

Peer Reviewed **Article of Interest**

COMPUTED TOMOGRAPHIC COLONOGRAPHY IN THE DIAGNOSIS OF BILATERAL SMALL BOWEL INGUINAL HERNIA: AN OVERVIEW OF INGUINAL HERNIAS AS EXTRACOLONIC FINDINGS

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ABSTRACT

Bilateral small bowel inguinal hernia and examples of other abdominal wall hernias as extracolonic findings at CT colonography are discussed. An overview of hernia types and complications are presented.

Keywords: gangrene, herniation, irreducible, ischaemia, obstruction, repair

LAY ABSTRACT

A range of hernias in the groin region are presented as well their complications.

INTRODUCTION

CT colonography (CTC), for colorectal cancer screening, is generally performed in patients 45 years or older.^[1,2] Intra-abdominal and pelvic organs are visualised at CTC, and extracolonic lesions may be identified.^[3] The majority of extracolonic lesions are not considered to be of clinical importance. However, the potential benefit of detecting an extracolonic lesion of high clinical importance means earlier detection and subsequent intervention. At CTC hernias are reported as extracolonic lesions. Abdominal herniation may be defined as the protrusion of part of its content from the abdominal cavity through a normal or abnormal aperture or from wall weakness.^[4] Figures 1a and b are normal pelvic region CT scans. Figure 1c shows bilateral inguinal hernia. Figure 1d shows normal abdominal muscles. Figure 1e shows small bowel valvulae conniventes and Figure 1f shows colon haustral markings.

Hernias may be symptomless, but a soft tissue swelling may occur in the abdomen or groin. Most hernias are of the abdominal type. Hernias may be reducible (i.e., can be safely pushed back into the abdominal cavity) or irreducible. The latter may then result in vascular compromise and possible ischaemia and ultimately gangrene.^[5] A hernia may cause obstruction resulting in failure of intestinal content to pass through the obstructed area.^[5] The focus of this paper is to demonstrate bilateral indirect inguinal hernias containing loops of small bowel and to compare the difference between small and large bowel inguinal hernias. Also included is a brief discussion of other abdominal hernias.

E-CLASSIFICATION

E-classification^[6] applies to asymptomatic patients when extracolonic findings (ECFs) are visualised during a CTC study.

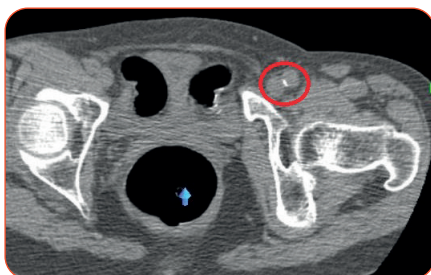


Figure 1a. Normal 2D supine axial view of pelvic region showing no evidence of inguinal hernia. Mild calcification of left femoral artery (red circle).



Figure 1b. Normal 2D supine axial view of pelvic region showing no evidence of inguinal hernia.

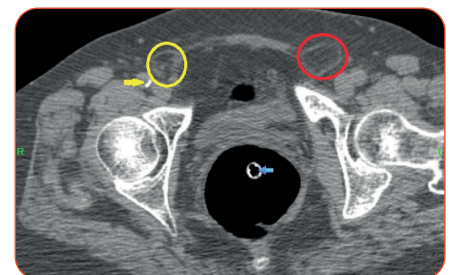


Figure 1c. 2D axial supine view showing bilateral small inguinal hernia (yellow hexagon and red circle). Yellow arrow indicates a small atherosclerotic plaque in the right femoral artery. This is an E3 ECF: moderate clinical importance classification.

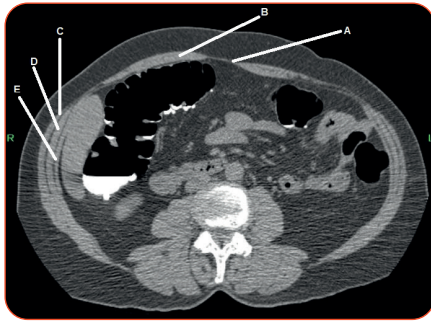


Figure 1d. 2D normal supine axial view. A = linea alba. B = rectus abdominis muscle. C = external oblique muscle. D = internal oblique muscle. E = transversus abdominis muscle.

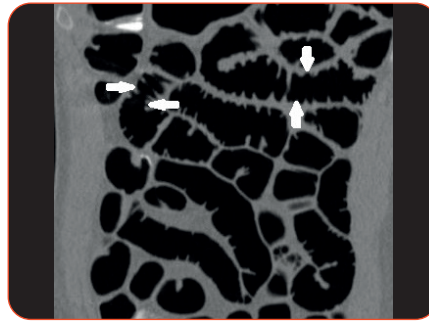


Figure 1e. 2D supine coronal view. White arrows = valvulae conniventes.

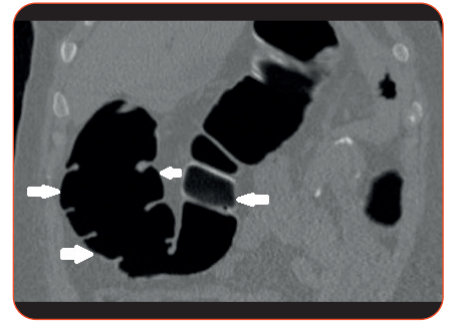


Figure 1f. Colon haustral markings (white arrows) on a 2D coronal view.

