THE MEDICAL BULLETIN OF
SISLI ETFAL HOSPITAL

DOI: 10.14744/SEMB.2020.35033
Med Bull Sisli Etfal Hosp 2021;55(1):18–22

Original Research

# Retrospective Evaluation of Ileocolic Artery and Vein Diameters according to Body Mass Index in the Diagnosis of Acute Appendicitis on Multislice Computerized Tomography

**Yahya Barac,[1] Burcin Agridag,[2] Huseyin Ozkurt[2]**

[1]Department of Radiology, Igdir State Hospital, Igdir, Turkey
[2]Department of Radiology, University of Health Sciences Turkey, Sisli Hamidiye Etfal Teaching and Research Hospital, Istanbul, Turkey

## Abstract

**Objectives:** We aimed to investigate the diagnostic value of the increasement in the ileocolic artery and vein diameters considering the body mass index (BMIs) of the patients with acute appendicitis.

**Methods:** Between January 2016 and April 2019, 76 patients who were diagnosed with acute appendicitis by contrast-enhanced abdominal multislice computerized tomography (MSCT) and had histopathologically confirmed appendicitis after an appendectomy were included in this study. To evaluate the value of MSCT, we created a control group, which consisted of 81 patients who had contrast-enhanced MSCT for other reasons and had no clinical and radiological findings suspicious for acute appendicitis and also had no other abdominal pathology that might interfere with ileocolic artery and vein diameter. In both groups, ileocolic artery and vein diameters were measured in axial MSCT scan. The body mass index was calculated for each patient (kg/m$^2$). Both groups were divided into three subgroups according to the BMI of patients (20-24.9; 25-29.9 and more than 30). Both groups and subgroups were compared individually. Statistical significance level was accepted as $p < 0.05$.

**Results:** Ileocolic artery and vein diameters were higher in the patient group than control group, which was statistically significant ($p<0.001$), and a positive correlation was found between BMI and ileocolic artery and vein diameters ($p < 0.001$).

**Conclusion:** Ileocolic artery and vein diameters with taking BMI into consideration can be used as alternative criteria in the suspicion of acute appendicitis in adults.

**Keywords:** Appendicitis; ileocolic artery; ileocolic vein; body mass index; multislice computerized tomography.

Please cite this article as "Barac Y, Agridag B, Ozkurt H. Retrospective Evaluation of Ileocolic Artery and Vein Diameters according to Body Mass Index in the Diagnosis of Acute Appendicitis on Multislice Computerized Tomography. Med Bull Sisli Etfal Hosp 2021;55(1):18–22".

Acute appendicitis is one of the most commonly encountered and important diseases requiring emergency surgery in cases referred to the emergency department due to abdominal pain.[1,2] Anamnesis, physical examination, laboratory and imaging findings have crucial roles in the diagnosis.[3,4] Acute appendicitis is most commonly seen between the first and third decades of life; however, it may occur at any age.[5,6] The lifetime risk of having acute appendicitis is approximately 7%.[5] The estimated risks of having acute appendicitis were reported as 6.7% in females and 8.6% in males.[5-7]

Ultrasonography (USG) is the first and most commonly used imaging modality in the diagnosis of acute appendicitis. Multislice Computerized Tomography (MSCT) is preferred as an adjunct imaging modality when USG is inconclusive or in patients with atypical clinical findings.[8,9] MSCT is used widely in the diagnosis of acute appendicitis. In diagnostic work-up of patients with acute appendicitis, multiple parameters should be evaluated like rising in the diameter of the appendix, rising in the periappendiceal inflammatory densities and periappendiceal fluid collection and increasement in the diameter of periappendi-

**Address for correspondence:** Burcin Agridag, MD. Saglik Bilimleri Universitesi, Sisli Hamidiye Etfal Tibbi Uygulama ve Arastirma Merkezi, Radyoloji Kliniği, İstanbul, Turkey
**Phone:** +90 535 632 40 44 **E-mail:** drburcinagridag@gmail.com

**Submitted Date:** March 11, 2020 **Accepted Date:** May 22, 2020 **Available Online Date:** March 17, 2021

ceal lymph nodes. However, the final diagnosis cannot be achieved in some cases.[6,10,11]

In this study, we aimed to investigate the diagnostic value of measuring ileocolic artery and vein diameters in consideration of BMI with intravenous contrast-enhanced MSCT.

