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**ORIGINAL RESEARCH**

# Role of MDCT in Evaluation of Bowel Ischemia with Surgical Correlation

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## ABSTRACT

**Background: Bowel ischemia is one of the serious and most catastrophic abdominal emergencies which lead to high mortality if unidentified and untreated. CT is described as the most useful diagnostic tool in diagnosing bowel ischemia and identifying the cause. The aim of the present study is to find about the imaging findings of bowel ischemia due to various causes.**

**Materials and Methods: The present study is a prospective study undertaken to evaluate the role of CT in bowel ischemia in indoor and outdoor patients being referred to the department of Radiodiagnosis and department of surgery, NRI Medical College & GH, Chinnakakani. All the study patients were investigated on 16 slice MDCT. All the study patients will be investigated on 16 slice MDCT.**

**Results: In our study out of 56 patients, 34 were females making about 60% of cases and 22 were males making about 40% of cases. Among 56 cases diagnosed and confirmed with CECT, 42 were of occlusive type and 8 were of non-occlusive type, 6 cases were due to obstruction. In the 42 cases, 28 cases were of arterial etiology and 14 cases are due to venous causes.**

**Conclusions: Thus MDCT can demonstrate the ischemic bowel segment, length of the segment involved and helps in determining the primary cause. The various patterns of bowel ischemia as described can aid in the diagnosis of bowel ischemia and thus in the further management.**

**Keywords: MDCT, Bowel ischemia, Image findings, Arterial etiology.**

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## INTRODUCTION

Bowel ischemia, which means decreased or insufficient blood flow to the bowel, is a potentially catastrophic entity that may require emergent intervention or surgery in the acute setting. The radiologist plays a central role in the initial diagnosis and preventing progression to irreversible intestinal ischemic injury or bowel necrosis. This is a life-threatening condition with mortality rate reaching 60–80%, even with surgical intervention.

Collateral circulation can protect the bowel from substantial damage when up to 75% of bowel perfusion is lost for 12 h; however, complete perfusion loss of more than 4–6 h results in significant bowel injury. Bowel ischemia can range from localized transient ischemia to

catastrophic necrosis of the gastrointestinal tract. Sequence of events include necrosis of the bowel wall, bacteria proliferation in the bowel wall, releasing gas in the wall itself (pneumatosis intestinalis) gas entry through mesenteric vessles into the portal vein (pneumatosis portalis) , sepsis and /or intestinal perforation or death. The primary causes of insufficient blood flow to the intestine are diverse and include thromboembolism, nonocclusive causes, bowel obstruction, vasculitis, abdominal inflammatory conditions, trauma, chemotherapy, radiation, and corrosive injury. With 93% sensitivity and 96% specificity, multidetector computed tomography (MDCT) scan is widely utilized as the first-line imaging choice to confirm and localize ABI, determine its severity .Computed tomography (CT) imaging can demonstrate the ischemic bowel segment, length of the segment involved and may be helpful in determining the primary cause. At imaging, not only imaging of the bowel is important, but evaluation of the mesenteric fat, vasculature, and surrounding peritoneal cavity also helps improves accuracy in the diagnosis of bowel ischemia.

**REVIEW OF LITERATURE:**

The gastrointestinal tract is made up of four layers, which include mucosa, submucosa, muscularis and serosa, from inner to outermost layer. There are 3 stages based on the involvement of each layer.

In stage I or the early stage, the damage is only confined to the mucosal layer.[1]

Stage II or the intermediate stage is described as presence of changes (edema, erosion, hemorrhage and necrosis) in submucosa and muscularis propria,[2] the site of enteric venous plexuses leading to loss of peristalsis and muscle tone.[3]

Stage III, the late stage, is manifested by transmural bowel necrosis and is developed if blood supply is not eventually restored.[1]

Bowel ischemia etiologies can be divided into: arterial, venous, non-occlusive and mixed type.[4]

Arterial etiologies are the most prevalent causes of ABI, accounting for 60–70% cases.[5] Can be embolic and thrombotic.