A screening CTC is done as a colorectal cancer test and most ECFs turn out to be not of clinical importance. Occasionally a finding may be diagnosed accidentally, such as abdominal aortic aneurysm or malignancy. In order to report on ECFs the following classification is used.

- E1 = not of any clinical importance.
- E2 = low clinical importance. Most ECFs are in this category (e.g., non-obstructing renal calculi, kidney and liver cysts).
- E3 = moderate clinical importance: in most cases in asymptomatic patients the lesions are benign.
- E4 = high clinical importance. These are potentially important findings (e.g., inguinal hernia containing loops of bowel, abdominal aortic aneurysm, extracolonic malignancy).

These classifications are used in the discussion of some hernia examples presented below, and in Figure 1c.

SMALL BOWEL BILATERAL INGUINAL HERNIA

In 2021 the physician of an 80 year-old requested a CTC which was to be her last large bowel screening examination. Her previous CTC was in 2015. Figure 2a shows an enlarged uterus containing a calcified fibroid. Figures 2b and c depict colon-maps. In 2018 she experienced intermittent vaginal

bleeding. Cancer of the uterus was diagnosed. She underwent hysterectomy, radiotherapy, and chemotherapy and was declared free of cancer by her oncologist. Following this she reported being well.

A routine screening CTC was performed on her in 2021 which comprised supine, prone and right lateral decubitus scans. She did not experience or complain of any pain during the introduction of carbon dioxide, via an automated pressure-controlled insufflator, to distend the colon. Small bowel was noted in bilateral indirect inguinal hernias in the supine and decubitus views (Figures 2d to l). However, these hernias emptied when she was in the prone position (Figure 2m). Figures 2n and o show a bulge in her groin area.

Her bilateral hernias were reported as an E4 classification, i.e. high clinical importance. Following her CTC study she was referred for surgery to repair the hernia defects. Her hernia repair was successful.



Figure 2a. 2D supine 2015 axial view showing small inguinal hernia on the left (red arrow) and enlarged uterus with calcified fibroid (yellow arrow): E3 classification. The CTC was normal.

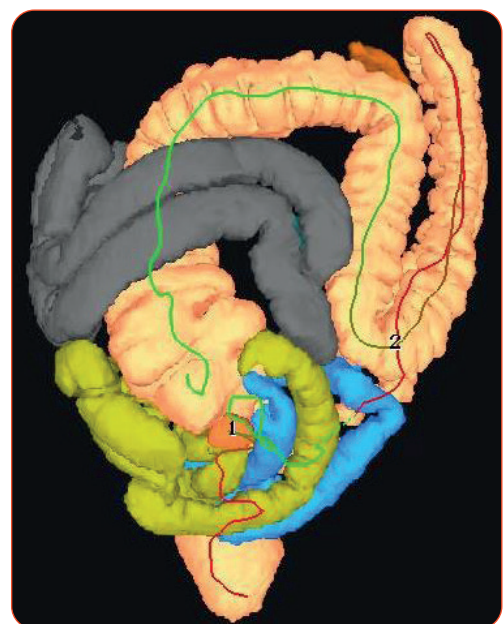


Figure 2b. Supine 2015 coronal map showing small bowel (yellow, blue and charcoal).

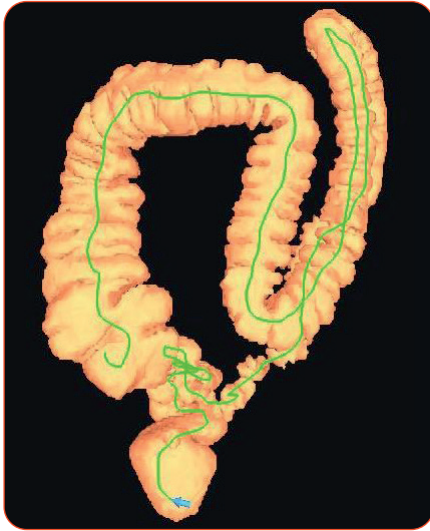


Figure 2c. Supine 2015 colon-map with small bowel removed. Note the normal layout of the large bowel.



Figure 2d. 2D axial view in 2021 showing presence of small bowel hernias in both inguinal canals (yellow and red circles).

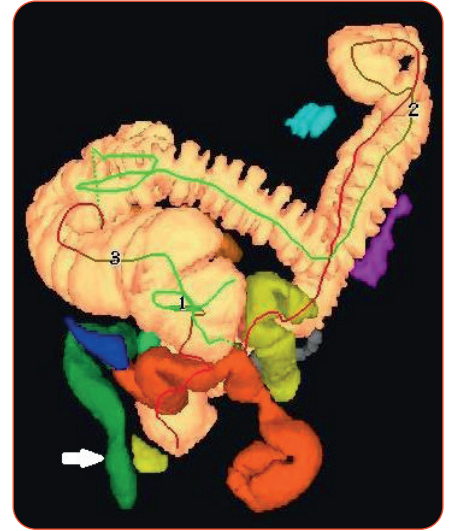


Figure 2e. 2021 colon-map supine showing small bowel inguinal hernia (white arrow) on the right.



Figure 2f. 2021 supine colon-map of large bowel with small bowel removed.