## Methods

Between January 2016 and April 2019, 76 patients who were diagnosed with acute appendicitis by contrast-enhanced abdominal multislice computerized tomography (MSCT) and had histopathologically confirmed appendicitis after an appendectomy were included in this study. To evaluate the value of MSCT, we created a control group, which consisted of 81 patients who had contrast-enhanced MSCT for other reasons and had no clinical and radiological findings suspicious for acute appendicitis and also had no other abdominal pathology that may interfere with ileocolic artery and vein diameter. The exclusion criteria were patients below 18 years of age and having another abdominal pathology that could interfere with ILC artery and vein diameters. In patient group, there were 76 patients who had right lower quadrant pain and had positive imaging findings (appendix diameter higher than six millimeters, periappendiceal inflammatory densities, presence of pericaecal lymph node) for acute appendicitis on MSCT.

The control group consisted of 81 patients who had no clinical or radiological findings in favor of acute appendicitis or who had no other abdominal pathology that could affect the diameter of the ileocolic artery and vein (e.g., inflammatory bowel disease and malignancy). Body mass indices (BMIs) of all of the patients in both groups were calculated with height and weight data using the formula of kilogram divided by the square of the meter. Both the patient and control group then divided into three subgroups considering the BMIs as BMIs between 20-24.99, 25-29.99, and more than 30. In a retrospective evaluation, there was only one patient in the patient group with BMI under 20. This patient was excluded from this study.

A total of 76 patients (52 male and 24 female) aged between 18 and 60 years (mean±SD, 32.1±11.6 years) and a total of 81 patients (47 male and 34 female) aged between 18 and 79 (mean±SD, 34.8±13.4 years) were included in patient and control group, respectively. Ileocolic artery and vein diameters were measured in the segment of three centimeter axial plane beginning from the superior mesenteric artery and vein junction from contrast-enhanced MDCT axial images (Figs. 1, 2). After measurement, mean ileocolic artery and vein diameters were calculated according to BMI subgroups. The aim of this grouping was to minimize the discrepency of the effect of BMI to ILC artery

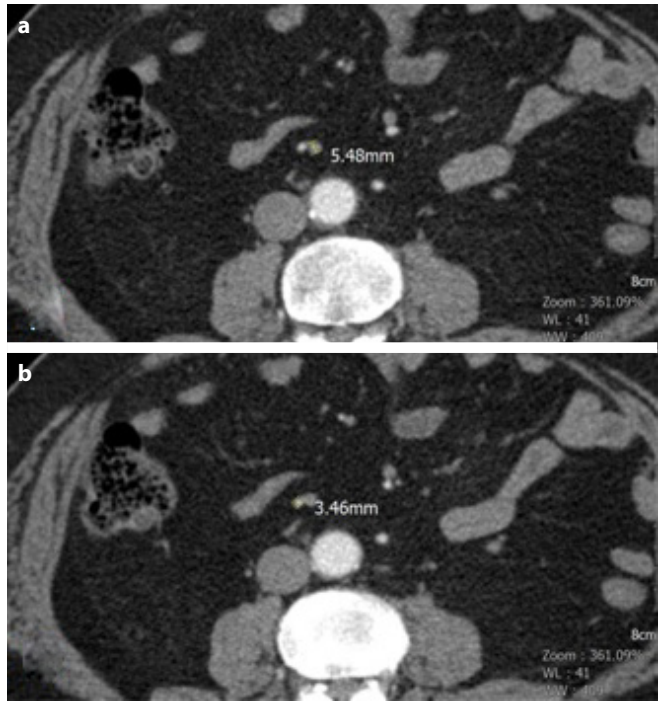


**Figure 1.** A 65-year-old male patient with BMI: 34,2 and diagnosed with acute appendicitis. Ileocolic artery diameter was 3.46 mm **(A)**, and ileocolic artery vein diameter was 5.48 mm **(B)** in axial plane MSCT.