SMA is more frequently affected than CA and IMA due to the larger diameter and sharper branching angle (~ 45º).[6]

Low-attenuation filling defect on CT angiography or high attenuation intravascular substance on an unenhanced CT scan is a direct sign for arterial embolus or thrombosis, which can lead to “pale ischemia” and cause “paper-thin” bowel wall.[7]

Mesenteric venous thrombosis (MVT) accounts for 5–15% of ABI cases. Thrombosis often affects SMV appears as a filling defect in the portal phase of contrast enhanced CT scan. In the early stage, the bowel wall is frequently thickened.[8] There is reduced venous outflow with high-pressure arterial inflow, which leads to intramural edema,[9] giving a more characteristic “Target” appearance is more common in venous compared to arterial ABI.[10,11]

Sometimes, there is exudative fluid which accumulates in the intraluminal space of ischemic bowel and results in “completely fluid filled, gasless, dilated loop”.[12] As it progresses , there is venous occlusion and decreased arterial perfusion leading to decreased or absent wall enhancement showing “Gray” pattern on CT.[12]

Non-occlusive mesenteric ischemia (NOMI) is responsible for almost 20% of ABI cases,[13] and is caused by nonocclusive reduction of arterial blood flow. Hemodynamic instability followed by mesenteric arterial vasoconstriction is the main cause,[14] seen in systemic hypotensive state associated with impaired sympathetic response in elderly or critically ill patients with concomitant multiorgan damage.

Generalized vasospasm seen as narrowing of IVC, aorta and mesenteric vessels resulting in decreased enhancement of affected bowel segments and occasionally other organs (liver, spleen and pancreas). Four radiological signs had been suggested by Siegelman et al. in 1974 for description of mesenteric vasospasm based on conventional angiography:[15] (1) narrowing in the origins of multiple branches of the SMA, (2) irregularities in intestinal branches as alternate dilatation and narrowing, "the string of sausages sign",[16] (3) spasm of the mesenteric arcades, (4) impaired filling of intramural vessels.

Strangulated bowel results from closed-loop obstruction and is responsible for 10% of ABI cases.[10] Occurs due to both diminished arterial inflow and venous drainage.[17]

Some specific features of closed-loop obstruction include radial distribution of intestinal loops and the "beak" sign or triangular loops, caused by fusiform tapering of fluid-filled bowel loops.[18,19] The closed-loop mechanism in combination with reduced bowel wall enhancement and diffuse mesenteric haziness has been shown to predict strangulation accurately in adhesive small bowel obstruction.[20]

## MATERIALS & METHODS

**Source of the subjects:** Patients presenting to the department of Radiodiagnosis and department of surgery, NRI Medical College & GH.

**Sample size: 56** patients **Duration of study: 2years**

**Inclusion criteria:**

- Patients who present with abdominal pain and presented to USG for evaluation.
- Patients who are suspected to have bowel obstruction
- Patients who have given consent.

**Exclusion criteria:**

- Patients who have adverse reactions for contrast use.
- Patients of chronic renal disease

**Method of data collection:**

The present study is a prospective study undertaken to evaluate the role of CT in bowel ischemia in indoor and outdoor patients being referred to the department of Radiodiagnosis and department of surgery, NRI Medical College & GH, Chinnakakani. All the study patients were investigated on 16 slice MDCT. All the study patients will be investigated on 16 slice MDCT.

Nonionic iodinated Contrast(Omnipaque, Visipaque) is administrated at the rate of 2-2.5 ml/kg body weight at the rate of 4ml/sec. Serious phases like plain , arterial (20-25 seconds), portal venous phase (45 seconds) are obtained.

## RESULTS

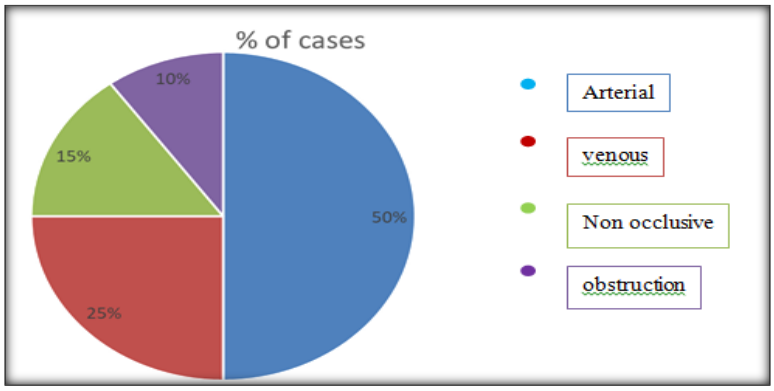


**Figure 1: Number of cases:**

**Table 1: Percentages of cases:**

| Cause | Number of Cases | Percentage % |
|---|---|---|
| Arterial | 28 | 50% |
| Venous | 14 | 25% |
| Non Occlusive Mesenteric Ischemia | 8 | 15% |
| Obstruction | 6 | 10% |