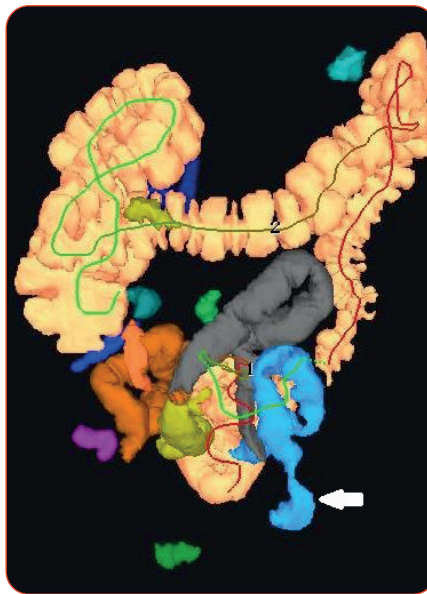


Figure 2g. 2021 colon-map prone showing small bowel inguinal hernia (white arrow) on the left.

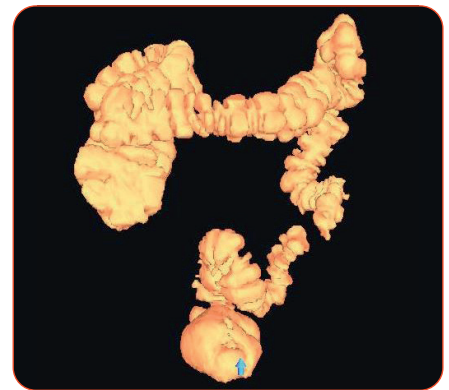


Figure 2h. 2021 prone colon-map of large bowel with small bowel removed.



Figure 2i. 2021 2D right supine sagittal view showing small bowel hernia (yellow circle).



Figure 2j. 2021 2D left supine sagittal view showing small bowel hernia (red circle).

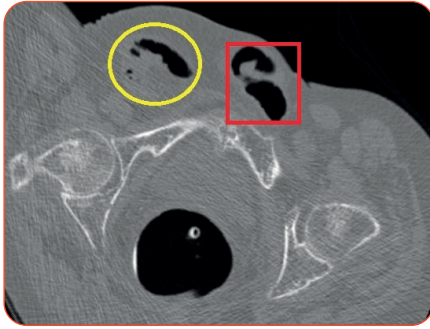


Figure 2k. 2021 2D right decubitus view showing left hernia (red square) and right hernia (yellow circle).

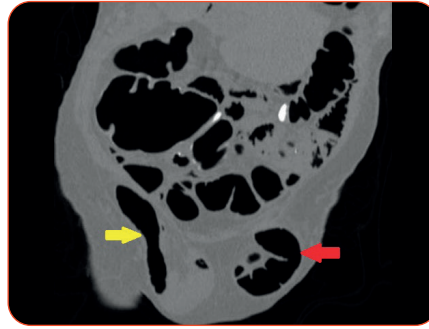


Figure 2l. 2021 2D supine coronal view showing bilateral small bowel hernias (yellow and red arrows).

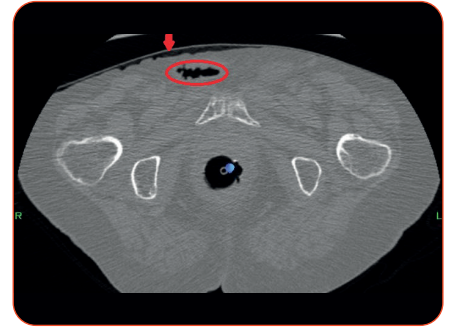


Figure 2m. 2021 2D prone axial showing marked reduction of hernia contents (red arrow and red circle).



Figure 2n. This shows a huge bulge in groin region. The patient did not experience any pain or discomfort during the CTC study. She provided permission for photographs to be taken and publication of her images. She was assured of anonymity.



Figure 2o. This shows a huge anterior bulge across her groin regions.

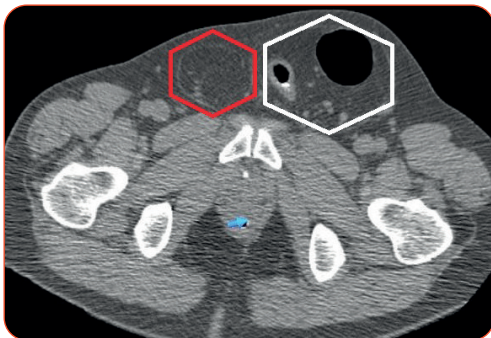


Figure 3a. 2D supine axial view showing bowel in left inguinal hernia (white hexagon) and fat in right inguinal hernia (red hexagon).



Figure 3b. 2D supine sagittal view showing bowel in the scrotum (red arrow) and small area of narrowing as it exits the inguinal canal (green arrow).

LARGE BOWEL INGUINAL HERNIA

Figures 3a to d are those of a 74 year-old male. He presented to his doctor complaining of an enlarged scrotal sac as well as pain and discomfort in his left groin. There was also a change in his bowel habits. On examination his scrotum was markedly enlarged and bowel sounds were audible on auscultation of the scrotal sac. He was referred for CTC and special attention was paid to the left inguinal region during CO₂ insufflation. No complications were encountered. His extracolonic finding (ECF) of the hernia was reported as an

E4: high clinical importance. Following the CTC study he was referred for surgery to repair the hernia defects. His hernia repair was successful.