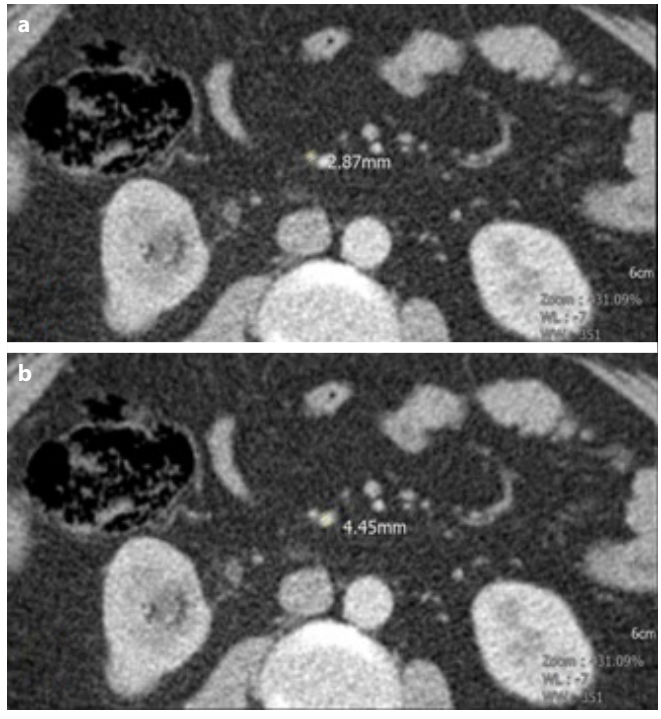


**Figure 2.** A 42-year-old male patient with BMI: 32,2 from the control group. Ileocolic artery diameter was 2,87 mm **(A)**, and ileocolic artery vein diameter was 4,45 mm **(B)** in axial plane MSCT.

and vein diameters. Measurements were obtained by a radiology specialist with 26 years of experience in abdominal imaging and a radiology assistant with four years of experience. Diameters were calculated in a consensus reading.

Siemens Somatom Definition AS 128 slice CT Scanner (Erlanger, Germany) was used to obtain images. Abdominal CT scan protocol was conducted as patients in the supine position, hands and arms on the head and through the diaphragmatic domes to the end of the symphysis pubis included in the image. Field of view (FOV) was between 350 and 420, slice thickness was 5 millimeter and the pitch value was 1. 1 milliliter per kilogram intravenous contrast was given to all patients at a rate of 3-4 milliliter per second with automatic injectors (CT injector; Ulrich Medical, Ulm-Jungingen, Germany). The images were obtained in the portal venous phase (60-70 seconds after injection). This study was approved by the Ethics Committee of Sisli Hamidiye Etfal Training and Research Hospital (28.05.2019-2412).

### Statistical Analysis

For statistical analysis, the 'SPSS 15.0 for Windows' program was used. Descriptive statistics were given as the number and percentage for categorical variables, mean, standard deviation, minimum, maximum for numerical variables were given.

Student's t-test was used to compare two independent groups when numerical variables provided the normal distribution condition, and the Mann-Whitney U test was used when the normal variables were not met. In independent groups, rates were compared with Chi-Square Analysis.

The relationships between the numerical variables were examined by Pearson Correlation Analysis when the parametric test condition was met and Spearman Correlation Analysis when the parametric test condition was not met. Cut-off values were analyzed using ROC Curve Analysis. Statistical alpha significance level was accepted as $p<0.05$.