**Figure 2: Paper thin and non-enhancing bowel loops**

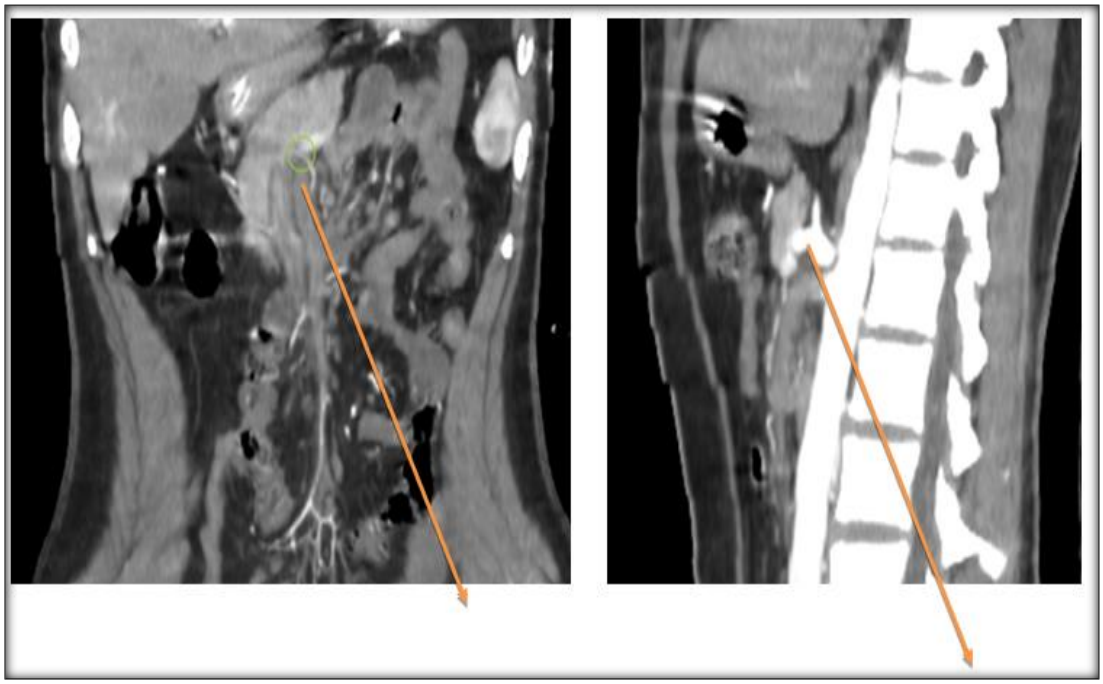

**Figure 3: Long segment filling defect in the superior mesenteric artery in coronal and sagittal planes**

**Figure 4: Case of venous thrombosis showing thrombosis of superior mesenteric vein with characteristic target appearance of bowel**