TYPES OF HERNIAS

Hernias may be congenital or acquired. A congenital malformation occurs in new-borns whilst in adults a hernia is due to stress on the abdominal wall, or a weakness in the elderly.^[7] Indirect inguinal hernias are the most common and protrude through the patent internal (deep) inguinal

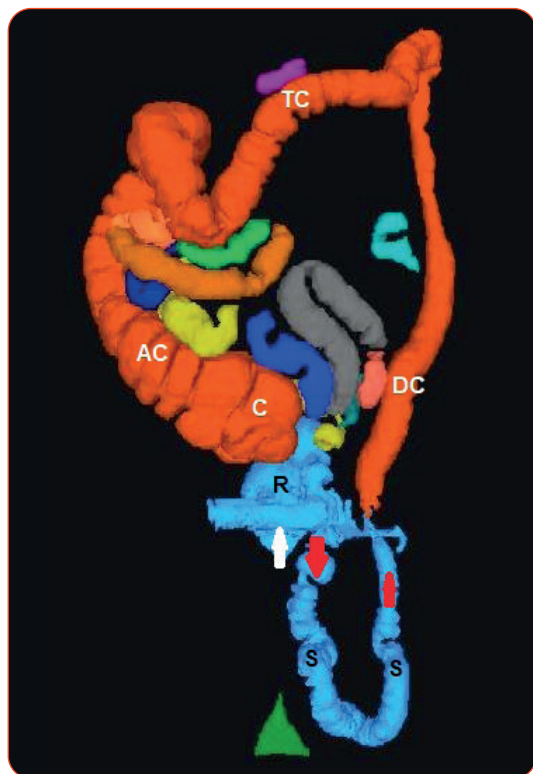


Figure 3c. Colon-map showing herniation of sigmoid colon (S). R=rectum, DC = descending colon, TC = transverse colon, AC = ascending colon, C = caecum. White arrow = R hip prosthesis (artefact). Red arrows indicate direction of flow of CO₂ in herniated sigmoid colon.

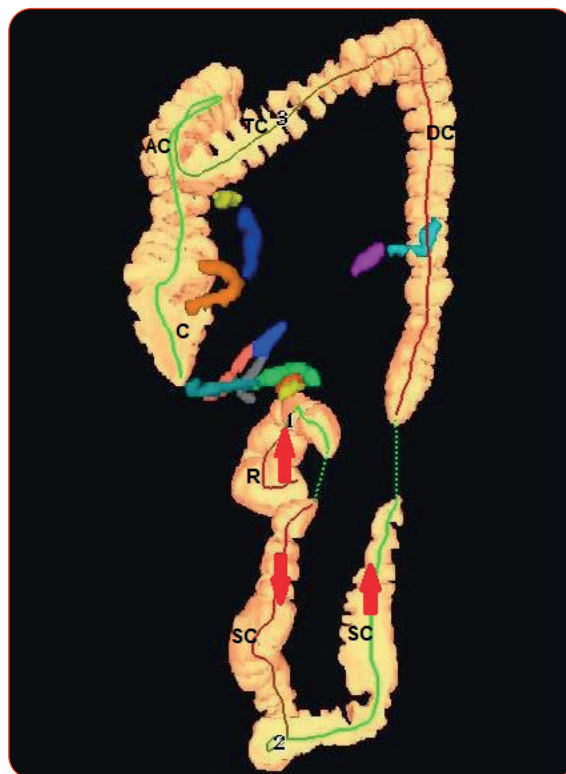


Figure 3d. Colon-map with small bowel removed showing herniation of sigmoid colon (SC). R = rectum, DC = descending colon, TC = transverse colon, AC = ascending colon, C = caecum. Red arrows indicate direction of flow of CO₂ from rectum to sigmoid colon.

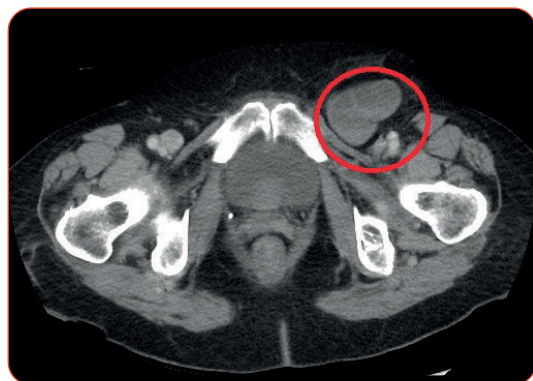


Figure 4a. 2D supine axial view showing left femoral hernia containing loops of small bowel (courtesy of Prof D Kim, Wisconsin University). E4 classification: high clinical importance.