## Results

The mean ileocolic artery and vein diameter of the patient group was significantly higher than of the control group ($p<0.001$) (Table 1). In addition, the mean ileocolic artery and vein diameters in both groups were positively correlated with BMI levels ($p<0.001$ for all) (Table 2). Mean ileocolic artery and vein diameters were significantly higher in patients with higher BMI in both study and control groups. ($p<0.001$) (Table 3, Fig. 3).

ROC curve analysis was performed and cut-off values of ileocolic artery and vein diameters were obtained for patient group regardless of BMI subgroups (Table 4). Cut-off values of ileocolic artery and vein were 2,59 millimeter (sensitivity 89.5%, specificity 87.7), and 3.995 millimeter (sensitivity 85.5%, specificity 75.3%), respectively. Cut-off values of ileocolic artery and vein diameters of each BMI subgroups of the patient groups were also obtained with ROC curve analysis (Table 5). Table 5 shows that sensitivity and specificity are significantly increased when cut-off values of ileocolic artery and vein diameters are determined by considering BMIs.

## Discussion

MSCT is the proper imaging modality in acute appendicitis with high and accurate diagnostic rates.[12] CT criteria for acute appendicitis is included as appendix diameter higher than 6 mm, presence of appendicolith in the lumen, appendix wall thickness higher than 3 mm, periappendiceal inflammatory density, presence of extraluminal gas, periappendiceal lymphadenopathy, increase in focal cecal wall thickness increase and intraluminal fluid depth exceeding 2.6 mm.[13] Balthazar et al.[8] showed the sensitivity and specificity of MSCT in the diagnosis of acute appendicitis as approximately 96% in the literature.

Arterial feeding of the appendix is provided by the appendicular artery, which is the branch of the ileocolic artery, and venous drainage is provided by the appendicular vein draining to the ileocolic vein.[14,15] Increment in the diam-

**Table 2.** The relation between Ileocolic artery-vein diameters and BMIs in patient and control group

| | BMI | |
|---|---|---|
| | rho | p |
| Patient Group | | |
| Ileocolic artery diameter | 0.77 | <0.001 |
| Ileocolic vein diameter | 0.77 | <0.001 |
| Control Group | | |
| Ileocolic artery diameter | 0.74 | <0.001 |
| Ileocolic vein diameter | 0.78 | <0.001 |

**Table 1.** Mean values of ileocolic artery and vein diameters in patient and control groups (±Standard Deviations)

| | Patient Group | | Control Group | | |
|---|---|---|---|---|---|
| | Mean±SD | Min-Max | Mean±SD | Min-Max | p |
| Ileocolic Artery diameter | 3.06±0.41 | 2.23-3.92 | 2.21±0.37 | 1.56-3.48 | <0.001 |
| Ileocolic Vein diameter | 4.52±0.54 | 3.7-5.9 | 3.79±0.45 | 2.98-5.04 | <0.001 |

**Table 3.** Mean ileocolic artery and vein diameters in BMI subgroups of patient and control group.

| BMI | Diameter (ileocolic artery and vein) | Patient Group | | Control Group | | p |
|---|---|---|---|---|---|---|
| | | Mean.±SD | Min-Max | Mean.±SD | Min-Max | |
| 20-24.9 | | | | | | |
| | Artery diameter | 2.84±0.29 | 2.23-3.48 | 1.93±0.27 | 1.56-2.44 | <0.001 |
| | Vein diameter | 4.22±0.38 | 3.7-5.9 | 3.40±0.29 | 2.98-3.97 | <0.001 |
| 25-29.9 | | | | | | |
| | Artery diameter | 3.30±0.32 | 2.73-3.92 | 2.18±0.21 | 1.57-2.57 | <0.001 |
| | Vein diameter | 4.86±0.45 | 4.21-5.7 | 3.80±0.33 | 3.18-4.82 | <0.001 |
| More than 30 | | | | | | |
| | Artery diameter | 3.71±0.17 | 3.46-3.88 | 2.84±0.32 | 2.27-3.48 | <0.001 |
| | Vein diameter | 5.25±0.25 | 4.95-5.72 | 4.43±0.38 | 3.82-5.04 | <0.001 |