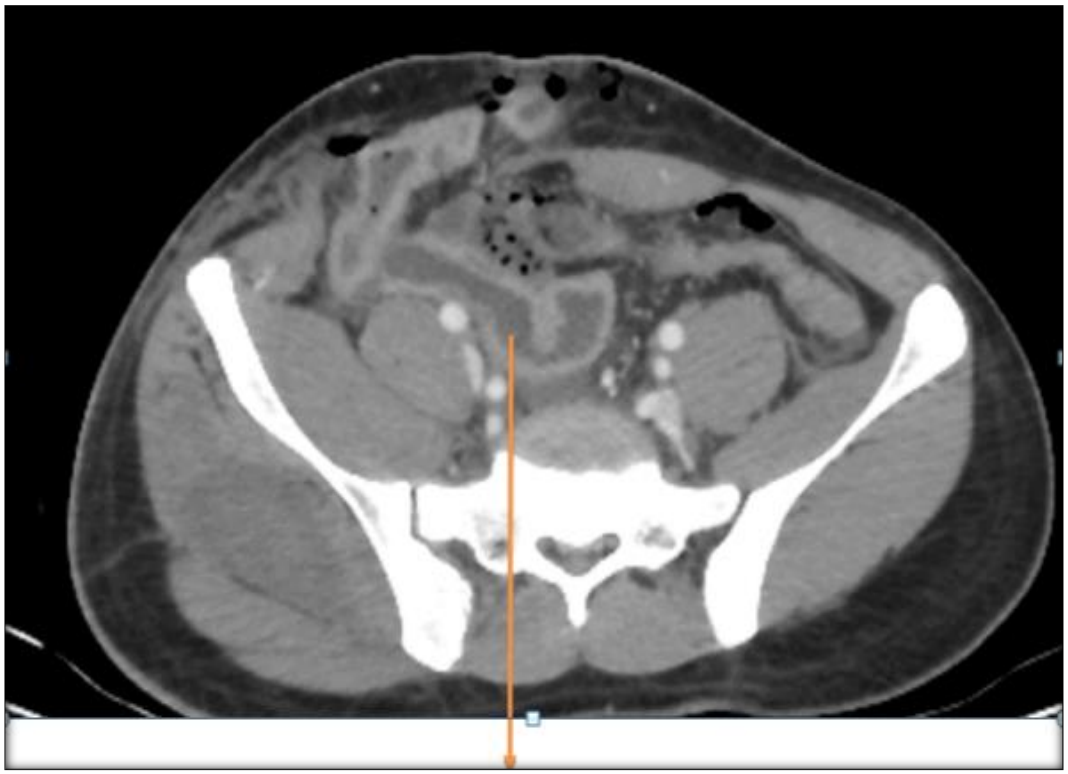

**Figure 5: Case of trauma with patient in hypotensive state. There is hyperenhancement and thickening of bowel loops --- shock bowel**