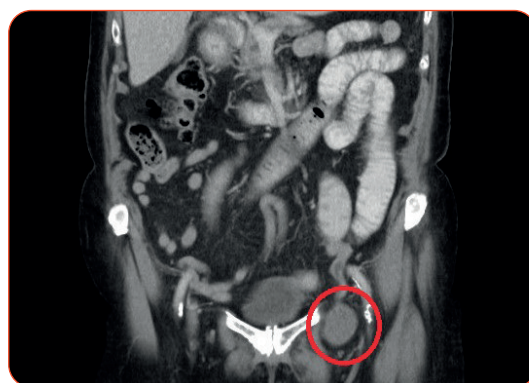


Figure 4b. 2D coronal supine view showing a loop of small bowel in a left femoral hernia. Mild proximal dilation of small bowel is present indicating partial obstruction (courtesy of Prof D Kim, Wisconsin University). E4 classification.

ring lateral to the inferior epigastric vessels. In men the hernia may extend together with the spermatic cord into the scrotum. In women the hernia may follow the course of the round ligament into the labia majora.^[8] The peritoneal sac containing bowel loops may protrude through the inguinal canal and emerge at the external inguinal ring. Direct inguinal hernias behave differently: they extend through an acquired weakness in the posterior wall of the canal, known as the Hesselbach triangle, and pass medially to the inferior epigastric vessels. A femoral hernia on the other hand

passes through the femoral canal, which is medial to the femoral vein and below the inguinal canal and lateral to the pelvic tubercle. Women have a wider bony pelvis compared to men thus femoral hernias are more common in women. A femoral hernia in a female is depicted in Figures 4a and b.

An incisional hernia is a common complication of abdominal surgery, especially after laparotomy and aortic surgery. Incisional hernias often occur months after surgery, and may even be delayed for years.

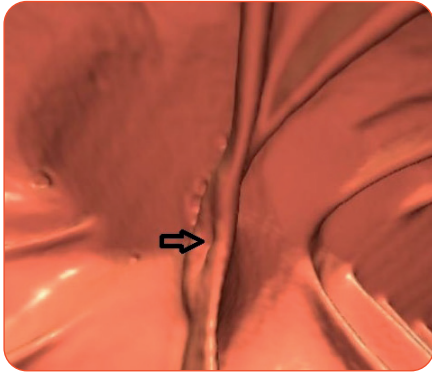


Figure 5a. 3D view showing closed ICV (black arrow).

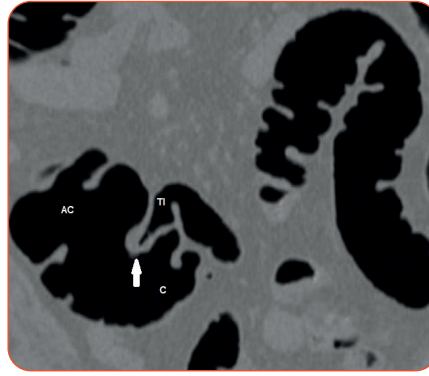


Figure 5b. 2D supine coronal view showing closed ICV (white arrow). TI = terminal ileum; C = caecum; and AC = ascending colon.

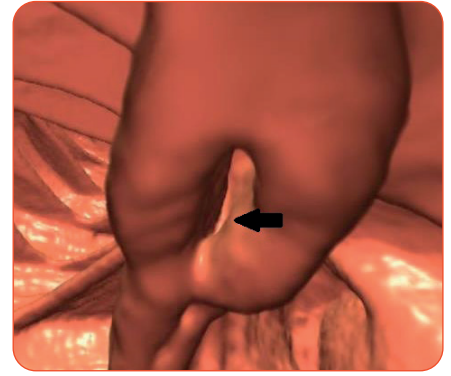


Figure 5c. 3D view showing ICV open (black arrow).

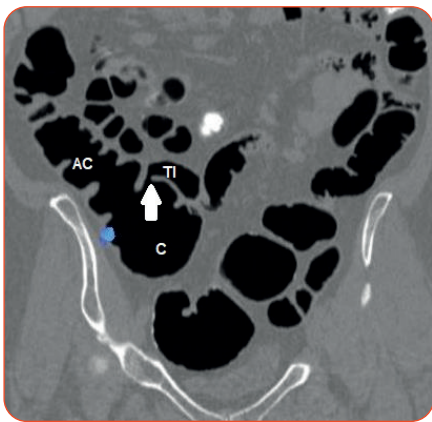


Figure 5d. 2D supine coronal view showing ICV open (white arrow). TI = terminal ileum; C = caecum; and AC = ascending colon.

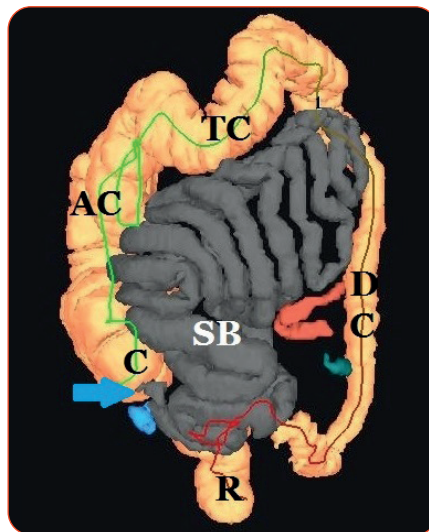


Figure 5e. Complication of a patent ICV showing reflux of gas into small bowel (SB grey) due to patent ICV (blue arrow).

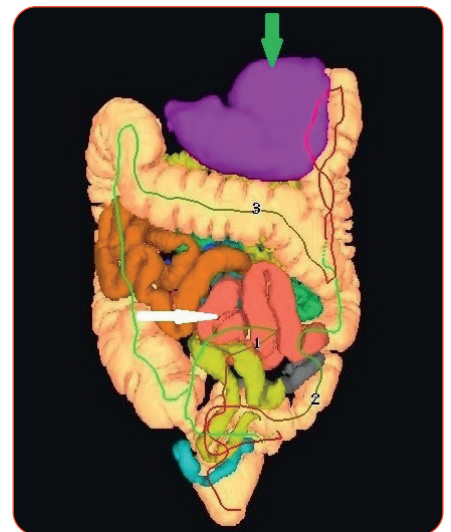


Figure 5f. Colon-map showing air in stomach (green arrow) and excessive air in small bowel (white arrow) as a consequence of severe reflux of CO₂ through a patent ICV.



