence of small-bowel Crohn's condition. All 33 patients had ileocolonoscopies and CT scans, and 30 of them also had MR scans. For identifying active The sensitivity of MR, CT enterography, and small-bowel Crohn's illness were similar (90.5% vs. 95.2%, respectively; $p = 0.32$). MR enterography tests had much worse picture quality ratings than CT enterography exams ($p = 0.005$). Eight instances (24%) Having been diagnosed with engaged small-bowel swelling were found using MR and CT enterography, and ileocolonoscopy revealed normal ileal mucosal. Additionally, in three additional individuals without ileal the procedure, enterography was the only imaging modality available. While the sensitivity of MR and CT enterography for identifying active small-bowel inflammation is comparable, CT provided higher-quality images for the whole study population. In addition to ileocolonoscopy, qualitative enterography offers more details (33).

The accuracy using determined tomographic (CT) enterography and electromagnetic resonance (MR) to detect and determine little -bowel disorders is being systematically compared by Gabriele Masselli et al. All subjects gave their informed permission, and the research procedure was approved by the institutional review board. CT and MR enterography were performed on 150 separate individuals (81 men and 69 women; suggest age, 38.8 years; variety, 18-74 years) among June 2009 and July 2013 who had experienced normal both lower and upper gastrointestinal endoscopy produces and who

had a possibility to possess a small-bowel illness based on clinical examination results.

In order to determine small-bowel disorders, distinguish among aggressive and noninflammatory conditions, and check for extraenteric consequences, two separate readers examined CT and MR enterographic pictures. The reference standard was the histopathologic results of surgical (n = 23) and endoscopic (n = 32) biopsy specimens; the outcomes of video-capsule endoscopy (n = 36) and clinical follow-up (n = 59) were solely used to verify that small-bowel illness was not present. When it came to detecting individuals with small-bowel lesions, the overall sensitivity, specificity, and accuracy for CT enterography were 75.9% (41 of 54), 94.8% (91 of 96), and 88.0% (132 of 150), whereas for MR enterography they were 92.6% (50 of 54), 99.0% (95 of 96), and 96.7% (145 of 150).

In terms of detecting tumors (P =.0412) and general small-bowel illness (P =.0159), MR enterography's empathy was substantially greater than CT enterography's, however not for detecting inflammatory disorders (P >.99) or non-inflammatory, non-cancerous illness (P =.6171) When it comes to determining small-bowel illnesses, MR enterography is far more precise than CT. It was especially better at identifying cancer disorders (34). The research study by Seung Soo Lee et al. compares the efficacy of small-bowel obedience (SBFT) examination and computed tomographic (CT) and magnetic resonance imaging (MR) enterography in detecting extraenteric problems and active small-bowel inflammatory processes among individuals with Crohn's disease (CD). The research procedure was authorized by the board of review, and each subject gave their informed permission. Thirty-one successive individuals with CD or believed to have CD received ileocolonoscopy, SBFT, and CT and MR enterography. To check for active terminal ileitis and extraenteric consequences, two separate readers examined SBFT images and CT, MR enterograms. Using ileocolonoscopic results as the reference standard, the receiver operating characteristic approach was used to assess the accuracy values of CT and MR enterography as well as SBFT for the detection of active terminal ileitis. The McNemar test was used to assess the sensitivities readings for CT and MR enterography and SBFT for the identification of extraenteric problems, using the outcomes of radiological investigations, surgery, and medical examinations as the basis for comparison. Thirteen women and seventeen men with CD (mean age: 29.0 years) made up the research

population. For the identification of active terminal ileitis, there were no significant differences in the boundaries beneath For readers 1 and 2, the corresponding the receiver working characteristic graphs were for CT enterography (0.900 and 0.894), MR enterography (0.933 and 0.950), and SBFT (0.883 and 0.928) (P >.017). Compared to SBFT (32% for reader 1 and 37% for reader 2), the sensitivity values for the identification of extraenteric problems were substantially greater for CT and MR enterography (100% for both) (P <.001). MR enterography is expected to be employed as a radiation-free option for the examination of individuals with CD since its diagnostic efficacy is equivalent to that of CT enterography (35).

A 10-point rating system was used to assess each investigation's excellence in examination, degree of clinical trust and the existence of Crohn's disease. To find the level of consistency among every individual's CTE and MRE, kappa analysis was used. Twenty-five patients finished the MRE.

All writers gave the CTEs an exceptional rating (reader 1 with a normal score of 9.5/10 and reader 2 with an average score of 9.1/10). It was highly probable ($p<0.05$) that all two readers rated the MREs' performance worse than the CTEs (reader 1 = average 8.9/10, reader 2 = average 7.2/10). For readers 1 and 2, there was no discernible difference in the degree of interpretive confidence among CTE and MRE ($p=0.3$). Regarding whether Crohn's illness was present or not, readers significantly agreed with both CTE (kappa=0.75) and MRE (kappa=0.67). For the detection of Crohn's sickness, MR enterography without anti-peristaltic drugs yields consistent results and high diagnosis reliability (36).

A thorough review study was conducted to examine the potential use of magnetic resonance imaging (MR), computed tomography (CT), enterography, and SIT in the detection of small intestine tumours. Materials presenting the identification of SIT by MR and CT enterography that were archived in Chinese and foreign literature repositories were found and evaluated using the methodology of quality assessment of reliable diagnostic research (QUADAS). The medical information extracted from the papers was employed for the a systematic review using Meta-disc 1.40 software. The detection chance ratio (DOR), both favourable and adverse chance ratios, accuracy, precision, and

DOR of MR and CT enterography were all evaluated in order to identify SIT (37).

This research contained a total of eight papers, which included 551 instances of SIT. In contrast to CT enterography, which had a sensitivity of 0.93 and a specificity of 0.83, the pooled sensitivity and specificity of MR enterography were 0.92 and 0.81, respectively. The area under the receiver operating characteristic curve (AUROC) for magnetic resonance enterography was 0.940, the combined positive likelihood ratio was 4.90, and the combined negative likelihood ratio was 0.10. The equivalent values for CT enterography were 5.40, 0.08, and 0.950. Considering that the initial probability for MR was 50%, the post-test chances for both positive and negative results were calculated to be 83% and 9%, accordingly. For CT enterography, with the prior chance of 50%, the subsequent probabilities results were 84% and 8%, correspondingly. MR and CT enterography are fairly precise in detecting SIT when it addresses the diagnosis and therapeutic management of these tumours (38).

Study was conducted to investigate the diagnostic accuracy of CTE when compared to a histological reference in the diagnosis of CD patients. 126 consecutive individuals with confirmed or suspected CD underwent ileocolonoscopy with retrograde terminal ileum intubation for CTE and biopsy. The correlation and Kappa coefficient agreement between CTE and histopathology were assessed using Spearman's rank. A receiver working pattern region beneath the curve (AUC) was used to evaluate the CTE diagnosis's specificity. Overall, CTE exhibited a sensitivity of 93.88% and an affinity of 85.71%. The PPV was 95.83% and the NPV was 80%. According to CTE accuracy, the overall probability of accurately categorising patients was 92.06%. AUC of the ROC for CTE was 0.898, with $P < 0.001$. Therefore, when assessing the small intestine CD, CTE has a high sensitivity. The histological gradings and CTE showed a strong connection (Spearman's coefficient = 0.962, $P < 0.001$). Outstanding agreement was seen between the histopathology and CTE (Kappa coefficient (κ) = 0.847, $P < 0.001$). When assessing CD, CTE is a dependable method with high diagnostic accuracy. As a result, it could be helpful for treatment planning follow-up and preoperative assistance (39).

