Peer Reviewed **Article of Interest**

PARTIAL INVERSION OF APPENDIX SIMULATING A CAECAL POLYP AT SCREENING CT COLONOGRAPHY: THE IMPORTANCE OF SCRUTINISING 3D AND 2D IMAGES OF THE REGION OF INTEREST TO EXCLUDE OTHER POSSIBLE APPENDICEAL PATHOLOGIES

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ABSTRACT

An appendiceal lesion at computed tomographic colonography (CTC) could be a range of conditions which presents a diagnostic dilemma. The importance of careful scrutiny of 3D fly-through as well as 3D and 2D images is essential to exclude other possible appendiceal pathologies. A partial inversion and a complete inversion of the appendix at CTC are described.

Keywords: adenomatous, colonoscopy, fly-through, intraluminal, intussusception, polypoidal

LAY ABSTRACT

A mass in the region of the appendix could be different conditions. A computed tomographic colonography/virtual colonoscopy study allows for checking the images in different ways to determine whether the mass could be an appendix.

INTRODUCTION

Computed tomographic colonography (CTC) is now well established as an accepted test in the diagnosis of polyps and carcinoma in the colon.[1,2] After 28 years of use and numerous improvements in techniques, tagging, and 3D software improvements CTC is on the same level as optical colonoscopy (OC) in terms of accuracy and has been awarded the "A" certificate by the US Preventive Service Task Force (USPSTF).[3] An A grade certificate means that the USPSTF recommends the service and that there is a high certainty that the net benefit is substantial in colorectal cancer (CRC) screening. Furthermore literature underscores that CTC is a socially distanced and minimally invasive study with a very low risk of transmission of infection hence is the preferred screening test compared to OC during the Covid-19 pandemic.[4] Literature recommends that CRC screening should now commence at 45 years of age and continue until 75 years of age.[3,5] The USPSTF suggests screening of adults age 76 to 85 years is an individual decision taking into account a patient's overall health and prior screening history. This paper illustrates one of the diagnostic dilemmas which one occasionally encounters during screening CTC when an appendiceal lesion is evident. The discussion includes a recent case and compares it to a previous case with an appendiceal lesion at CTC. Relevant literature is discussed.

CTC FINDINGS OF AN APPENDICEAL LESION THAT PRESENTED A DIAGNOSTIC DILEMMA

A 74 year-old female with an unremarkable clinical history decided to have a screening CTC during the Covid-19 pandemic. She had undergone several CRC screening optical colonoscopies over the years and all the examinations were regarded as normal: she had not undergone any previous abdominal surgery. She had a standard screening CTC, which included cathartic agents for bowel cleansing and dual tagging agents to tag stool and residual fluid. Oral bowel preparation on the day before the examination was as follows: two bisacodyl (dulcolax) tablets at 11:00; 296ml magnesium citrate at 13:00; 296ml magnesium citrate at 17:00 followed by 250ml 2% barium sulphate suspension to tag stool; and 50ml omnipaque (iohexol) non-ionic contrast media at 20:00 to tag residual fluid in the colon.

A standard CTC technique was used. Carbon dioxide (CO_2) was administered using a PROTOCOL 2 (EZM) insufflator. Scanning was done on an 8-slice CT scanner (Lightspeed Ultra, GE Healthcare) using 120kVP and 50mAs. She was scanned in supine, prone and right lateral decubitus positions. An 8 x 1.25 detector configuration was used with 1mm reconstruction interval. Commercial CTC software (V3D Colon, Viatronix) was used to read the images. This software includes a 3D translucent display (TD) tool. This is a colour map as it provides a semi-transparent view in different colours beneath the surface. The software's different colour attenuation values are: red indicates soft tissue; white indicates high attenuation values, such as barium; green indicates negative values in the fat attenuation range; and blue indicates negative values, such as air. The colour map (TD)

allows for visualisation of the composition of a polypoidal lesion: a polyp will have a high intensity (red) center, surrounded by a thin layer of green (fatty tissue) and a blue layer which is air. Figure 1a is of a pedunculated polyp and Figure 1b is a TD (colour map) of Figure 1a showing predominately red indicating soft tissue polyp.