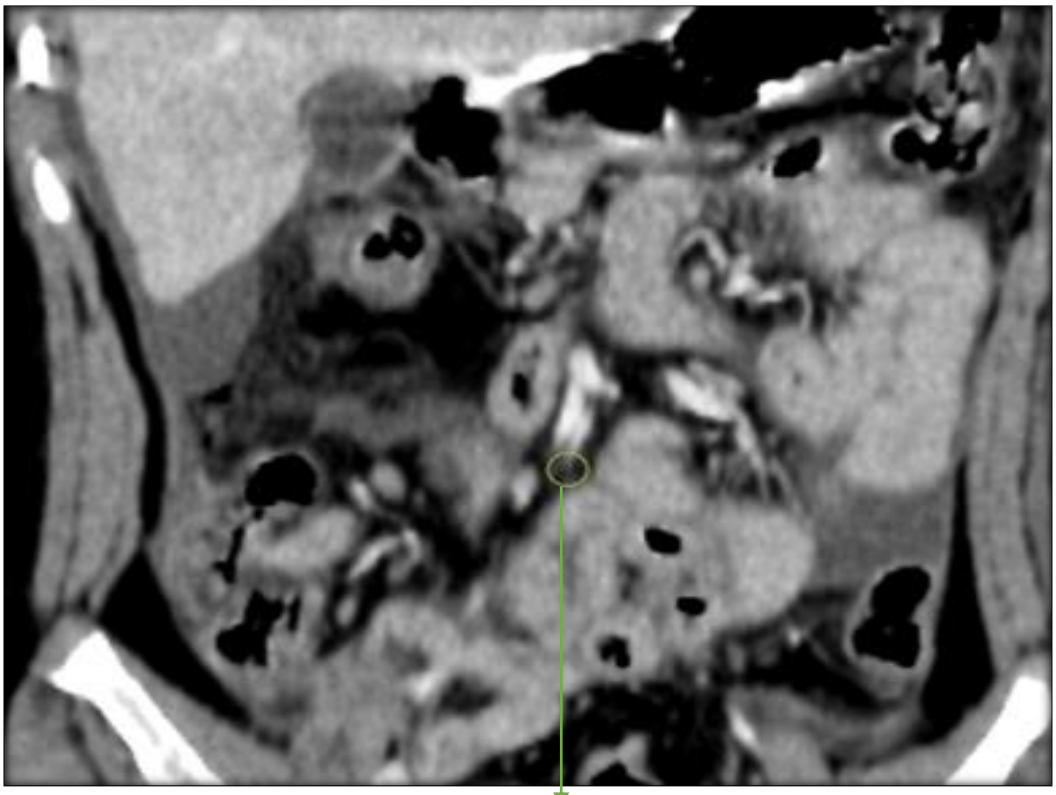

**Figure 6: Another case of shock bowel showing hyperenhancement of bowel loops**

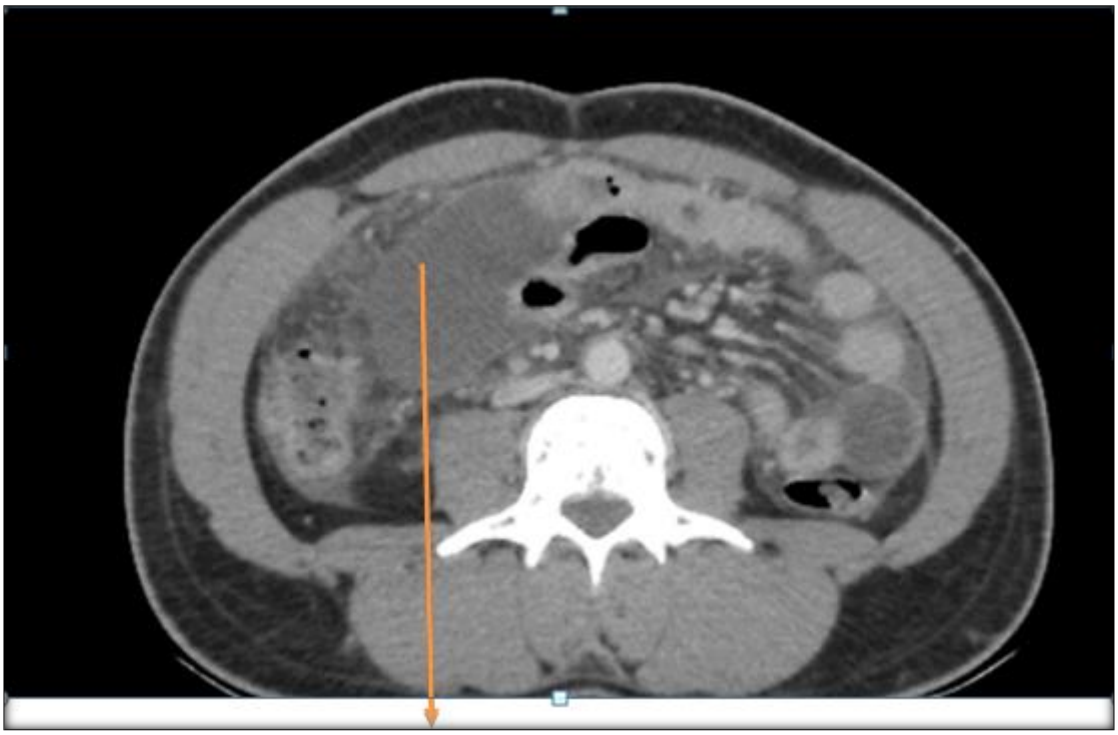

**Figure 7: Case of perforation following obstruction showing non enhancement of bowel loops**

## DISCUSSION

Mesenteric ischemia can be due to various causes like arterial or venous insufficiency or due to obstructive causes. It is more common in females compared to males. In our study out of 56 patients, 34 were females making about 60% of cases and 22 were males making about

40% of cases. This is similar to the study done by L Chang et al., in which female cases accounted for 64%, where in our case it was about 60%.