Study conducted to investigate to determine the effectiveness of iso-osmotic mannitol as an oral contrast agent in multidetector computed tomography (MDCT) enterography for the assessment of small intestinal illnesses. METHODS CT enterography on a 128-slice

CT scanner using isoosmotic mannitol as neutral enteral contrast was performed on thirty patients (mean age 40 years; range 14-66 years), 16 of whom were male and 14 of whom were female. The patients had clinical suspicions of small bowel diseases based on imaging, laboratory, or clinical investigations. The most frequent diagnosis was intestinal TB. The majority of non-neoplastic patients had segmental symmetrical involvement with an enhanced target pattern. Two instances of adenocarcinomas, or small intestinal tumors, were observed. Focal asymmetrical involvement with heterogeneous enhancing patterns was linked to neoplasms. For every patient, computerized tomography enterography provided an accurate picture of the obstruction's location, degree, and etiology with a sensitivity and specificity of 96% and 100%, respectively. The results showed that 98% of small intestinal disorders might be detected by CTE. For the assessment of small bowel illnesses, CT enterography is an effective, non-invasive, well-tolerated, sensitive, and specific imaging technique that offers superior assessment of the intraluminal, mural, and extraintestinal pathologies (40).

Recent study conducted 41 consecutive individuals who were eventually diagnosed with ileocolonic CD were included in a comparative investigation. Within two weeks, DW-MRE, contrast-enhanced CTE, and ileocolonoscopy were performed on all of the patients. Two skilled radiologists independently assessed DW-MRE and CTE pictures to determine if active CD segments were present or absent. The simplified endoscopic score for CD (SES-CD) was used to assess the ileocolonic segments (terminal ileum, right colon, transverse colon, left colon, and rectum) as inactive (0–2), mild (3–6), or moderate-severe (≥ 7). Using ileocolonoscopy as the reference standard, the diagnostic efficaciousness of DW-MRE and CTE for mild and/or moderate-severe CD segments were computed and compared. SES-CD was used to score 190 ileocolonic segments from 41 CD patients, resulting in 31 moderate-severe, 68 mild, and 91 inactive CD lesions. Diffusion-weighted MR enterography (DW-MRE) demonstrated superior sensitivity in differentiating active from inactive Crohn’s disease (CD) segments when compared to CT enterography (CTE), while both modalities exhibited comparable specificity. In these subgroup analysis, DW-MRE and CTE showed sensitivity rates of 96.8 percent and 93.5 percent, respectively (P = 1.00) (41).

MRE identified 14 percent more aberrant MRI results in patients with continuing clinical disease as compared to CTE. There was involvement of the small intestine in five patients on CTE and ten patients on MRE (p=0.133). Ileocolonic involvement was present in 15 CTE patients and 19 MRE patients (p=0.28). Stricture was present in two of the patients with CTE and nine of the patients with MRE (p=0.01). MRE yield was increased absolutely by 58.6 percent compared to CTE and resulted in change in clinical care of 17 patients. There was a significant correlation with the MRI severity score and disease activity ($r=0.70$, $p<0.0001$), fecal calprotectin ($r=0.52$; $p<0.003$), but not CRP (0.03; $p<0.1$). The average price of CTE was rupees 9214 (INR) and 12121 (INR) in the case of MRE. MRE performed better than CTE when it came to the diagnosis of CD stricture. The clinical activity and fecal calprotectin were correlated with the MRI severity index (42).

According to a study, CTE demonstrated comparatively high specificity and sensitivity in the detection of active inflammation, complications, and stenosis, which include abscesses and fistulas. CTE has good spatial resolution that can show very fine details of bowel wall thickening and mesenteric alterations. It also has high sensitivity and specificity in its diagnosis of 80-95% across the disease state and location(17).Taylor et al. (2018), have reported that MRE performs similarly to CTE in the diagnosis of Crohn disease, and some have indicated that it may be more accurate in the detection of active inflammation and fibrosis because it can measure bowel motility and wall enhancement. The sensitivity and specificity of MRE in the detection of Crohn disease activity is reported to be 85-95 percent high (43).

Chapter 3

METHODOLOGY

3.1. Research Design

This prospective cohort study aimed at determining the diagnostic performance, image quality and overall clinical usefulness of CT enterography (CTE) and MR enterography (MRE) in respect to the disorders of the small bowel. The patients were recruited over a specified duration and they were clinically suspected of having small bowel pathology, but they all underwent CTE and MRE, examinations. The diagnostic abilities of either of them were examined whilst focusing on the major pathological characteristics including inflammation of bowel walls, fistulous tracts, strictures in the lumen and lesions of the neoplastic nature. Along with it, the degree to which such imaging methods affect clinical decision-making is also investigated in this work. The research highlights the role of CTE and MRE in treatment plans, diagnostic certainty, and patient outcomes by correlating imaging results with post-treatment plans. Such an all-inclusive study provides the opportunity to understand the relative merits and drawbacks of each modality and thus provide outputs that can guide the best imaging options in managing small bowel diseases.

3.2. Clinical Settings

The current research was carried out in a hospital in Lahore known as Services hospital which have radiology areas, gastrointestinal (GI) departments, and interdisciplinary teams comprising GI specialists and radiologists experienced in small bowel picture reading. The study involved all the patients who required imaging tests in the case of possible blockages of the small bowel such as small bowel tumor evaluations, diagnosis of Crohn disease, and inflammatory bowel disease studies.

3.3. Sample Size

In this study, 40 patients were included and divided into two groups of 20 patients who underwent CT enterography (CTE) and MR enterography (MRE). However, the data collected from sampling was analyzed using statistics to determine the significant difference in the diagnostic accuracy and clinical impacts of the two imaging modalities in the assessment of the small bowel disorders.

3.4. Sampling Technique

The study utilized basic random selection to obtain participants from the group of patients who need diagnostic imaging for suspected small bowel conditions. The eligible patient group has participated in the study through random sample selection with each participant having the same chance of being enrolled. The technique implements random selection which reduces bias in the study while obtaining a suitable representative group of patients.

3.5. Duration of Study

This research project extended over a four-month period to fulfill patient enrollment procedures as well as imaging procedures and data collection needs. The specified timeframe of four months allowed enough time to collect enough participants for complete comparative analysis of diagnostic results.

3.6. Selection Criteria

3.6.1. Inclusion Criteria

- Adults aged 18 - 75 years**.**
- The study includes adult patient's nodes who exhibit signs requiring a small bowel disease evaluation including Crohn's disease and small bowel tumors as well as other inflammatory bowel diseases.
- The study includes registered patients older than 18 years and under 75 years who both understand and accept participating in the assessment.

3.6.2. Exclusion Criteria

- Pregnant women and those who breastfeed were excluded from testing because CTE exposes them to harmful radiation.
- Patients with contraindications for MR enterography (MRE), such as the presence of metal implants (e.g., pacemakers) or known allergies to gadolinium contrast agents.
- The study excludes patients whose physical discomfort includes severe abdominal pain or claustrophobia prevents them from completing imaging exams.
- Irradiation methods in patients who underwent large portions of bowel removal or received extensive small bowel surgical procedures.

3.7. Ethical Consideration

The research strictly complied with the standards from the Declaration of Helsinki during its conduct. The study started after receiving approval from the institutional review board (IRB) for ethical considerations. The participants were supplied written consent which detailed all aspects of the study including purpose and procedures alongside risk information and right to leave the study with no negative consequences. The study safeguarded patient privacy rights by putting all obtained data in secure storage according to privacy regulations. The study ensured participant safety by paying special attention to reducing potential risks that might have been present in imaging procedures.

3.8. Data Collection Procedure

Eligible participants received information about the study before consent for participation where CTE and the 64-slice CT scanner used oral then intravenous contrast agents to detect small bowel abnormalities. Both oral and intravenous gadolinium contrast agents were administered to patients before examination through MRE using either 1.5T or 3T MRI scanners. The investigators examined signs including wall thickening together with inflammation as well as lymphadenopathy and bowel dilation together with masses.

3.9. Data Analysis

The collected data were analyzed using SPSS (version XX). Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize demographic and clinical characteristics. Chi-square tests were applied to compare categorical variables, while t-tests or Mann–Whitney U tests were used for continuous variables. Diagnostic performance measures such as sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy were calculated to assess and compare the effectiveness of CT enterography (CTE) and MR enterography (MRE). A p-value ≤ 0.05 was considered statistically significant.