Figure 2a is an example of a normal appendiceal orifice. In the current case the appendiceal orifice on the supine 3D view was open and clear (Figure 2b). Figure 2c shows no evidence of a polyp. However, a 7mm polypoidal lesion at the appendiceal orifice was visualised on the prone (Figures 2d and e) and decubitus scans. Figure 2f represents a colour map of the polypoidal lesion which shows plentiful green indicating that the lesion favours an appendix and not a polyp.

She confirmed that she never had an appendectomy. The 2D images (Figures 2g to i) were carefully scrutinised. Fat was seen within the lesion as shown in Figures 2i and 2j. No lesion was evident on the supine study. However, prone and decubitus views showed the polypoidal lesion was considered to be a partial inversion of the appendix and not an adenomatous polyp. No referral to OC was made.

The current case shows partial appendiceal inversion whereas a case in 2015 showed complete appendiceal inversion.[6] A brief summary of the case is provided. A 52 year-old female underwent a screening CTC examination. Her medical history was that at the age of 15 years she had a hysterectomy for haematometra in a hypoplastic uterus. An 'alleged' appendectomy was performed at the same time. A diagnosis at the time of surgery was Mayer-Rokitansky-Küster-Hauser (MRKH) syndrome. The patient was adamant that the surgeon told her that her appendix had been removed. At CTC a 5cm long linear structure was noted best on the prone study (Figures 3a and b). A TD (colour map) of the structure showed high-attenuation tissue (i.e., red colour) interspersed with fat (i.e., green colour) as shown in Figure 3C. This finding alone would have been sufficient to make the diagnosis of complete inversion of the appendix, but because her history suggested differently it was decided to refer her on the same day for an OC which confirmed complete inversion of the appendix (Figure 3d). Histologically the findings were that of an appendix.

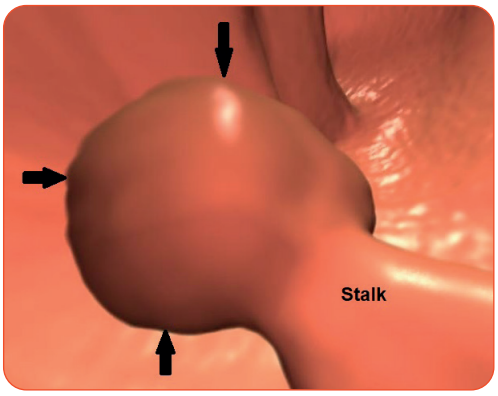

Figure 1a. 3D pedunculated polyp (black arrows).

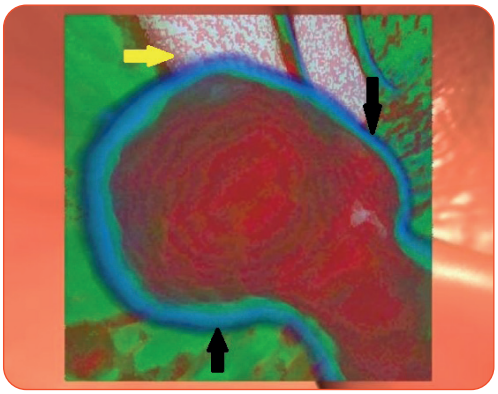

Figure 1b. TD (colour map) showing high intensity red center surrounded by thin layer of green (fat tissue) and a blue layer which represents air (black arrows). Yellow arrow indicates a pool of barium lying adjacent to the head of the polyp.

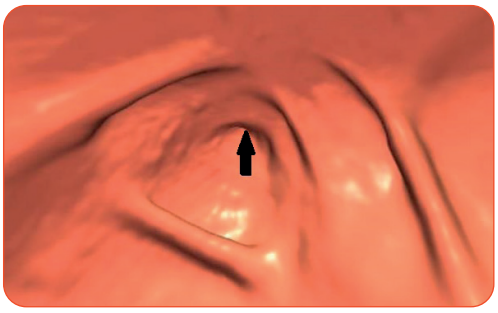

Figure 2a. 3D view showing a normal appendiceal orifice (black arrow).

