Correlation of Ultrasonography and Computed Tomography Findings of Bowel Lesions

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Abstract: *Introduction: This was retrospective - perspective study to evaluate USG and CT finding of bowel lesion and correlation between them. Technological advancement in USG and CT has changed diagnostic accuracy and approach to intestinal lesion's diagnosis. In the last few decades, the introduction of a non - invasive cross sectional imaging techniques including Ultrasound (US), Computed Tomography (CT) have changed the diagnostic approach to the bowel pathologies. ULTRASOUND: Among the imaging modalities ultrasound is less invasive, more comfortable for the patient and has a significant diagnostic accuracy. Modern ultrasound devices with high - frequency (high resolution) probes and harmonic imaging significantly improve examination of bowel by offering better overall image quality, better visualization of bowel pathology and associated changes in real time ("live anatomy"). Unlike to other cross sectional imaging technique, USG is able to evaluate bowel wall peristalsis, compressibility, Wall vascularity and probe tenderness. Computed Tomography: The development of multi - detector CT (MD - CT) scanner with rapid acquisition of thin slices and multi planar reconstruction allows detailed investigation of intestinal loops. Intravenous contrast together with distension of intestinal lumen by water or contrast agents is very useful in the detection of inflammatory and neoplastic intestinal pathologies as well as in the evaluation of extra - intestinal involvement (mesenteric lymph nodes, matted bowel loops, sinus/fistulas). Advances in MDCT with multi planer (MPR) and 3 - Dimensional (3D) reformat capabilities allows the demonstration of pathological processes involving the bowel wall, bowel lumen, mesentery, mesenteric vessels and peritoneal cavity. Therefore knowledge and awareness of the valuable 3D CT features and proper application technique of MDCT are very useful to achieve the accurate diagnostic goal of one step imaging. Objectives: 1) To study the role of USG and MDCT in suspicion of bowel pathologies. 2) To determine accuracy of MDCT in comparison to USG in evaluation of bowel lesions. To study the imaging characteristic of bowel lesions by using both modalities and to narrow down the differential diagnosis. Materials & Methods:100 patients were evaluated in this study conducted at tertiary care hospital (P. D. U. medical hospital, Rajkot), from October 2020 to April 2022 over a period of 1½ years. USG was performed on Samsung RS80 - EVO high end machine and CT was performed using GE bright speed 16 slice MDCT machine. Results: Non neoplastic lesions are more prevalent as compared to neoplastic lesions. Colorectal malignancies are more common than small bowel malignancy and most of them will involve the recto sigmoid region of large intestine. CT has more accurate and superior results as compared to USG in detecting intestinal malignancy. CT appears to be the modality of choice to demonstrate the wide spectrum of findings seen in abdominal tuberculosis. Conclusion: Ultrasonographic examination has provided real time correlation between clinical symptoms and sonographic appearance of examined bowel segment (maximal tenderness, resistance, compressibility, presence or absence of peristalsis). CT scan is more accurate in diagnosing fat stranding and extra luminal complications like strictures, fistulas or abscess as compared to USG which is more common in chronic idiopathic inflammatory disease. CT is more specific for detection of small intestinal lesions as compared to USG.*

Keywords: USG, MDCT, bowel lesions, intestinal malignancy

1. Introduction

This was retrospective - perspective study to evaluate USG and CT finding of bowel lesion and correlation between them. Technological advancement in USG and CT has changed diagnostic accuracy and approach to intestinal lesion's diagnosis.

For many years, traditional radiological techniques have played a very crucial role in the diagnosis of bowel diseases. In the last few decades, the introduction of a non - invasive cross sectional imaging techniques including Ultrasound (US), Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Positron - Emission Tomography (PET) have changed the diagnostic approach to the bowel pathologies.

Ultrasound:
Among the imaging modalities ultrasound is less invasive, more comfortable for the patient and has a significant diagnostic accuracy. In the last 2 decades, US have had a growing role for the diagnosis of bowel diseases.

Modern ultrasound devices with high - frequency (high resolution) probes and harmonic imaging significantly improve examination of bowel by offering better overall image quality, better visualization of bowel pathology and associated changes in real time ("live anatomy").

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Unlike to other cross sectional imaging technique, USG is able to evaluate bowel wall peristalsis, compressibility, Wall vascularity and probe tenderness.