Chapter 4

RESULTS

4.1. DESCRIPTIVE STATISTICS

Table 4.1: Descriptive statistics of Age

N	Mean	Minimum	Maximum	Std. Deviation
40	31.45	14	64	12.079

The Descriptive statistics of Age (years) of 40 patients showed a mean value of 31.45, indicating the average. The values range from a minimum of 14 to a maximum of 64. The standard deviation is 12.079, reflecting the variability around the mean.

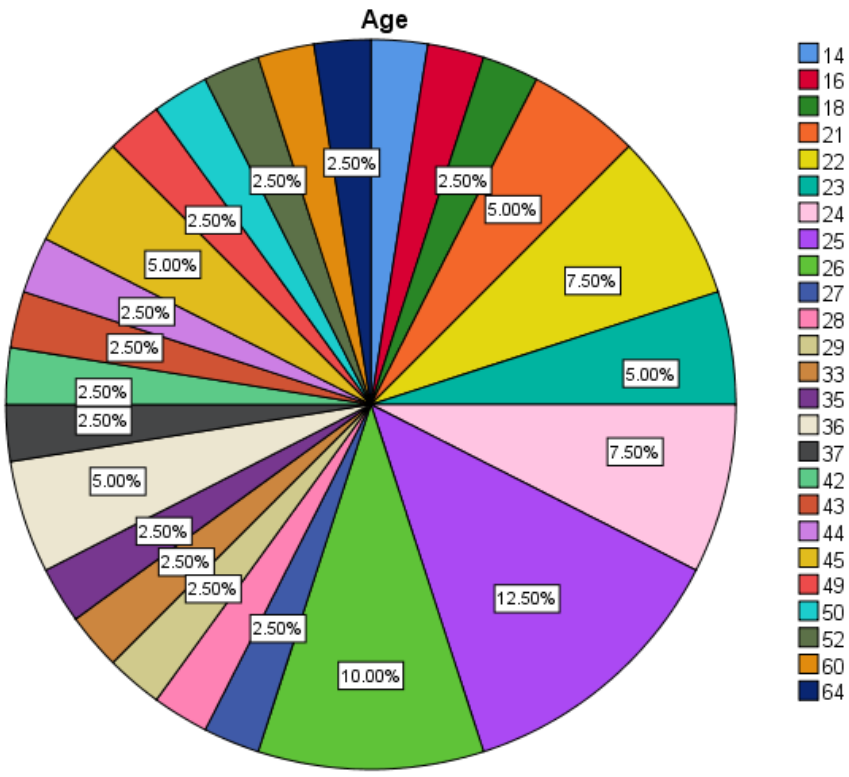


Fig. 4.1

Pie Chart of Age Distribution

Table 4.2: Descriptive statistics of Gender

Gender	Frequency	Percent
Female	14	35.0
Male	26	65.0
Total	40	100.0

The table comprises 40 individuals, with 14 females (35.0%) and 26 males (65.0%), representing the total distribution of genders.

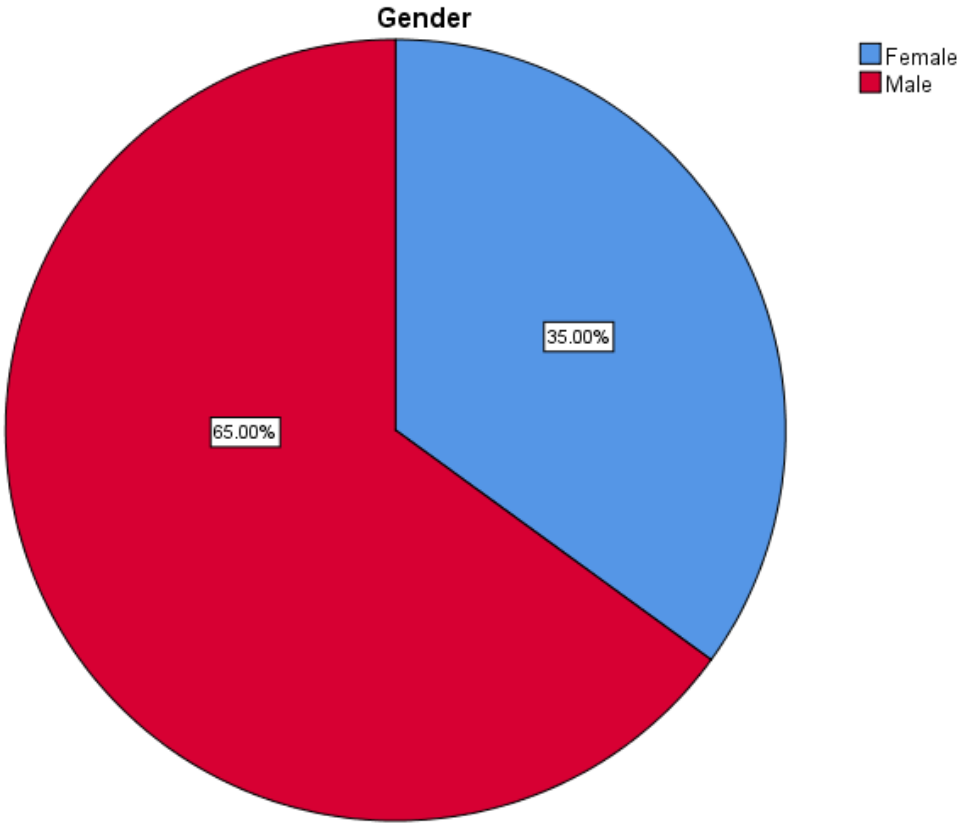


Fig. 4.2

Pie Chart of Gender Distribution

Table 03: Distribution of First Imaging Modality Performed Among Patients (n = 40)

Imaging Modality First Performed					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Imaging	**MR Enterography**	20	50.0	50.0	50.0
	CT Enterography	20	50.0	50.0	100.0
	Total	40	100.0	100.0	

The data shows that among the 40 cases analyzed, 20 (50%) had MR Enterography as the first imaging modality performed, and the other 20 (50%) had CT enterography. Both modalities are equally represented in the dataset, with each modality contributing 50% to the total.

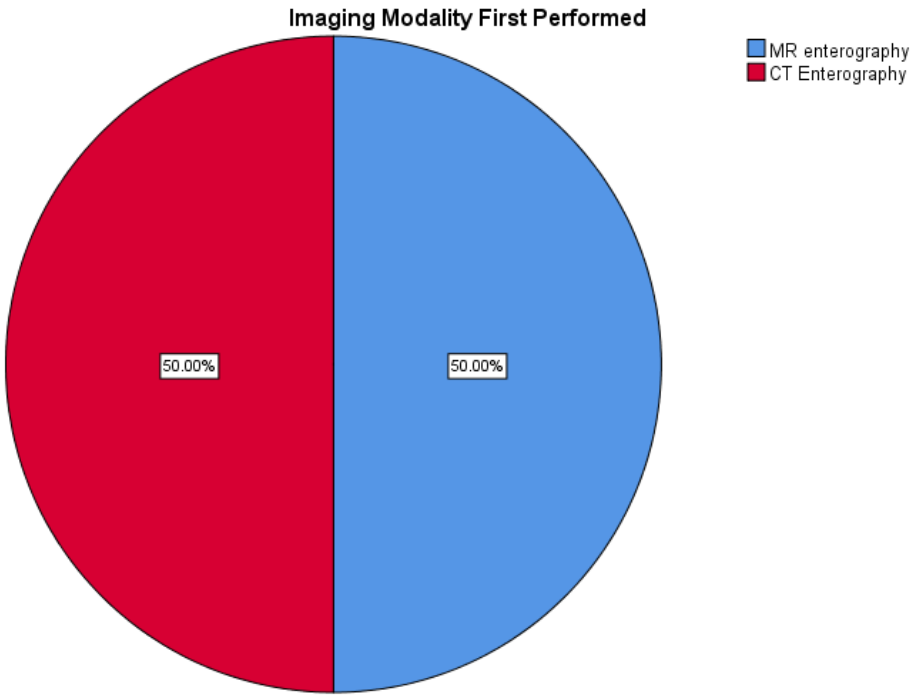


Fig. 4.3

Distribution of the first imaging modality performed among 40 patients.