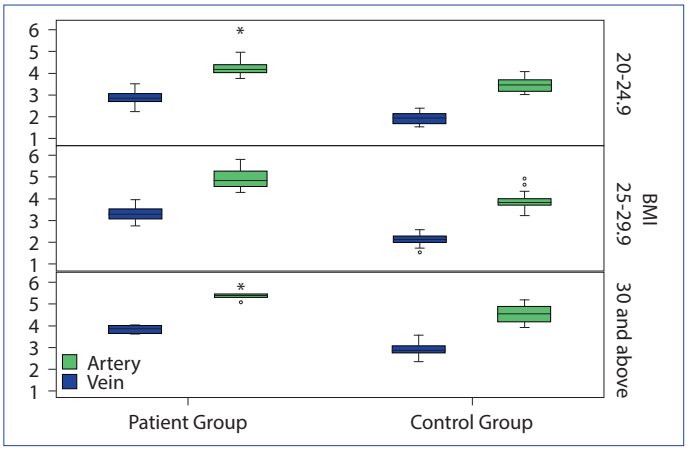


**Figure 3.** Mean ileocolic artery and vein diameters in BMI subgroups of patient and control group.

eter of appendiceal and periappendiceal vascular branches was observed regarding to severity of inflammation.[16] In the light of these data, we retrospectively evaluated and compared the ileocolic artery and vein diameters in the patient and control group. In addition, we aimed to determine a cut-off value that can be used in the diagnosis of acute appendicitis. However, BMIs are also effective on vascular structure diameter. We divided patient and control group into three subgroups regarding BMIs and evaluated each group separately. In our study, we stated that ileocolic artery and vein diameters increase in direct proportion to BMI. Since the effect of BMIs on ILC artery and vein diameters is presumable, the diameters can be evaluated according to BMIs. On axial MDCT images, even the sensitivity and specificity of the ILC artery and vein diameters in the diagnosis of acute appendicitis increase when patients were subgrouped according to BMIs, in daily practice; cut-off values of the diameters without considering BMI can also reliably used.

In a study conducted by İncesu et al., PDUS (power Doppler ultrasonography) and CEPD US (contrast-enhanced power Doppler ultrasonography) evaluation showed that appendiceal wall thickness and periappendiceal vascularization increased in patients with acute appendicitis. This statement supports the main idea of our study that the caliber of the vascular structures that feed inflamed appendix tends to increase. Ileocolic artery and vein diameters were firstly evaluated as diagnostic criteria in acute appendicitis in a study conducted by Mehmet Şirik et al. They also stated that ileocolic artery and vein diameters increase in patients with acute appendicitis when compared to the normal population.[17] In this study, we further compared ileocolic artery and vein diameters in both patient and control groups and also in BMI subgroups.

**Table 4.** Cut-off values of ileocolic artery and vein diameters in the patient group (ROC curve analysis was performed regardless of BMI subgroups)

| Diameter | Cut-off Value (mm) | Sensitivity (%) | Specificity (%) |
|---|---|---|---|
| Ileocolic artery | 2.59 | 89.5 | 87.7 |
| Ileocolic vein | 3.995 | 85.5 | 75.3 |

**Table 5.** Cut-off values of ileocolic artery and vein diameters in BMI subgroups (ROC curve analysis was performed considering BMI subgroups of the patient group)

| Diameter | Cut-off Value | Sensitivity (%) | Specificity (%) |
|---|---|---|---|
| Ileocolic artery | | | |
| 20-24.9 | 2.385 | 95.5 | 95.0 |
| 25-29.9 | 2.65 | 100 | 100 |
| More than 30 | 3.34 | 100 | 91.7 |
| Ileocolic vein | | | |
| 20-24.9 | 3.78 | 95.5 | 95.0 |
| 25-29.9 | 4.275 | 96.2 | 93.9 |
| More than 30 | 4.885 | 100 | 91.7 |