Figure 5g. Complication of a patent ICV: 2D supine coronal view showing small bowel valvulae conniventes (white arrows) and gas in the stomach (S).

COMPLICATIONS OF ABDOMINAL WALL HERNIAS: OBSTRUCTION, INCARCERATION, AND STRANGULATION

Complications of abdominal wall hernias include obstruction, incarceration and strangulation, and clinically include abdominal pain, vomiting and distension. Adhesions are the leading cause of bowel obstruction, followed by abdominal hernias causing small bowel obstruction.^[5] Reflux of CO₂ is a complication during a CTC study.^[9,10] These complications are discussed below.

- Obstruction of the colon by abdominal wall hernia is uncommon. Obstruction of small bowel is best diagnosed on multi-detector CT (MDCT) scans showing dilated bowel proximal to the hernia and normal or reduced calibre or collapsed bowel distal to the obstruction.^[5]
- Incarceration occurs when a hernia cannot be reduced or pushed back manually and diagnosis may be suggested if a hernia occurs through a small defect and the hernial sac has a narrow neck. Incarceration may pre-

dispose to obstruction, inflammation or ischaemia. The latter occurs due to a compromised blood supply.^[5]

- Strangulation may be caused by incarceration when there is free fluid within the hernia sac, bowel wall thickening is present or bowel is dilated. If the blood supply is compromised then ischaemia or strangulation occurs. This happens when there is obstruction to the afferent and efferent loops by the hernia defect.^[5]
- Reflux of CO₂ into the small bowel occurs when the ileo-caecal valve (ICV), instead of being closed, is partially or completely open (patent). This allows the CO₂ to reflux into the terminal ileum. Figures 5a and b show closed ICV and Figures 5c to e show ICV open. The CO₂, depending on the amount introduced, may then advance in a retrograde fashion in the small bowel and may even enter the stomach (Figures 5f and g). When this occurs the patient may complain of sudden nausea and usually breaks out into a sweat.^[10] This minor complication is easily managed by instructing the patient to burp and this then relieves the sensation of being nauseous and the patient recovers immediately.

FREQUENCY OF HERNIAS AND EXAMPLES OF SOME TYPES OF HERNIAS

The findings of an analysis of 2510 cases of hernia repair performed over 30 years were that recurrent repair of hernia occurred in 6.9% of patients.^[11] The analysis showed that hernias of the abdominal wall account for the vast majority of external ones and include inguinal, umbilical, para-umbilical, epigastric, incisional, femoral, Spigelian, and lumbar hernias. These hernias consist of a peritoneal sac which protrudes through a weakness or a congenital/acquired defect in the muscular layers on the abdomen. Dabbas et al^[11] found that most hernias were right-sided (54%) and the remainder (46%) left-sided. They had a re-look at hernia frequency and previously estimated repairs indicated that inguinal hernias were the most frequent (71%). Literature reports that inguinal hernias are 20 times more common in men than women.^[12,13] Dabbas et al^[11] also underscore that inguinal hernia repair was carried out almost 15 times more in men than women. They however add that there has been a reduction in inguinal hernias over time accompanied by an increase in the proportion of midline abdominal wall hernia repairs.

Umbilical/para-umbilical hernia occurs when part of the intestine or fatty tissue protrudes through an opening in the abdominal muscles near the navel (see Figures 6a to d). Men are twice as likely to develop this hernia compared to women. It is mainly caused by raised intra-abdominal pressure: obesity and pregnancy are predisposing factors for this type of hernia.

Femoral hernias are the 5th most common abdominal hernia type and accounted for 3.7% of the retrospective analysis by Dabbas et al.^[11] Almost two thirds (63.4%) of femoral

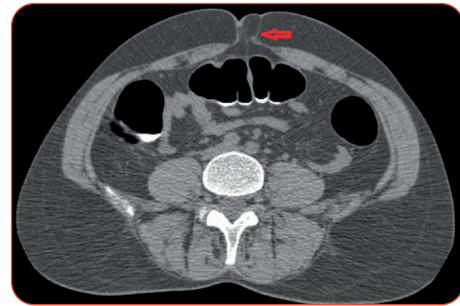


Figure 6a. 2D supine axial view showing umbilical hernia containing fat (red arrow). E2 classification: low clinical importance.

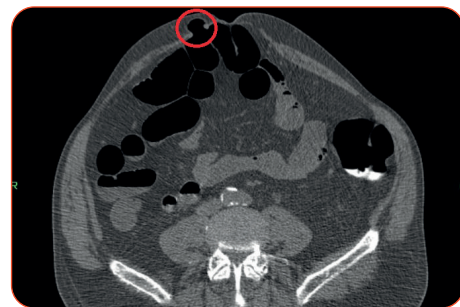


Figure 6b. 2D supine axial view showing paraumbilical hernia containing fat (red circle): E2 classification.