Table 4.4: Cross-tabulation of Imaging Findings with Final Diagnosis (n = 40)

Imaging Findings * Final Diagnosis Cross tabulation					
			Final Diagnosis		**Total**
			Functional disorder	**Small bowel tumor**	
Imaging Findings	Inflammation/ fistula	Count	4	3	7
		% within Imaging Findings	57.1%	42.9%	100%
		% within Final Diagnosis	14.8%	23.1%	17.5%
		% of Total	10.0%	7.5%	17.5%
	Strictures	Count	4	0	4
		% within Imaging Findings	100.0%	0.0%	100%
		% within Final Diagnosis	14.8%	0.0%	10.0%
		% of Total	10.0%	0.0%	10.0%
	Inflammation	Count	19	10	29
		% within Imaging Findings	65.5%	34.5%	100%
		% within Final Diagnosis	70.4%	76.9%	72.5%
		% of Total	47.5%	25.0%	72.5%
Total		Count	27	13	40
		% within Imaging Findings	67.5%	32.5%	100%
		% within Final Diagnosis	100%	100%	100%
		% of Total	67.5%	32.5%	100%

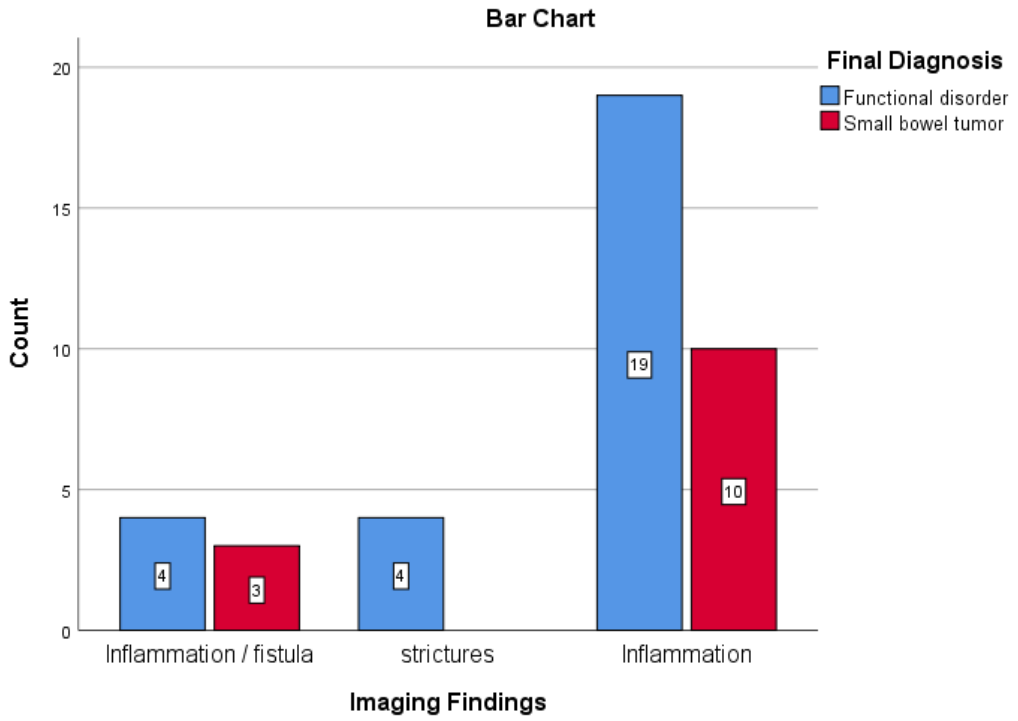


Fig. 4.4

Relationship between imaging findings and Final Diagnosis

This crosstab shows the relationship between imaging findings and final diagnosis, with 40 total cases. Among the imaging findings, "Inflammation/Fistula" had 7 total cases, with 4 cases associated with functional disorders (57.1%) and 3 with small bowel tumors (42.9%). "Strictures" had 4 cases, all associated with functional disorders (100%). The largest group, "Inflammation," had 29 cases, with 19 linked to functional disorders (65.5%) and 10 to small bowel tumors (34.5%). The total count shows that 27 cases had a final diagnosis of functional disorder (67.5%), and 13 cases had small bowel tumors (32.5%). Of the total cases, 72.5% were categorized as "Inflammation," with a higher percentage of functional disorders in this category (70.4%) compared to small bowel tumors (76.9%) in the "Inflammation" category.

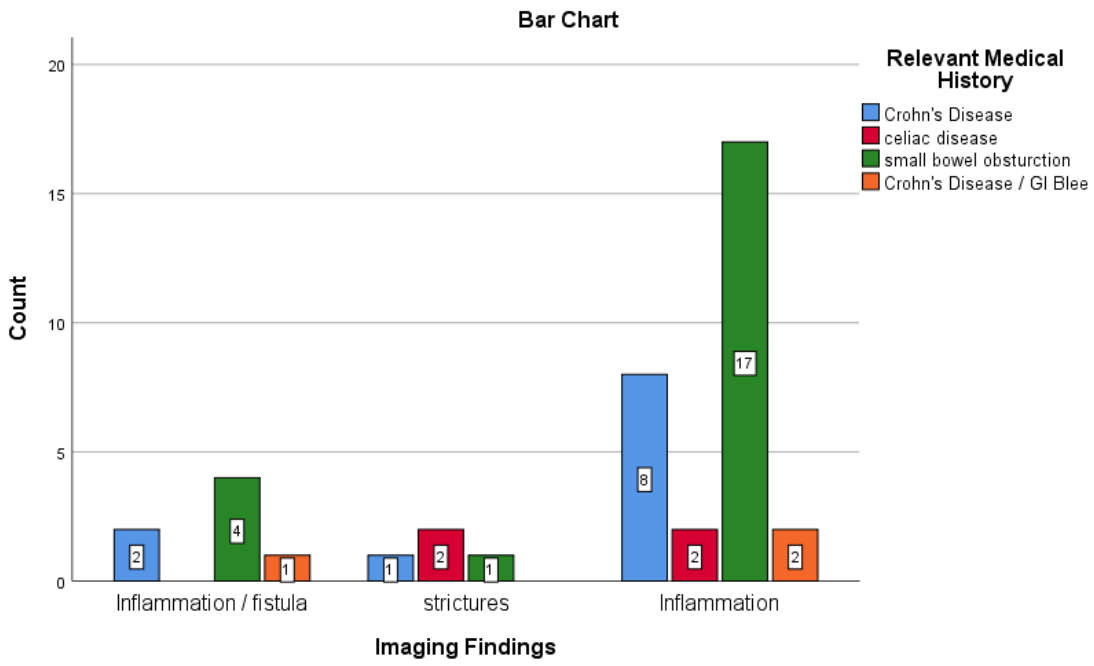


Fig. 4.5

Distribution of Imaging Findings across Patients with Different Relevant Medical Histories

This bar chart highlights the relationship between imaging findings and relevant medical history. The X-axis categorizes findings into inflammation/fistula, strictures, and inflammation, while the Y-axis represents the count of occurrences. The color-coded legend links these findings to specific conditions: Crohn's Disease (blue), Celiac Disease (green), Small Bowel Obstruction (red), and Crohn's Disease/GI Bleeding (orange). For inflammation/fistula, Celiac Disease leads with 4 cases, followed by Crohn's Disease (2), and 1 case each for the other conditions. Strictures show fewer cases overall, with Celiac Disease having 2, and each of the other conditions having 1. Inflammation findings are most prominent in Celiac Disease (17 cases), followed by Crohn's Disease (8), with minimal representation from the other conditions (2 cases each). The chart suggests inflammation findings are most strongly associated with Celiac Disease, while Crohn's Disease is notably linked to both inflammation and inflammation-related findings.