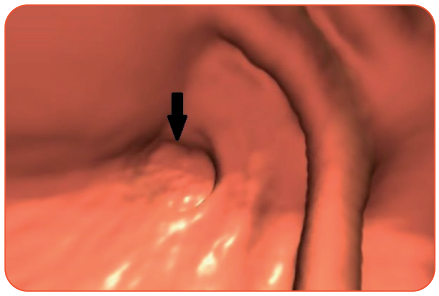

Figure 2b. 3D supine of current case showing the appendix orifice (black arrow) is open and clear.

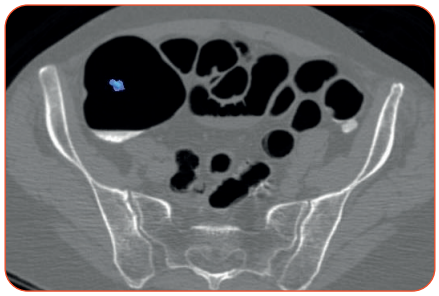

Figure 2c. 2D axial view of caecum: no polyp is visualised.

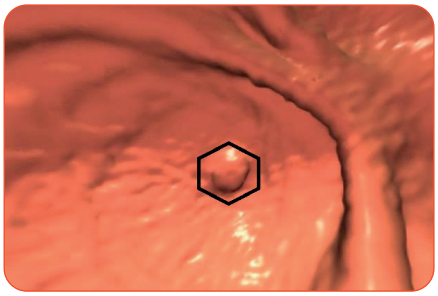

Figure 2d. 3D prone polypoidal mass in appendix region (black hexagon).

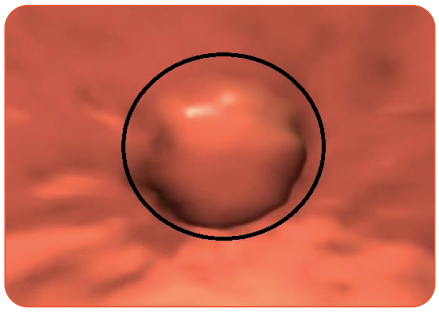

Figure 2e. Magnified prone polypoidal mass (black circle) of Figure 2d.

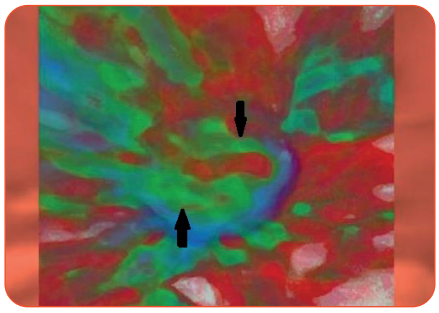

Figure 2f. Colour map showing fat (black arrows). Green = negative values in the fat attenuation range.

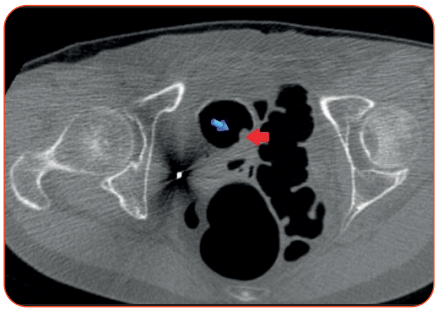

Figure 2g. 2D axial prone view showing soft tissue polyp (red arrow).

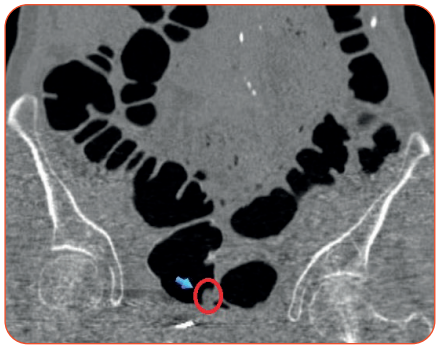

Figure 2h. Coronal view 2D showing soft tissue polyp (red circle).