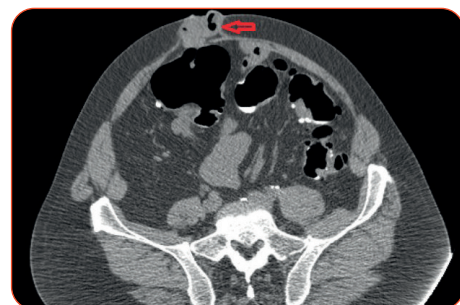


Figure 6c. 2D supine axial view showing umbilical hernia containing bowel (red arrow). E4 classification: high clinical importance.

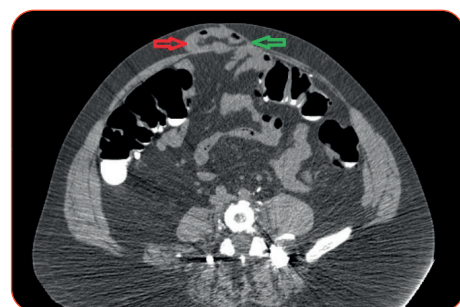


Figure 6d. 2D supine axial view showing umbilical hernia containing small bowel (red and green arrows) E4 classification. Also shown is previous lumbar spine surgery

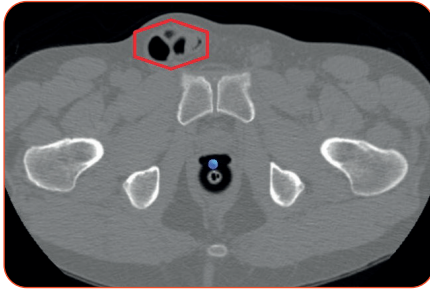


Figure 7a. 2D axial supine image showing small bowel in right inguinal hernia (red hexagon). E4 classification: high clinical importance.

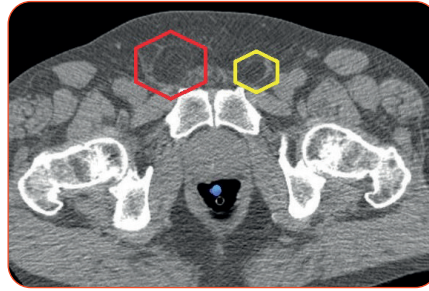


Figure 7b. 2D axial supine view showing a right inguinal containing fat (red hexagon) and a small left inguinal hernia containing fat (yellow hexagon). E3 = moderate clinical importance.

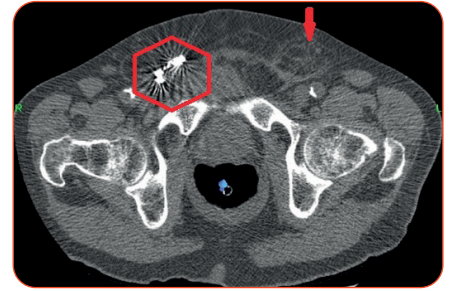


Figure 7c. 2D axial supine view showing repair of right inguinal hernia (red hexagon). Red arrow = left inguinal hernia.

hernias were right-sided and only 4.3% were bilateral in 93 cases.^[11] They found that women tended to have more femoral hernias as only 33.3% occurred in men (see Figures 4a and b)

Inguinal hernias are a more common cause of groin pain and their repair is the commonest one for hernias. Dabbas et al^[11] report that 96.8% of repair cases were in men and 3.2% in women. Figures 7a is an ECF of small bowel in right inguinal hernia. Figure 7b is an ECF of bilateral inguinal hernias (see also Figure 1c). Figure 7c shows repair of an inguinal hernia.

Spigelian hernia is a rare acquired hernia with just over 1000 cases reported in the literature.^[14] It is an anterior abdominal wall hernia and is prone to complications, for example, incarceration, small or large bowel obstruction, and strangulation. Figures 8a to d are examples of an incarcerated Spigelian hernia which is an E4 classification of high clinical importance. The patient underwent surgery for hernia repair. He died four days post-surgery from ischaemic heart disease.

SURGICAL REPAIR PROCEDURES

There are different surgical procedures for abdominal wall hernias repair. They vary from open repair to laparoscopic suture repair with or without the use of mesh (see Figure 7c). The most commonly used method is 'tension-free' mesh repair and is regarded as the standard surgical technique for the majority of cases. Complications of surgical repair may involve up to 50% of cases. Hernia recurrence is the most common one irrespective whether mesh is used or not. Fluid collection after surgery may occur as well as infection.^[5]

TIPS TO DETERMINE WHETHER SMALL OR LARGE BOWEL IS TRAPPED IN AN INGUINAL HERNIA

- If valvulae conniventes are seen within the trapped bowel, the diagnosis is small bowel as shown in Figure 9. If haustral markings are observed then it is large bowel (see also Figure 1d).
- The most accurate way of deciding whether it is small or large bowel is by looking at the colon-map, initially with

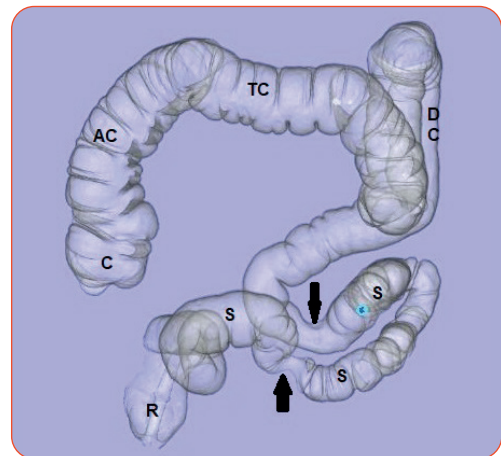


Figure 8a. Colon-map showing narrowing of sigmoid colon loops (black arrows). C = caecum, AC = ascending colon, TC = transverse colon, DC = descending colon, S = sigmoid colon.