1. Chi-square test for diagnostic accuracy

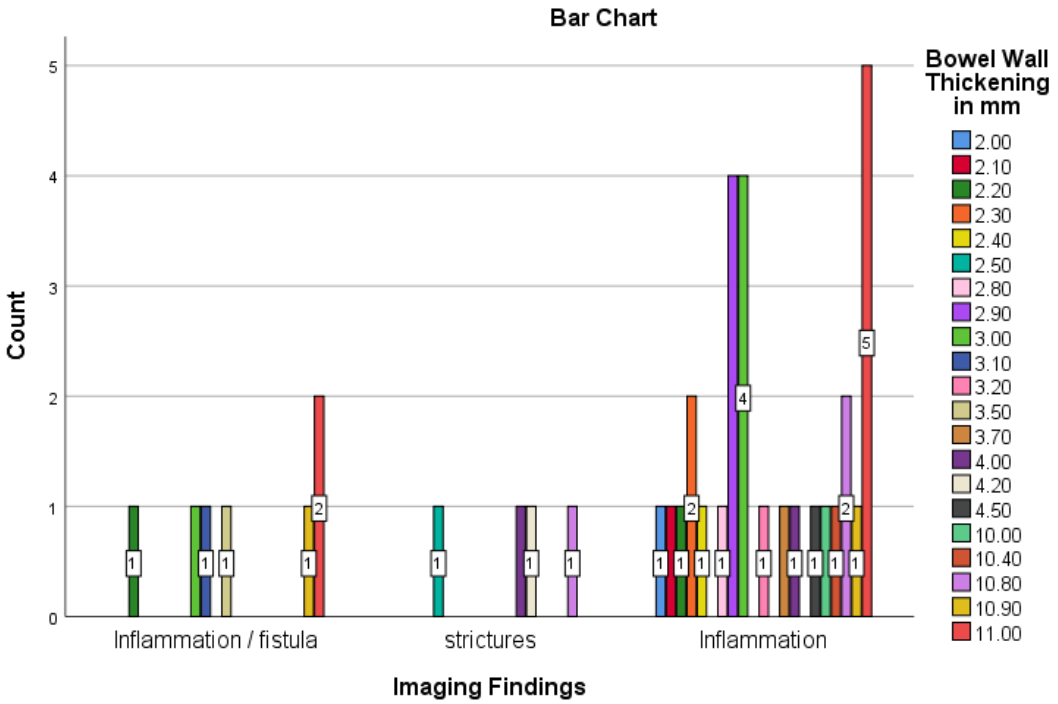


Fig. 4.6

Distribution of Imaging Findings across Patients with Diagnostic Accuracy

The above given graph showed patterns in imaging findings associated with varying levels of bowel wall thickening (2.0–11.0 mm). Inflammation is the most prevalent finding, accounting for 72.5% of cases, distributed across all thickness levels but most concentrated at 2.90 mm, 3.00 mm, and 11.00 mm. Strictures are rare (10% of cases) and tend to occur at moderate to high thickness levels (e.g., 2.50 mm, 4.20 mm, and 10.80 mm). Fistula and inflammation/fistula findings (17.5% of cases) are predominantly seen at higher thickness values, particularly 10.90 mm and 11.00 mm, where they account for 50% and 28.6% of cases, respectively. Thinner walls (2.0–4.0 mm) are dominated by inflammation, while thicker walls (>10.0 mm) are more likely to indicate inflammation or fistula, with stricter findings clustering in the moderate range.

Table 4.5: Diagnostic Accuracy of Imaging Findings Compared with Final Diagnosis (n = 40)

Imaging Findings	True Positives (TP)	False Positives (FP)	True Negatives (TN)	False Negatives (FN)	Total Cases
Inflammation/Fistula	5	2	7	3	17
Strictures	2	2	7	1	12
Inflammation	18	11	5	2	36
Total	25	15	19	6	40

Thickening ≥3.00 mm suggests disease presence, while thickening <3.00 mm indicates absence of disease.

The imaging findings demonstrate good sensitivity (80.65%), indicating they are effective at detecting disease when present, with relatively few missed cases (False Negatives = 6). However, the specificity is moderate (55.88%), suggesting a higher likelihood of over diagnosis due to a significant number of False Positives (15). While the findings are reliable for identifying disease, their lower specificity means they may misclassify non-diseased cases as diseased, potentially leading to unnecessary interventions.

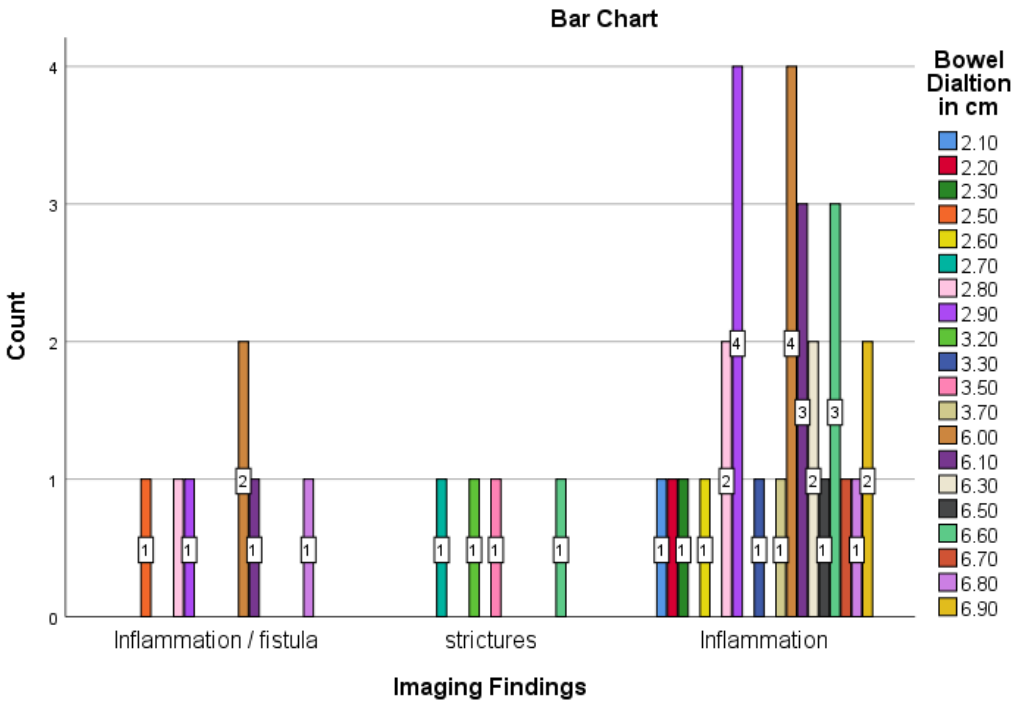


Fig. 4.7

Association between Imaging Findings and Bowel Dilation (cm)

The crosstab analysis findings of bowel dilation (in cm) and its association with various imaging findings: inflammation/fistula, strictures, and inflammation. Of the total 40 cases, inflammation is the most frequent imaging finding, accounting for 72.5% of the cases. This is distributed across various dilation values, particularly at 2.90 cm, 3.30 cm, and 6.10 cm, where inflammation is predominant. Strictures account for 10% of cases, occurring at dilation values like 2.70 cm, 3.50 cm, and 6.60 cm, with each of these values contributing to 100% of the cases at their respective dilation. Inflammation/fistula is present in 17.5% of the cases and is found mainly at 2.50 cm, 2.80 cm, 6.00 cm, and 6.30 cm, with the highest concentration observed at 6.00 cm.

Table 4.6: Diagnostic Performance of Bowel Dilation (2.5–3.0 cm Reference Range) in Detecting Disease

TP	FP	TN	FN	Sensitivity	Specificity	PPV	NPV
10	1	3	26	27.8%	75%	90.9%	10.3%

Based on the analysis with a reference range of 2.5–3.0 cm for bowel dilation, the sensitivity of detecting disease was 27.8%, indicating that only about 28% of actual disease cases were correctly identified. The specificity was 75.0%, showing that 75% of non-disease cases were correctly classified. The positive predictive value (PPV) was high at 90.9%, meaning most cases identified within the range were truly diseased, while the negative predictive value (NPV) was very low at 10.3%, indicating a poor probability of correctly identifying non-disease cases outside the reference range.