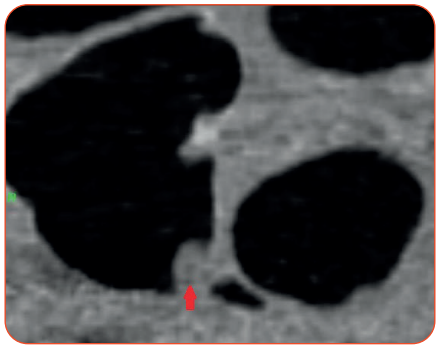

Figure 2i. A slightly magnified 2D view of small lucencies compatible with fat (red arrow).

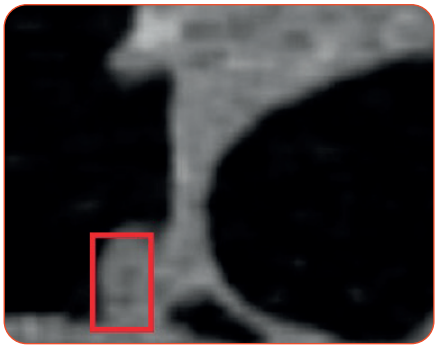

Figure 2j. Magnified 2D view of Figure 2i showing small lucencies compatible with fat (red square).

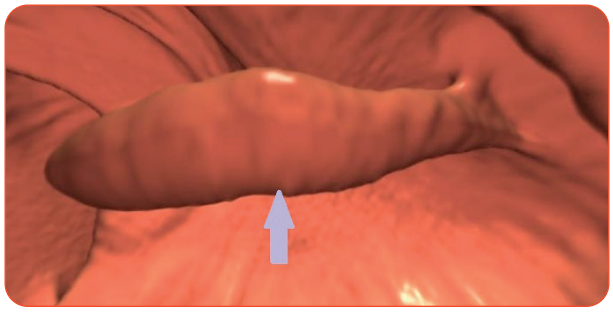

Figure 3a. 3D prone showing an elongated structure (violet arrow) compatible with an inverted appendix.

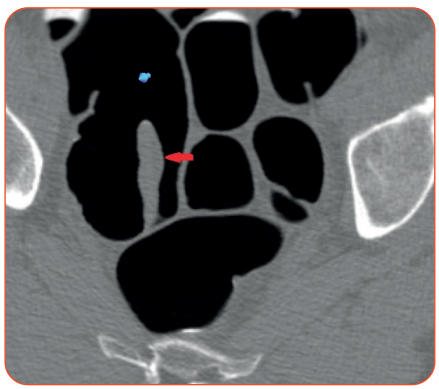

Figure 3b. 2D prone axial view showing full length of inverted appendix (red arrow).

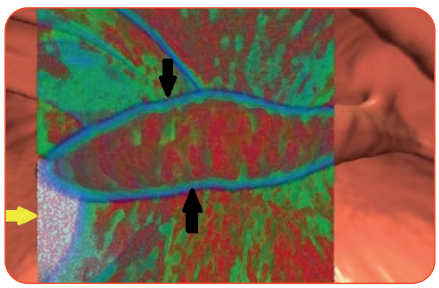

Figure 3c. Prone colour map of Figure 3a showing outline of inverted appendix (black arrows). There is a small pool of barium (yellow arrow). The patches of green indicate fatty tissue interspersed with the high intensity of red indicating soft tissue of the appendix.

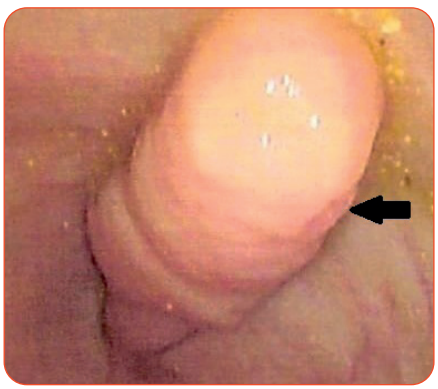

Figure 3d. Digital photograph via OC performed on the same day as the CTC confirms 5cm intact appendix (black arrow).