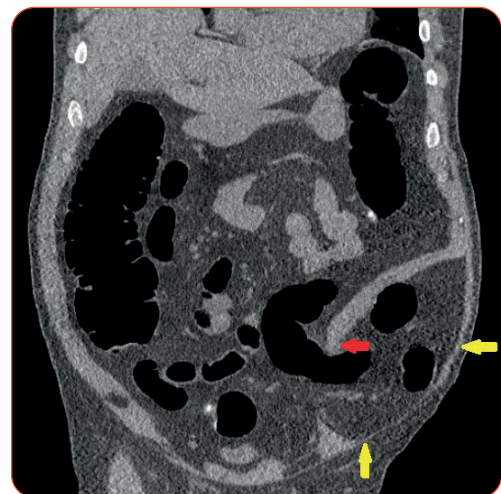


Figure 8b. 2D supine coronal image of the Spigelian hernia through the muscular defect. Red arrow indicates site of muscular defect. Yellow arrows show marked thinning of the external oblique muscle inferiorly.



Figure 8c. 2D supine sagittal view shows the Spigelian hernia sandwiched between the internal oblique and transversus muscle superiorly (red arrows) and thinned out external oblique muscle inferiorly (yellow arrow).

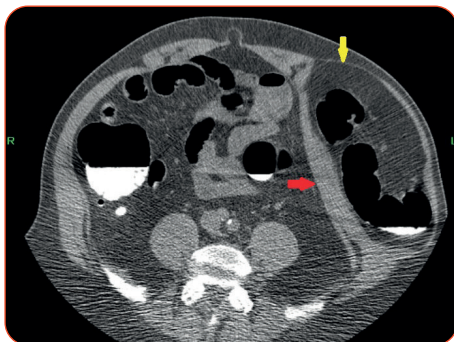


Figure 8d. 2D supine axial view showing Spigelian hernia between internal oblique and transversus muscle (red arrow) and the external oblique muscle thinned out superiorly (yellow arrow).

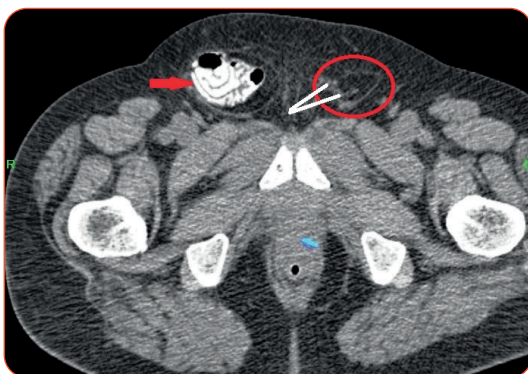


Figure 9. 2D axial scan of an abdominal CT study showing collapsed small bowel loops containing barium in a right direct inguinal hernia (red arrow). Left side shows a small direct inguinal hernia containing fat (red circle) with vessels displaced medially (white lines).

small bowel included and then removing the small bowel which is usually an automatic process.

- If the contour of the large bowel remains intact then no large bowel has herniated and the content is small bowel (see Figures 2e and f).
- When large bowel herniates, it is usually sigmoid colon and the colon-map will show displacement of sigmoid colon inferiorly, making it a left-sided hernia entering the scrotum in the male (see Figures 3a and b) and possibly in the labia of the female.
- Colon hernias are usually left-sided.

KEY POINTS

- CTC has the ability to uncover important extracolonic findings.
- 2D images need to be carefully assessed to check for the presence of abdominal hernia.
- Knowledge of the abdominal wall muscles is important as a change in their pattern/outline may indicate the presence of a hernia.
- Inguinal hernias mainly affect males (97%) hence the case of such a hernia in a female, as discussed in this paper, is unusual.
- Bilateral inguinal hernias are a rare occurrence.
- It is important to report on all ECFs because, as discussed in this paper, a hernia of low clinical importance in the space of five years developed into a significant finding.
- When a hernia containing bowel is visualised it is important to determine whether it is reducible or whether obstruction, incarceration or strangulation has occurred and which bowel (large or small) is involved.

CONCLUSION

Inguinal hernias are commonly present in males and rare in females. They often remain undiagnosed as many patients do not complain of symptoms or swelling in the groin region. Most patients who undergo screening CTC are surprised when a unilateral or bilateral extracolonic defect is present. Small or large bowel may be present in inguinal hernias. CTC is a safe, efficient and quick way of examining the colon. However, care must be taken with the introduction of CO₂ in known patients with direct or indirect inguinal hernias. If a patient complains of pain in the groin soon after CO₂ insufflation it is essential to clinically examine such a patient to exclude the presence of an inguinal hernia. Complications of inguinal hernia include perforation or obstruction. E-classification must be used to report on the presence of abdominal hernias as extracolonic findings in terms of patient management.

COMPETING INTEREST

The author declares that he does not have any financial or personal relationships that may have inappropriately influenced him in writing this article.

AUTHOR CONTRIBUTION

Sole author.

ETHICAL CONSIDERATIONS

This article followed all ethical standards for research.

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