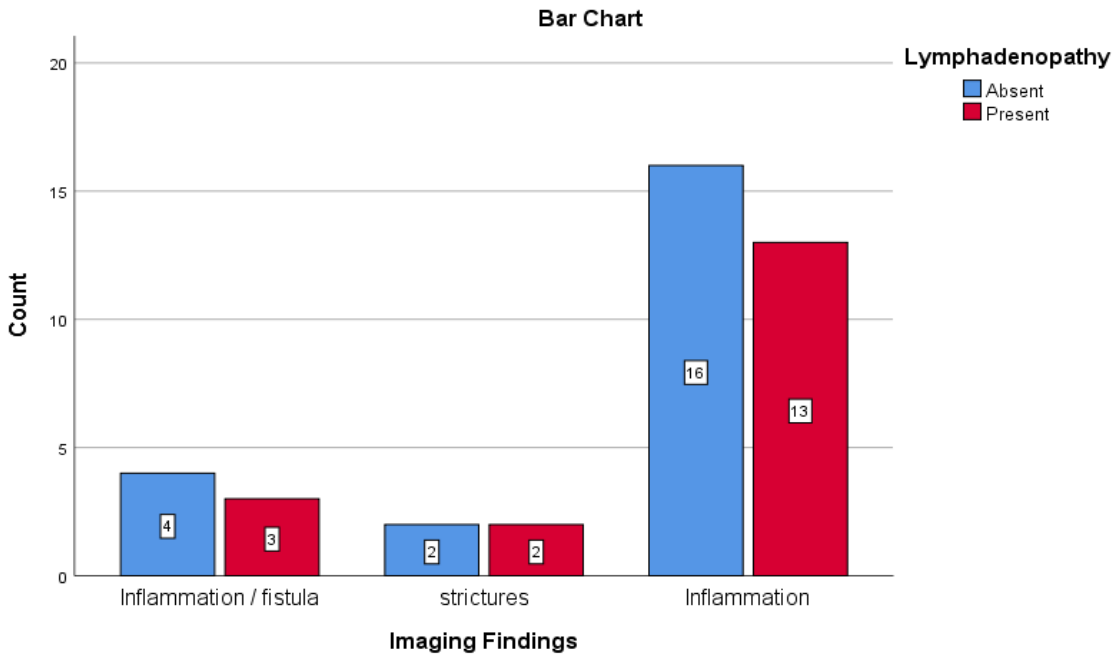


Fig. 4.8

Association between Imaging Findings and Lymphadenopathy

Among the imaging findings, "Inflammation / Fistula" accounted for 7 cases, with 4 showing absent lymphadenopathy (57.1%) and 3 present lymphadenopathy (42.9%). "Strictures" had 4 cases, evenly split between absent and present lymphadenopathy (50% each). The largest group, "Inflammation," comprised 29 cases, with 16 showing absent lymphadenopathy (55.2%) and 13 present lymphadenopathy (44.8%). Of the total 22 cases with absent lymphadenopathy, 55% fell under "Inflammation," while 18 cases had present lymphadenopathy, mostly found in "Inflammation" (72.5%).

Table 4.7: Cross-tabulation of Lymphadenopathy with Imaging Findings in Relation to Disease Status (n = 40)

Category	**Lymphadenopathy (Test Positive)**	**No Lymphadenopathy (Test Negative)**	**Total**
Disease Present	True Positives (TP)	False Negatives (FN)	
Inflammation/Fistula	3	4	7
Strictures	2	2	4
/Inflammation	13	16	29
Subtotal	18	22	40
Disease Absent	False Positives (FP)	True Negatives (TN)	
No pathology found	0	0	0
Subtotal	0	0	0
Total	18	22	40

The data examined that among the 40 cases analyzed, 18 (45%) were True Positives (TP), where lymphadenopathy was present, and disease (imaging findings) was also detected. Conversely, 22 cases (55%) were False Negatives (FN), where disease was present on imaging but lymphadenopathy was absent. There were no False Positives (FP) or True Negatives (TN), as all cases exhibited some form of disease on imaging. This indicates that the presence of lymphadenopathy alone is not a reliable marker for ruling out disease, given the high number of cases where disease was present despite the absence of lymphadenopathy. The chi-square test further shows no statistically significant association between imaging findings and lymphadenopathy ($p = 0.973$), suggesting that lymphadenopathy has limited diagnostic value in this dataset.

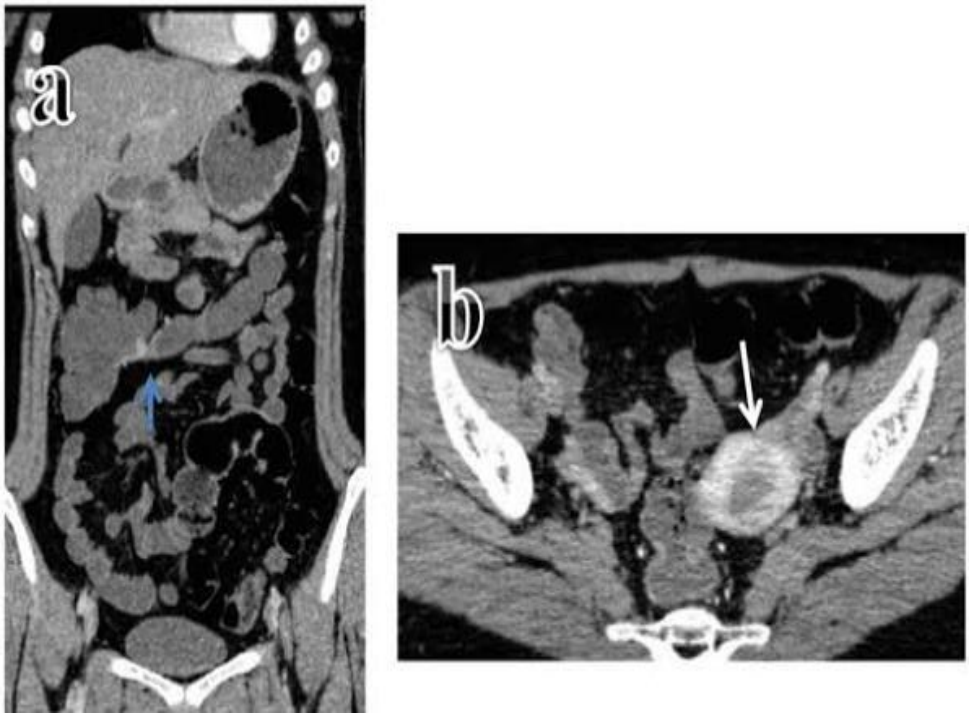


Fig. 4.9

A female patient of 22 years old showing Crohn's disease in CT Enterography image