Wide availability, relatively low cost scanning, non - invasiveness, reproducibility, and absence of radiation make USG "doctor and patient friendly", which is why it is safe in young patients and pregnant women and in frequent follow up of chronic idiopathic inflammatory bowel disease. Moreover Doppler and contrast enhancement US (CEUS) contribute important information about blood flow.

High resolution (high - frequency) probes still have disadvantage of unsatisfactory penetration, so cannot be used in evaluating of deep abdominal structures, especially in obese patients.

However, sonography is highly operator dependent method and correct interpretation of sonographic findings needs adequate experience in abdominal and bowel sonography.

Computed Tomography:
The development of multi - detector CT (MD - CT) scanner with rapid acquisition of thin slices and multi planar reconstruction allows detailed investigation of intestinal loops.

Given the significant limitations in the diagnostic accuracy and specificity of plain film radiography, cross - sectional imaging like CT has revolutionized the assessment of bowel pathologies. CT has effectively replaced Barium contrast studies as the imaging modality of choice for suspected bowel pathologies.

Intravenous contrast together with distension of intestinal lumen by water or contrast agents is very useful in the detection of inflammatory and neoplastic intestinal pathologies as well as in the evaluation of extra - intestinal involvement (mesenteric lymph nodes, matted bowel loops, sinus/fistulas).

Advances in MDCT with multi planer (MPR) and 3 - Dimensional (3D) reformat capabilities allows the demonstration of pathological processes involving the bowel wall, bowel lumen, mesentery, mesenteric vessels and peritoneal cavity.

MDCT is superb in confirming the presence, determining the site, level and cause of bowel pathologies and in demonstrating complications, for example infarction and perforation. Thus, CT has become an important tool in the pre - operative assessment of bowel pathologies, providing an anatomical road - map for surgery, especially for bowel obstruction.

Therefore, knowledge and awareness of the valuable 3D CT features and proper application technique of MDCT are very useful to achieve the accurate diagnostic goal of one step imaging.

2. Aims & Objectives

- To study the role of USG and MDCT in confirmation of clinically suspected bowel pathologies.
- To study the Imaging characteristics of various bowel pathologies and narrow down the differential diagnosis using both modalities.
- To study the comparison of findings detected on USG and CT in patients of bowel pathologies.
- To determine the accuracy of MDCT in evaluation of small bowel pathologies in comparison to USG.

3. Materials & Methods

The present study was conducted in the Department of Radio diagnosis and Imaging at P. D. U. Medical College and Civil Hospital, Rajkot from October 2020 to April 2022 over a period of 1 ½ years.

USG and MDCT scan of 100 patients who fulfilled below mentioned inclusion criteria were analyzed and findings of both were correlated. Relevant clinical history pertaining to patient's complaint was evaluated for radiological diagnosis from the case records/registers.

Inclusion criteria:
- Patients who are referred to the department of Radio diagnosis with suspicion of bowel pathology and who underwent sonography and CT scan study.

Exclusion criteria:
- All cases of isolated appendicitis

Equipment and Technique:
A history of the patient including symptoms, relevant physical Examination, relevant biochemical investigations and radiological investigations (x - ray/barium study), if any, were recorded and tabulated. Ultrasonography imaging was performed on SAMSUNG RS - 80 EVO ultrasonography machines using surface and convex probe. Patient was placed on USG table in the supine position with both arms raised above the head. Multi Detector Computed Tomography imaging was performed on 16 SLICE GE BRIGHT SPEED MD - CT SCANNER.

Followed Imaging technique was initial plain CT in supine position on gantry table. Oral neutral contrast was provided 40 - 45 min. prior to IV contrast administration. Images were acquired following contrast administration in arterial, Porto - venous and delayed phases. Oral negative and oral positive contrast administered as required. Multi planar reformation and 3D reconstruction was done where ever necessary.

4. Discussion

Presentation of 100 Cases of Intestinal Lesions
Distribution of the 100 cases of intestinal lesions on USG and CT is as follows - 73 cases were of non - neoplastic lesions and 27 cases of were of neoplastic lesions

Among non - neoplastic lesions, 45 cases were of infective bowel disease, 8 cases were of Ischemic Bowel disease, 20

cases were of chronic idiopathic inflammatory bowel disease.

Most of the patients of intestinal lesions were presented with abdominal pain, fever and altered bowel habits.

Non neoplastic lesions
The non neoplastic lesions were most common in:
Male patients
Small intestine.
7th and 6th decades.

Infective Bowel Disease
Infective lesions were identified in 45 patients.
It was more common in male patients as compared to females. Maximum numbers of patients were present in 7th decade.