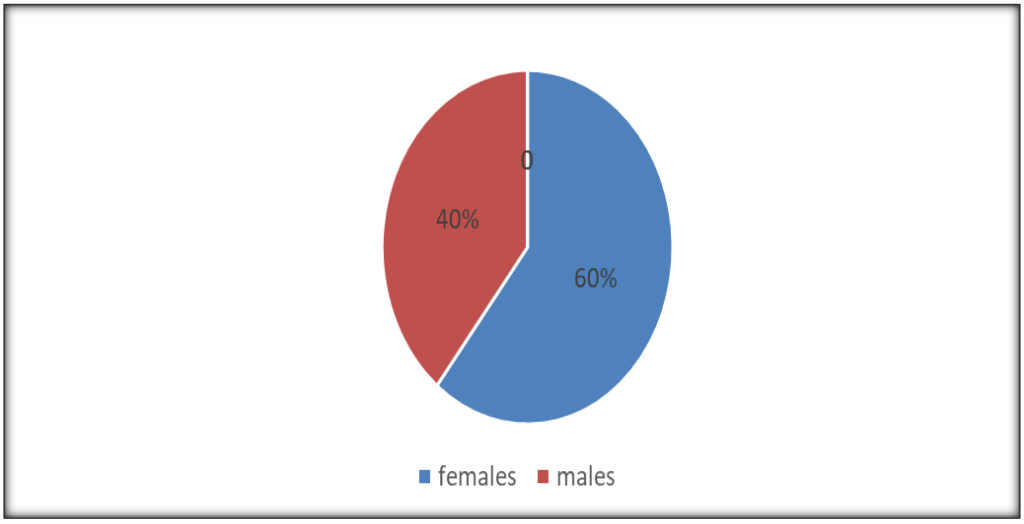


**Figure 9: Sex of the Patients**

**Table 2: Age distribution**

| Age (in years) | Number | % of total cases |
|---|---|---|
| 10-20 | 3 | 5.3% |
| 20-30 | 5 | 8.9% |
| 30-40 | 6 | 10.7% |
| 40-50 | 18 | 32.1% |
| 50-60 | 20 | 35.7% |
| 60-70 | 4 | 7.1% |

It is seen most commonly in elderly age group of 50-60 years (35.7%). Among 56 cases diagnosed and confirmed with CECT, 42 were of occlusive type and 8 were of non-occlusive type, 6 cases were due to obstruction. In the 42 cases, 28 cases were of arterial etiology and 14 cases are due to venous causes. Arterial occlusion was seen in about 28 cases accounting for about 50% of cases.[5] The results were similar to the study done by Acosta et al. SMA thrombosis in most of the patients was short segmental involvement occurring about 3-5cms away from the origin. In 28 cases of mesenteric ischemia due to arterial causes, 27 cases were mostly due to thrombosis or embolism. Out of the 28 cases, 6 cases were due to thrombosis in coeliac artery accounting for about 21% of cases. Two cases showed thrombosis in both coeliac artery and superior mesenteric artery. And 18 cases were due to thrombosis of SMA alone accounting for about 64% of cases. In our study the most common artery being involved is the superior mesenteric artery. This is similar to the study done by Bhagirath Desai et al, which states that superior mesenteric artery is the most common artery being involved due to the larger diameter and sharper branching angle (~45º).[6] Other conditions causing arterial type of mesenteric ischemia like vasculitis was observed in 1 patient of younger age group of 10-20 years accounting for about 3.5% of cases. As compared with the study done by DG Clair et al,[4] where it accounted to about 5% of cases, in our study it was about 3.5%. The patient presented with post prandial abdominal pain for which CECT was done which showed long segment occlusion of SMA, On follow up patient was tested positive for ANCA antibodies. Inonecase there is arterial dissection which involved the

origins of coeliac and superior mesenteric artery resulting in poor prognosis. This was seen similar to the study done by Kolkman et al.[24] In 18cases involving SMA alone about 3 cases had long segmental arterial occlusion in which complications like gangrene were seen. These patients underwent emergency exploratorylaparotomy and gangrenous bowel was resected. Out of the 3 cases, 1 patient was admitted in ICU post operatively and died of electrolyte imbalance. Other 2 patients were followed up periodically and were discharged on postoperative day 10. Patients in whom long segment arterial occlusion was seen, atherosclerosis was commonly associated with the disease at the origin of coeliac artery and SMA origin. Prognosis in long segment involvement i.e. involvement of origin was poor compared with short segment involvement similar to study done by Florim et al.[22] Smaller emboli tend to reach the distal branches were observed to have better prognosis. This is similar to the study done by S Florim.[23] In 4 patients with short segmental involvement, findings on CT such as mild decreased enhancement of bowel loops with mild adjacent fat stranding revealed intraoperative changes of bowel ischemia with no signs of bowel infarction. Mesentericvenous thrombosis is corresponding to about 25% of cases. Most common vein involved being SMV followed by portal vein. Involved bowel segments of venous occlusion appear edematous and thickened. The findings are similar to the study done by Dhatt HS.[8] Venous occlusion was managed conservatively in most of the patients. Non occlusive mesenteric ischemia was seen in 15% of cases. Most of the patients were in ICU due to many reasons and who have cardiac failure or in patients with shock. Similar etiology was seen in the study done by Kolkmann et al.[25]

## CONCLUSION

The radiologist plays a central role in the initial diagnosis and further prevention of progression to irreversible intestinal ischemic injury or bowel necrosis.

Thus MDCT can demonstrate the ischemic bowel segment, length of the segment involved and helps in determining the primary cause. At imaging it is not only important for imaging of the bowel, but evaluation of the mesenteric fat, vasculature and surrounding peritoneal cavity also helps in the diagnosis of bowel ischemia. The various patterns of bowel ischemia as described can aid in the diagnosis of bowel ischemia and thus in the further management.

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