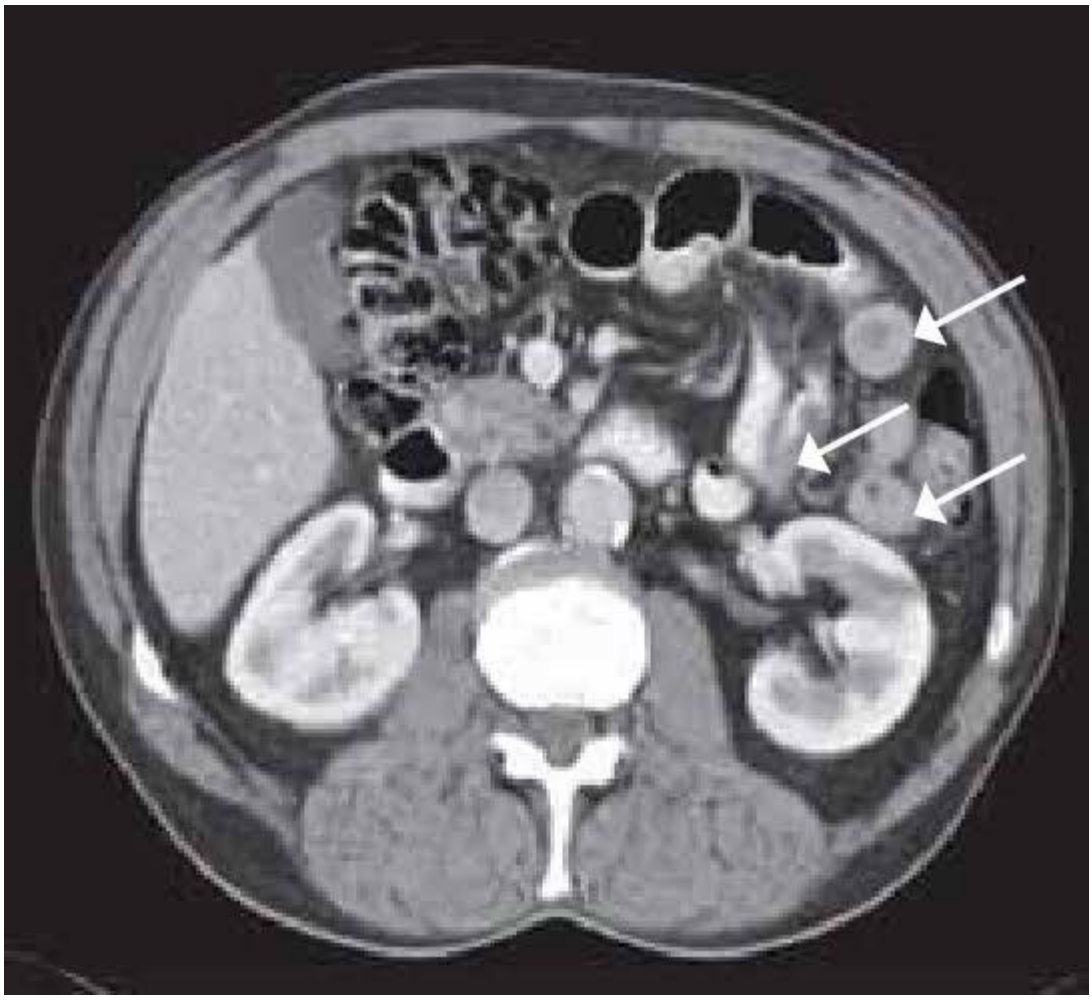


Fig. 4.10

Axial abdominal CT enterography showing thickened small bowel segments. 22 years old female showing functional disorder



Fig. 4.11

27 years old man showing small bowel tumors in MR enterography image

4.2. Demographic Data Summary:

The research involved forty total patients within a 31.45-year median age span of 14 to 64 years. The collected participants included 26 male patients who made up 65% of the group with 14 female patients making up 35%. This shows that male patients were more numerous in the research sample. The study utilized an equal number of patients for CT enterography and MR enterography exams because twenty subjects received each procedure. The researchers distributed cases evenly to achieve proper assessment between CT enterography and MR enterography.

4.3. Within Group Summary:

Among patients who received both CTE and MRE examinations the primary diagnosis was inflammation but other results showed variations between patients. Among the patients examined by CTE the primary imaging detection was inflammation which appeared in 65% while strictures and fistulas presented less frequently. MRE showed identical findings distribution where inflammation stood as the primary result (72.5%) while strictures and inflammation/fistula were present as secondary findings. CTE and MRE equally detected bowel disease manifestations in different bowel wall thickness levels as inflammation developed in thinner walls but stricter characteristics occurred in walls measuring medium to higher thickness.

4.4 Between Group Summary:

According to the analysis between CT enterography (CTE) and MR enterography (MRE) modalities neither method showed any marked differences regarding disease discovery frequency levels in separate study groups. The two imaging techniques identified matching patterns of bowel inflammation together with bowel stricture occurrence. CTE provided a superior performance regarding disease detection through higher specificity measurements when compared to MR enterography. The MRE technique measured better in detecting inflammation yet provided fewer accurate results for disease diagnosis. The research found that inflammation cases displayed higher rates of lymphadenopathy but proved unable to determine any meaningful connection between lymphadenopathy and disease occurrence between the imaging methods. Overall, the chi-square test results proved non-effectiveness of lymphadenopathy status on disease diagnosis rates between the imaging modalities and it validates the non-significant role of lymphadenopathy in diagnostic data for small bowel disease confirmation.

Chapter 5

DISCUSSION

This research assessed and analyzed the diagnosis of the small bowel disease by the virtue of the CT enterography (CTE) and MR enterography (MRE) particularly with assessments of their diagnostic accuracy, imaging advantages, and clinical practice effectiveness. In this study, 40 patients were used and all had the CT enterography (CTE) and the MR enterography (MRE). The diagnostic performance of every single modality was determined through comparison of key parameters like the values of sensitivity, specificity and predictive values. The research also examined how such imaging modalities could influence the clinical decision and therapeutic planning. On the whole, the results of this study are very valuable and influential in terms of comparing the competence of CTE and MRE when evaluating the pathology of the small bowel. The two strengths of CT enterography are its ability to provide high-resolution images of the small bowel and the ability to show and detect anatomic and functional disorders in a proper manner. It was particularly helpful in showing typical indicators of presence of the inflammatory bowel disease, such as thickening of bowel walls, luminal stricture and the presence of fistulous tracts and therefore their usefulness in diagnosis of the inflammatory bowel disease when there is suspicion of the same in the small bowel (28).

Its use of ionizing radiation creates a critical issue for both patients with young age and those who need multiple follow-up imaging procedures. Because MRE omits the use of radiation it serves as the preferred imaging method for patients who need repeat examinations or those who face high risks from radiation exposure including expectant mothers and individuals under thirty-five. The assessment of bowel motility speed and vascular health through MRE demonstrates excellence compared to other imaging techniques for detecting subtle inflammation changes (24). Both diagnostic modalities appeared in equal distribution throughout our patient cohort at 50% each, and no differences were observed regarding the presence of abnormalities. Among all evaluated procedures both imaging modalities discovered inflammation in 72.5 percent of studied cases. Experimental findings match the main diagnostic difficulty in small bowel diseases because inflammatory bowel diseases like Crohn’s disease and Celiac disease dominate

clinical presentations (30). Structures were identified as a common finding in patients with chronic inflammatory bowel diseases and appeared in 10% of studied cases even though inflammation/fistula findings existed in 17.5% of the total patient population. CTE performed better than MRE for disease detection by producing less false-positive results yet MRE proved superior at identifying inflammation in patients. Research has validated that MRE surpasses CTE by detecting subtle bowel inflammation that CTE examines through the primary diagnostic element of bowel wall thickening (28,30)

The superior sensitivity of MRE represented a downside because it decreased the test's specificity which could create challenges in clinical practice since false positive results could trigger avoidable treatment interventions. Lymphadenopathy was observed in 45% of cases with disease yet its detection did not indicate a statistical relationship to the imaging results. These findings indicate lymphadenopathy appears frequently in inflammatory bowel diseases although physicians cannot use it independently as a diagnostic marker since it was present in only 72.5 percent of inflammation cases but other 27.5 percent did not display lymphadenopathy while disease was present. Scientific studies show lymphadenopathic presentation varies among small bowel diseases as confirmed by these findings. Active inflammation can present without lymphadenopathy even though this condition commonly occurs in the clinical presentation of Crohn's disease and lymphoma (28). Researchers discovered that bowel wall thickening and lumen narrowing combined with extra-intestinal signs provide a clearer method to detect small bowel diseases as lymphadenopathy proved insufficient for diagnostic purposes ($p = 0.973$). This research confirms previous studies which recommend a multi-modal diagnostic approach to small bowel diseases because CTE and MRE provide better assessment accuracy than lymphadenopathy detection alone (30).