Most common presentation for Infective etiology was abdominal Pain (75.5%) followed by changes in bowel habits (62.2%) These findings were consistent with findings of **Azer SA et al.**

In our study, out of 48 cases of infective bowel disease, mild bowel wall thickening noted in 34 (75.55%) on USG and 35 (77.77%) on CT scan.

Marked bowel wall thickening noted in 11 (24.44%) on USG and 12 (22.22%) on CT scan.

In our study, focal involvement of bowel was detected in 26 (54.16%) cases on CT scan and segmental involvement in 22 (48.88%).

Symmetrical bowel wall involvement was detected in 30 (62.5%) and asymmetrical involvement in 18 (37.5%) on CT scan.
This is in agreement with study done by **Omprakash AR and group** on Characterization of Bowel wall thickening with CT scan.

In our study, out of 48 cases of infective bowel lesions, Cases of intestinal tuberculosis was not separately counted.

In our study, peritoneal thickening and ascites were detected in 19 (39.58%) and 16 (33.33%) cases out of 48 cases on CT scan, respectively.

Peritoneal thickening with ascites and central necrotic mesenteric lymph nodes is highly suggestive intestinal tuberculosis.

Study done by **Sinan T. And group** (CT features in abdominal tuberculosis: 20 years experience) says peritoneal involvement was the most common feature (77.5%) with ascites (wet peritonitis) seen in more than half the cases (55.2%). The rest showed peritoneal, mesenteric or omental thickening or mass formation but no ascites (dry peritonitis). Other findings included lymphadenopathy (46.9% mainly of diffuse nature, bowel wall thickening (38%) and solid organ involvement (20.4%).

Chronic Idiopathic Inflammatory Bowel Disease:
Male to female ratio of prevalence is 0.8. This finding was consistent with **Kedia S**

Most frequent Symptom of chronic inflammatory bowel disease was changes in bowel habits (80%) followed by blood in stool (70%) and abdominal pain (60%). This finding was in concordance with study done by **Alreheili K et al**

Table 12: Comparison of site of involvement in CD

Site of involvement	CT	Govind M makaria
Small bowel	16.66%	28.9%
Large bowel	5.55%	31.4%
Both	22.22%	39.6%

In present analysis, most commonly involved part by crohn's disease is small bowel followed by ileo - colic region and then large bowel. This is in consistent with study done by **Govind M.**

Table 13: Comparison of Site of involvement in UC

Site of involvement	CT	Govind M makaria
Colon	27.77%	42.8%
Left side colon	16.66%	38.8%
Rectum	11.11%	18.3%

In present analysis, most commonly involved part by ulcerative colitis is colon (pan colitis) followed by left sided colon and least was rectum involvement. This is in consistent with study done by **Govind M.**

In present analysis, mild bowel wall thickening was detected in 14 (77.77%) of patients and marked thickening in 4 (22.22%).
Worlicek et al reported that thickening of bowel wall was detected in 87% patients with crohn's disease and in 53% with ulcerative colitis.

J H Lim has reported that thickening of bowel wall in 89% in inflammatory bowel disease.

Table 14: Comparison of USG detection of Complications:

Findings		Current study	C Gasche
Perienteric complication	Fistula	66.66%	87%
	Stricture	50%	100%
	Abscess	100%	100%

In present analysis, 5 patient of Crohn's disease has peri enteric complication in form of abscess, sinus and stricture.

Abscess was detected in 2 patients out of 3, Fistulas were detected in 1 patient out of 2, 2 structure were detected on USG out of 2 detected in CT. This is in concordance with study done by **C gasche.**

In a series of 58 patients with CD, including 28 (48.27%) patients with bowel stenosis, 23 (39.65%) patients with fistulas and 10 (17.24%) patients with abscesses, high - resolution US showed a high diagnostic accuracy in comparison to clinical, endoscopic, radiological and operative findings was found in study done by **Holger neye and group.**

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Ischemic Bowel Disease
8 patients of bowel ischemia were identified. Most common etiology was mesenteric artery thrombosis (62.5%), followed by Non occlusive mesenteric ischemia (25%) then Mesenteric vein thrombosis (12.5%).

Maximum no. of cases were of mesenteric vessels thrombosis was detected in CT [6 (75%)]. Out of this, 5 cases were detected of superior mesenteric artery thrombosis (62.5%). **Regineli et al and Dhatt H S** demonstrates MDCT reaches a similarly high sensitivity in diagnosing acute bowel ischemia.