DISCUSSION

The appendix is part of the caecum and has a similar mucosal lining as the colon. The length of the appendix varies from 5cm to 10cm, but a 35cm long appendix has been reported in the literature.[7] The base of the appendix is usually situated 2cm below the ileocaecal valve (ICV) (Figure 4a). The convergence of the three taeniae in the caecum forms two prominent folds, called the crow's foot, within the caecum.[8] The appendiceal orifice lies between the two folds (Figure 4b). The appendix may differ in course and direction in individuals; this is due to the peritoneal fold which represents the mesentery of the appendix. It may lie in the pelvic cavity and even be in contact with the bladder and uterus. It is commonly retro-caecal in position and may lie in the right paravertebral gutter or even in the inguinal canal (Figures 5a and b).

The appendix may become inverted (i.e., turned inside out) which then results in partial or complete inversion. Figures 2d and 2e shows a partial inversion and Figures 3a and b show a complete appendiceal inversion. Intussusception on the other hand is a rare occurrence; an incidence of 0.01% in terms of an analysis of 71000 appendix specimens following appendectomy.[9] In other words, out of the 71000 specimens there were seven intussusception of the appendix specimens. In 2006 a case of appendiceal intussusception was diagnosed at CT.[10] This pathology may present at any age, but is more common in adults.[11] More than 70% of cases have 'lead points' such as endometriosis, adenomatous polyps, mucoceles, and adenocarcinomas;[12] 25% of adults may only have idiopathic inflammatory changes such as lymphoid follicular hyperplasia and hyperaemia without a definitive lesion.[13]

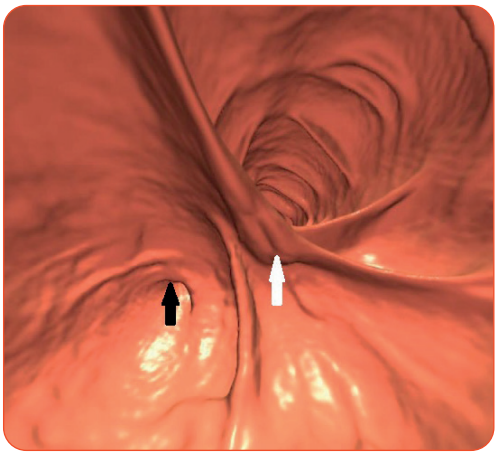

Figure 4a. 3D view showing orifice of the appendix (black arrow) and the ileocecal valve (white arrow).

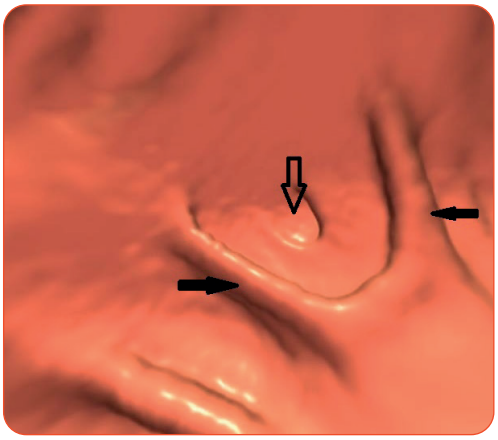

Figure 4b. 3D supine appendiceal orifice (open black arrow) and crow's feet (black arrows).

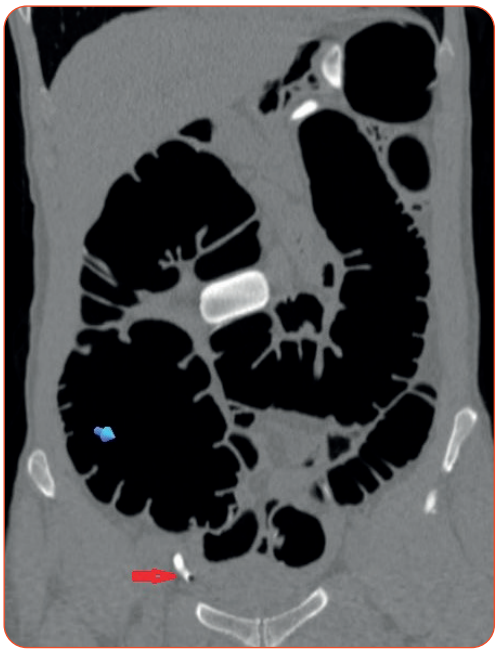

Figure 5a. 2D coronal view showing appendix containing barium in the right inguinal canal (red arrow).