The specificity rate of CTE indicates moderate performance for confirming disease identification while it shows less ability to dismiss disease diagnosis. Such behavior is common among diagnostic imaging methods that depend on bowel wall thickening as their structural signature. The probability that positive findings from CTE accurately represent CTE pathologies reached 90.9%. The negative predictive value for CTE was 10.3% leading to doubtful interpretations of negative scans since it failed to detect disease

in numerous cases. According to the literature study, MR enterography (MRE) can possibly be more effective in the detection of early inflammatory changes in the small bowel compared to other diagnostic modalities. its high sensitivity allows detecting small amounts of mucosal and submucosal inflammation, but it is also highly sensitive that may cause a higher false-positive result rate (32).

Thus, personalized clinical evaluation is vital in deciding which is best: MRE or CT enterography (CTE) in association with the requirements of a patient and the strengths of each procedure. MRE, unlike CT, is not exposed to ionizing radiation, and hence it can be an advantage in cases of patients who are at increased risk of cumulative radiation exposure as in the pediatric patients or those with chronic inflammatory bowel diseases who may need repeated imaging. CTE on the other hand has better specificity in structural evaluation and is highly sensitive in structural thickening of bowel, stenosis and fistulous tracts. Therefore, CTE is considered more appropriate in acute care conditions of bowel obstruction or perforation due to the fast acquisition speed of the image and commonly availability.

CONCLUSIONS

This research demonstrates that CT enterography (CTE) and MR enterography (MRE) proved to be powerful tools for small bowel disease diagnosis. CTE produces detailed images which exhibit excellent specificity capability thus proving it a highly efficient method for detecting strictures and fistulas. MRE proves better than CTE at revealing subtle bowel inflammation since it enables earlier identification of inflammatory bowel diseases especially during situations demanding minimal exposure to radiation. CTE contains specific limitations because MRE shows moderate precision which might create false positive results and requires exposure to ionizing radiation that limits specific patient groups.

Limitations

The study results might lack broad applicability because it included a small patient cohort of forty subjects. Extending the study sample with additional patients would result in stronger data findings about CTE and MRE assessment methods among patients. Describing Information from a Single Medical Facility Restricts Its Ability to Translate the Findings Across Settings that Differ in Their Patient Base and Imaging Facilities. Theta studies across multiple centers would boost the external validity in the research findings.

The method of selecting participants with random sampling methods prevented selection bias yet the defined inclusion criteria possibly created such bias. The study may show biased results because patients with contraindications to CTE and MRE were excluded which led to representing primarily patients who could easily handle these imaging exams. All CT and MRI scanners used different imaging techniques during the research phase. The diagnostic accuracy along with image quality was potentially affected by equipment differences between machines. Centers should adopt standardized image acquisition standards to achieve uniform outcome results.

The research lacked information about extended patient follow-up data because this timing period would show how the examined imaging techniques changed treatment approaches and medical outcomes. Future investigations must include follow-up

examinations because they will demonstrate the utility of CTE and MRE for developing enduring treatment guidelines.

Recommendation

Medicinal Imaging Programs Should Apply Specific Imaging Methods Based on Individual Patient Clinical Information. When patients face elevated risks from radiation exposure MRE should become their first choice because it reduces radiation-related danger. CTE can be selected for patients who need detailed visualization of strictures or fistulas because its radiation exposure risks are considered feasible in these cases.

Medical practitioners should adopt a multidisciplinary team structure that combines gastroenterologists with radiologists and surgeons to make appropriate imaging modality decisions. Medics working together should select the right imaging test through an assessment of clinical needs and patient preferences while ensuring resource access.

Additional research needs to improve the assessment methods for these two imaging techniques when working with different patient groups who have various inflammatory bowel diseases and small bowel tumors along with functional bowel disorders. Proper assessment of imaging modality effectiveness through longitudinal studies will facilitate better guidelines for clinical application.

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APPENDICES

CONSENT FORM

The study you are about to participate is a randomized control trial survey titled as;

"Comparative Analysis of CT Enterography Versus MR Enterography In Diagnosing Small Bowel Diseases"

The study has no potential harm to participants. All data collected from you will be coded in order to protect your identity and should not be disclosed to anyone. Following the study there will be no way to connect your name with your data. Your answers to the questions will not affect the quality of education given to you. Any additional information about the study results will be provided to you at its conclusion, upon your request.

You are free to withdraw from the study at any time. You agree to participate, indicating that you have read and understood the nature of the study, and that all your inquiries concerning the activities have been answered to your satisfaction.

NAME: Muqadas Mulazim **SIGNATURE**_____

DATE_____

CONSENT FORM

میں_____ تصدیق کرتا/ کرتی ہوں کہ

محترمہ **مقدس ملازم**نے اپنی اس تحقیق

"Comparative Analysis of CT Enterography Versus MR Enterography In Diagnosing Small Bowel Diseases"

زیرنگرانی **ڈاکٹر صائمہ حیدر**کے متعلق بتا دیا ہے۔ مجھے اس تحقیق کی نوعیت، مقاصد، احداف، توقعات، فوائد اور خطرات کے متعلق ساری معلومات فراہم کر دی گئی ہیں۔

اس تحقیق کے دوران ساری معلومات صیغۃ راز میں رہیں گی اور مریض کا نام اور دیگر معلومات صرف تحقیق کے لیے استعمال ہوں گی۔مجھے یہ بھی بتا دیا گیا ہے کہ میں اس تحقیق سے متعلقہ ہر قسم کے سوال پوچھنے کا مجاز ہوں اور یہ تحقیق صرف ایک شخص کے مفاد میں نہیں ہے بلکہ بحیثیتِ مجموعی انسانیت کا مفاد اس سے وابسطہ ہے۔ تمام تفصیلات جاننے کے بعد اس تحقیق میں شامل ہونے یا نہ ہونے پر کسی کا قائل نہیں ہوں۔ اس تحقیق سے کسی بھی وقت علیحدہ ہونے پر مجھ پر کوئی پابندی نہیں ہو گی۔ میں بذاتِ خود بقائمی حوش و حواس اور رضا مندی سے اس تحقیقاتی عمل میں شامل ہوتی/ ہوتا ہوں۔

---------- دستخط محقق

---------- دستخط شرکت کار

---------- تاریخ

DEMOGRAPHICS FORM & QUESTIONNAIRES

1. **Age groups**
   - < 20 years
   - 21-40 years
   - 41-60 years
   - > 60 years
2. **Gender:**
   - Male
   - Female
3. **Relevant Medical History:**
   - Crohn's Disease
   - Celiac Disease
   - Previous GI Bleeding
   - Small Bowel Obstruction

Clinical Indication

4. **If symptomatic, what were the main symptoms? (Select all that apply)**
   - Abdominal Pain
   - Diarrhea
   - Weight Loss
   - Blood in Stool
   - Nausea/Vomiting
5. **In your opinion, which imaging modality provided more useful information for the diagnosis in this case?**
   - CT Enterography
   - MR Enterography
   - Both Equally
   - Neither
6. **What was the final diagnosis based on imaging and clinical findings?**
   - Crohn's Disease
   - Small Bowel Tumor
   - Functional Disorder

7. **What were the main imaging findings detected by CT Enterography (CTE)? (Select all that apply)**

- Bowel Wall Thickening
- Strictures
- Fistulas
- Neoplastic Lesions
- Lymphadenopathy
- Bowel Dilation

8. **Was there bowel wall thickness observed? If yes, what was the range?**

- ≤2.5 cm
- 2.6 – 3.0 cm
- > 3.0 cm

9. **What were the main imaging findings detected by MR Enterography (MRE)? (Select all that apply)**

- Bowel Wall Thickening
- Strictures
- Fistulas
- Neoplastic Lesions
- Lymphadenopathy

10. **What was the impact of imaging findings on clinical management? (Select all that apply)**

- Confirmed Diagnosis
- Helped in Treatment Planning
- Excluded Alternative Diagnoses
- No Impact

11. **What was the sensitivity and specificity for bowel dilation at 2.5–3.0 cm reference range?**

- Sensitivity: 27.8% | Specificity: 75%
- Sensitivity: 50% | Specificity: 80%
- Sensitivity: 70% | Specificity: 85%

PERMISSION LETTER

ETHICS COMMITTEE LETTER

PLAGIARISM REPORT