Table 15: Cause of bowel ischemia

Cause	Current Study	Dhatt H S
Arterial embolus/ thrombosis	62.5%	65%
Venous embolus/thrombosis	12.5%	7.5%
Non Thrombotic	25%	25%

In present analysis, most common cause of bowel ischemia was vessels thrombosis. Among them arterial thrombosis was most common followed by non thrombotic occlusion ischemia. This is in concordance with study done by **Dhatt H S.**

Table 16: Comparison of CT findings

Findings		Current study	Macari et al
Length of involvement	Segmental	14.28%	16%%
	Diffuse	85.71%	**84%**

In present analysis, diffuse involvement of bowel was most common in ischemic bowel disease followed by segmental involvement**.**

No focal bowel involvement was seen our study. This is in concordance with study done on bowel wall thickening evaluation on CT by **Macari et al.**

In present analysis, USG was able to detect mild bowel wall thickening in 4 (57.14%) cases and thinning of bowel wall in 3 (42.85%) cases.

Study done by **A Reginelli** says late phase US may show a fluid - filled lumen, bowel wall thinning, evidence of extra luminal fluid and decreased or absent peristalsis. Ultrasound may show a homogeneously hypo echoic intestinal wall as a result of edema that occurs earlier in the course of disease when compared with SMA compromise. In late stage US reveals mural thickening of the involved segment.

Mild thickening of bowel wall seen on CT in 5 cases of ischemia out of 7 cases. In Acute mesenteric ischemia of venous causes, wall thickening is more frequent than other causes. This is in agreement with study done by Lorenzo Garzelli. Bowel wall thickening of >8 mm and up to 15 mm is often observed with mesenteric venous occlusion proved in study done by **Wasnik and group**.

When acute arterial occlusion results in intramural hemorrhage, edema and/or superimposed infection, abnormal bowel wall thickening up to 15 mm of the small and large intestines is commonly demonstrated in study done by **H S Dhatt.**

Out of 4 cases of superior mesenteric arterial ischemia, 2 (37.5%) patient had thinning of bowel wall on CT.

This is in agreement with study done by **Lorenzo Garzelli o**n CECT for the diagnosis of acute mesenteric ischemia saying bowel wall thickening is typically encountered in cases of arterial occlusion with bowel wall typically having paper thin appearance. Sensitivity is reported to be 40%. Bowel wall thinning is an early and suggestive feature in NOMI without perfusion.

Out of 7 patients, 6 patients has showed decreased bowel wall enhancement on CT scan in our study. This is in agreement with study done by **Lorenzo Garzelli** saying decreased bowel enhancement is major features because it is a sign of the decreased blood in flow to the bowel wall. This feature has sensitivity of range 18% - 92%.

Neoplasia
27 cases of neoplasm were identified.19 cases were male and 8 were female. Neoplastic lesions were most common in the 7th decades of life.

Table 17: Comparison of site specific malignancy for small intestine:

Part of small intestine	Current Study (%)	Emmy Ludwig
Duodenum	14.81%	25.4%
Jejunum	7.40%	15.3%
Ileum	3.70%	29.7%

The frequency of small bowel tumors decreases from the proximal to distal small bowel. This finding is in concordance with Study of **Emmy Ludwig.**

Table 18: Comparison of Site specific malignancy for large intestine:

Part of Large Intestine	Current Study (%)	M. Ponz de Leon
Recto sigmoid region	29.62%	30.7%
Descending colon	11.11%	8.1%
Ascending Colon	11.11%	13.6%
Transverse colon	3.70%	13.4%
Ceacum	3.70%	8.1%

- Among Neoplastic lesions, Large intestine involved more frequently.
- Among Large intestine, malignant lesion was more prevalent as compared to benign lesion.
- Recto sigmoid region is the most commonly involved site (29.6%) for malignancy of large intestine which is consistent with study of **M. Ponz de Leon**.

Table 19: Comparison of CT imaging feature for bowel neoplasms

Wall thickening	CT	Cengiz Karacin
Severe	62.96%	33.3%
Asymmetrical	70.37%)	41.7%
Focal	74.07%)	62.5%

In present analysis, neoplasm was presented with severe asymmetrical and focal wall thickening on CT scan. This is in concordance with study done by **Cengiz Karacin.**

Table 20: Comparison of peritoneal metastasis detection

Finding	CT	Prachi S. Patil
Peritoneal Metastasis	11.11%	9.9%

In present analysis, peritoneal metastasis detection was in 11.11% by CT scan. This is 9.9 % in study done by **Prachi S patil.**

Out of 23 malignant lesions, 20 has shown heterogeneous enhancement while 3 has showed homogenous enhancement.