Figure 5b. 2D sagittal supine view showing the appendix containing barium in the inguinal canal (red arrow).

Polypoidal lesions at the level of the appendiceal orifice can be the cause of a diagnostic dilemma. Is one dealing with an adenomatous polyp, neoplasm, appendiceal endometriosis or merely a partial or complete appendiceal inversion? As presented above Figures 3a to c are examples of an inverted appendix.

Intussusception is an uncommon pathological condition which may occur at any age.[14] There are two main types of intussusception: limited intussusception of the appendix; and complete intussusception of appendix into the caecum which may result in a colo-colic and/or ileo-colic intussusception.[14,15] The prevalence of endometriosis of the appendix is five in 10,000 cases (0.05%). The prevalence of adenocarcinoma of the appendix is eight in 10,000 cases (0.08%).

Confusion exists between the terms inversion or intussusception of the appendix. This presents one with a challenge as to what would be the correct terminology to use to report on CT study? Professor Pickhardt from Wisconsin University (personal communication 8 September 2021) says he uses the following terms when describing CTC images: partial inversion is when there is still some body/tip sticking out in the usual space; a complete inversion is when the appendix is fully intraluminal; and intussusception should be reserved for cases where the appendix serves as the lead point for telescoping.

An appendiceal inversion may appear on endoscopy to be a polypoid area covered with normal mucosa[16] hence resembling an adenomatous polyp. A CTC examination includes a 3D fly-through which is viewed as a video. The 3D fly-through allows for viewing the inside of the colon from the rectum to the caecum and returning back to the rectum. This means that the entire colon is viewed twice. One is able to stop the fly-through at any stage in order to visualise any part of the colon that may have a lesion. Varying speeds may be selected hence one can 'travel' at a low or high speed. One can view the inside of the colon in the supine, prone, and decubitus views.

It is important that radiologists and radiographers trained in CTC interpretation are confident when making a diagnosis. This is essential for patient management because if a patient were to undergo a 'polypectomy' of an appendiceal inversion this could result in bleeding and perforation.[17,18]

The patient in the 2015 case was adamant that she had undergone an appendectomy at the age of 15 years. Her CTC findings showed an appendix hence she underwent an OC to exclude a pedunculated polyp. OC confirmed complete inversion of the appendix. The 2021 patient confirmed she never had surgery. In view of that, and her TD colour map (Figure 2f), she was not referred for OC and a partial appendiceal inversion was reported.

CONCLUSION

A polypoidal soft tissue mass at the appendiceal orifice was visualised on the prone study of the 2021 case: the appendiceal orifice on the supine study was clear of any polypoidal mass. When such a mass is seen at CTC it raises the possibility of multiple causes for this appearance, for example, adenocarcinoma of the appendix, partial inversion of the appendix, and the possibility of endometrioma of the appendix. In view of this range of conditions it is essential to differentiate between benign and malignant conditions.

An OC to biopsy the lesion would be an appropriate decision to make. However, for a patient this would involve twilight anaesthesia, admission to a surgical centre, and the risk of haemorrhage, perforation or infection from an unclean colonoscope. In view of available software CTC tools it is possible to narrow down the possibilities of such a lesion in order to avoid unnecessary colonoscopy.

If a translucent display (colour map) software tool (e.g., Viatronix V3D System) is available it is possible to see the composition of the polypoidal mass to determine whether there is fat present. This will determine whether the mass is a true polyp. As discussed in the 2021 case there was fat present in the lesion. When assessing an appendiceal mass the presence of fat within the lesion will immediately allow a reader to exclude an adenomatous polyp. Software systems that do not have a TD facility require a careful 2D study of the region of interest. If low density areas on 2D magnified images are present within the lesion then this is indicative of fat. As discussed the 2D magnified images of the 2021 case did include low density areas in the lesion. As should be done for all CTC studies the 3D images and 2D images were carefully correlated allowing for a diagnosis of a partial inversion of the appendix.

The take away lesson is that 3D and 2D images are both essential in order to arrive at a correct diagnosis in a case of a polypoidal mass in the appendix region. A low density in the lesion on a 2D image indicates fat and thereby excludes an adenomatous polyp.

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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