Study done by **Macari et al** confirms this saying Heterogeneous enhancement is typical of small - bowel neoplasm. Although -any small bowel tumor may appear this way, heterogeneous enhancement is most frequent with adeno carcinoma and malignant gastrointestinal stromal tumors (GISTs).

5. Results

Non neoplastic lesions are more prevalent as compared to neoplastic lesions.

Colorectal malignancies are more common than small bowel malignancy and most of them will involve the recto sigmoid region of large intestine.

CT has more accurate and superior results as compared to USG in detecting intestinal malignancy.

CT appears to be the modality of choice to demonstrate the wide spectrum of findings seen in abdominal tuberculosis.

6. Conclusion

- CT appeared to be the modality of choice to demonstrate the wide spectrum of findings seen in the Infective bowel lesions. CT was able to demonstrate more number of findings as compared to ultrasonography in patients of infective bowel disease.
- Ileum and Ceacum accounts for majority of cases of infective lesions followed by recto sigmoid.
- USG was less specific for detection of small intestinal lesions due to gaseous content and central abdominal fat deposition.
- CT was more able to detect fat stranding and mesenteric thickening as compared to USG.
- In inflammatory bowel disease, CT has higher sensitivity for detection of extra luminal complication as compared to USG.
- Most common region to be involved in inflammatory bowel disease is ileo - caecal region in crohn's disease and left sided colon in ulcerative colitis.
- CT had superior results for detection of intestinal lesions and its complication /consequences in all aspect as compared to USG.
- In every age group, USG had very good sensitivity for diagnosis of intestinal lesion as compared to CT scan. So USG has a very crucial role in as a first line investigation in low resource and remote health care centre where cross section modality is difficult to access.

References

[1] Michal Patlas, Douglas S. Katz mariano scaglione - springer 2018 - MDCT and MR Imaging of Acute abdomen, New technologies and Emerging issues.
[2] John Haaga, Daniel Boll, CT and MRI of the Whole Body 6th edition.
[3] Grainger and Allison's Diagnostic radiology Essentials, 2nd Edition.
[4] Carol M. Rumack et al - Diagnostic ultrasound 4th edition.
[5] Guyton and Hall Textbook of Medical Physiology, 13th Edition.
[6] Gray's Anatomy: The Anatomical Basis of Clinical Practice, 41st edition.
[7] Gordon PH, Nivatvongs S [eds]: Principles and practice of surgery for the colon, rectum and anus, ed 2, St Louis, 1999, Quality Medical Publishing, p 23.
[8] Weir & Abrahams' Imaging Atlas of Human Anatomy 6th Edition - June 25, 2020.
[9] Azer SA, Tuma F. Infectious Colitis. [Updated 2022 May 1]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan.
[10] AR, Omprakash., MB, N. R., MP, B., & K S, D. (2021). Characterization of Bowel wall thickening with CT Scan. *International Journal of Health and Clinical Research*, *4* (3), 119–12. Retrieved from https: //www.ijhcr. com/index. php/ijhcr/article/view/892
[11] Sinan T, Sheikh M, Ramadan S, Sahwney S, Behbehani A. CT features in abdominal tuberculosis: 20 years experience. BMC Med Imaging.2002 Nov 12; 2 (1): 3. doi: 10.1186/1471 - 2342 - 2 - 3. PMID: 12427257; PMCID: PMC139990.
[12] Kedia S, Ahuja V. Epidemiology of Inflammatory Bowel Disease in India: The Great Shift East. Inflamm Intest Dis.2017 Nov; 2 (2): 102 - 115. doi: 10.1159/000465522. Epub 2017 Apr 8. PMID: 30018961; PMCID: PMC5988149
[13] Alreheili K, Almehaidib A, Banemi M, Aldekhail W, Alsaleem K. Clinical presentation of inflammatory bowel disease in Saudi children (Single centre experience). Int J Pediatr Adolesc Med.2016 Dec; 3 (4): 175 - 179. doi: 10.1016/j. ijpam.2016.08.004. Epub 2016 Sep 15. PMID: 30805489; PMCID: PMC6372438.
[14] Makharia, G. K., Ramakrishna, B. S., Abraham, P. *et al.* Survey of inflammatory bowel diseases in India. *Indian J Gastroenterol* 31, 299–306 (2012). https: //doi. org/10.1007/s12664 - 012 - 0258 - 1
[15] Worlicek, H., Lutz, H., Heyder, N. and Matek, W. (1987), Ultrasound findings in Crohn's disease and ulcerative colitis: A prospective study. J. Clin. Ultrasound, 15: 153 - 163.
[16] J H Lim, Y T Ko, D H Lee, J W Lim, and T H Kim Sonography of inflammatory bowel disease: findings and value in differential diagnosis. American Journal of Roentgenology 1994 163: 2, 343 - 347.
[17] Gasche C, Moser G, Turetschek K, Schober E, Moeschl P, Oberhuber G. Transabdominal bowel sonography for the detection of intestinal complications in Crohn's disease. Gut.1999 Jan; 44

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(1): 112 - 7. doi: 10.1136/gut.44.1.112. PMID: 9862836; PMCID: PMC1760075.

[18] Holger Neye, Daniel Ensberg, Peter Rauh, Ulrich Peitz, Klaus Mönkemüller, Gerhard Treiber, Sabine Klauck, Peter Malfertheiner & Steffen Rickes (2010) Impact of high - resolution transabdominal ultrasound in the diagnosis of complications of Crohn's disease, Scandinavian Journal of Gastroenterology, 45: 6, 690 - 695, DOI: 10.3109/00365521003710190

[19] Reginelli, A., Genovese, E., Cappabianca, S. et al. Intestinal Ischemia: US - CT findings correlations. Crit Ultrasound J 5 (Suppl 1), S7 (2013). https: //doi. org/10.1186/2036 - 7902 - 5 - S1 - S7

[20] Dhatt HS, Behr SC, Miracle A, Wang ZJ, Yeh BM. Radiological Evaluation of Bowel Ischemia. Radiol Clin North Am.2015 Nov; 53 (6): 1241 - 54. doi: 10.1016/j. rcl.2015.06.009. PMID: 26526436; PMCID: PMC4633709

[21] Macari M, Balthazar EJ. CT of bowel wall thickening: significance and pitfalls of interpretation. AJR Am J Roentgenol.2001 May; 176 (5): 1105 - 16. doi: 10.2214/ajr.176.5.1761105. PMID: 11312162.

[22] Wasnik, Liu & Plat –openaccessjournals. com/articles/imaging - findings - in - diagnosis - of - mesentric - ischemia - how - can - we - be - sure.

[23] Lorenzo Garzelli, Alexandre Nuzzo, Pauline Copin, Paul Calame, Olivier Corcos, Valérie Vilgrain, and Maxime Ronot Contrast - Enhanced CT for the Diagnosis of Acute Mesenteric Ischemia - American Journal of Roentgenology 2020 215: 1, 29 - 38

[24] Ravi Kumar Yeli, Shivanand V. Patil, Nagababu Pyadala. Multidetector computed tomography in small and large bowel lesions. International Journal of Contemporary Medicine Surgery and Radiology.2018; 3 (1): 151 - 154.

[25] Emmy Ludwig, Robert C. Kurtz, in Sleisenger and Fordtran's Gastrointestinal and Liver Disease (Ninth Edition) , 2010.

[26] Ponz de Leon, M., Rossi, G., di Gregorio, C. *et al.* Epidemiology of colorectal cancer: the 21 - year experience of a specialised registry. *Int Emergency Med* 2, 269–279 (2007). https: //doi. org/10.1007/s11739 - 007 - 0077 - z.

[27] Karacin C, Türker S, Eren T, Imamoglu GI, Yılmaz K, Coskun Y, Gunes SO, Sökmen F, Yazilitas D, Şimşek Z, Altınbaş M. Predictors of Neoplasia in Colonic Wall Thickening Detected via Computerized Tomography. Cureus.2020 Sep 20; 12 (9): e10553. doi: 10.7759/cureus.10553. PMID: 32968607; PMCID: PMC7505674.

[28] Patil PS, Saklani A, Gambhire P, Mehta S, Engineer R, De'Souza A, Chopra S, Bal M. Colorectal Cancer in India: An Audit from a Tertiary Center in a Low Prevalence Area. Indian J Surg Oncol.2017 Dec; 8 (4): 484 - 490. doi: 10.1007/s13193 - 017 - 0655 - 0. Epub 2017 Apr 22. PMID: 29203978; PMCID: PMC5705504.