In accordance with the study of Mehmet Şirik et al., mean ileocolic artery and vein diameters, cut-off values and sensitivity and specificity of the cut-off values (ileocolic artery diameter ≥3.05 mm with sensitivity 83.8% and specificity 80.9%, ileocolic vein diameter ≥4.55 mm with sensitivity 75% specificity 73%) were similar to our study results. Additionally, when cut-off values were calculated considering the BMI subgroups, a significant increase in the sensitivity and specificity of the cut-off value has been observed.

In the study of Min Yeong Kim et al., the sensitivity and specificity of criteria currently used in patients with acute appendicitis were evaluated. The sensitivity and specificity of the maximal outer diameter of appendix >6 mm; mural thickness > 3 mm; presence of mural enhancement; the presence of periappendiceal inflammation; and presence of appendicolitis were calculated as 97.5%, 59.6%; 78.8%, 8.8%; 96.3%, 80.9%; 32.5%, 97.8%, respectively.[17] In our study, the sensitivity and specificity of ILC artery and vein cut-off values without subgrouping according to BMIs was calculated as 89.5%, 87.7% and 85.5%, 75.3% retrospectively. Determined cut-off values that were calculated considering BMI subgroups even increased sensitivity between 95.5% and 100% and increased specificity between 91.7% and 100%. This study highlights that ILC artery and vein diameters calculated from the axial MSCT scan can be used as new criteria in the diagnosis of acute appendicitis.

We have a few limitations in this study. Firstly, patients under 18 years of age were not included in this study. Secondly, since there is not enough number of patients with BMI below 20, we could not determine a cut-off value for those groups of patients. Additionally, interobserver variability could not be assessed since the diameters were calculated in the consensus reading of two radiologists with different years of experience. We believe that further studies may investigate the possible added value of interobserver variability in the measurement of ILC artery and vein diameters.

## Conclusion

In the diagnosis of acute appendicitis with MSCT, ileocolic artery and vein diameters can be used reliably. Moreover, if the evaluation is made considering the BMI of the patients, the contribution of the measurements to the diagnosis will be much higher.

### Disclosures

**Ethics Committee Approval:** This study was approved by the Ethics Committee of Sisli Hamidiye Etfal Training and Research Hospital (28.05.2019-2412).

**Peer-review:** Externally peer-reviewed.

**Conflict of Interest:** None declared.

**Authorship Contributions:** Concept - Y.B., H.O.; Design - Y.B., H.O.; Supervision - H.O., B.A.U.; Materials - Y.B., B.A.U.; Data collection & or processing - Y.B., B.A.U.; Analysis and/or interpretation - Y.B., B.A.U., H.O.; Literature search - Y.B.; Writing - Y.B., B.A.U.; Critical Review - H.O.

## References

1. Aydemir İ. Apendiks hastalıkları. Genel cerrahi ders kitabı. In: Göksoy E, editor. İstanbul: İstanbul Üniversitesi Cerrahpaşa Tıp Fakültesi, Yayın no:4892; 2010. p. 878–87.
2. Sammalkorpi HE, Mentula P, Leppäniemi A. A new adult appendicitis score improves diagnostic accuracy of acute appendicitis--a prospective study. BMC Gastroenterol 2014;14:114.
3. Doğan S,Bulut AŞ,Karamürsel BS. A rare differential diagnosis of acute appendicitis: Appendiceal endometriosis. Ulusal Cerrahi Dergisi 2012;28:159–61.
4. Fisher JE, Bland KI, Callery MP, Clagett GP, Jones DB, Logerfo FW, et al. Mastery of Surgery. In: Özmen MM, translation editor. Apendiks. 5th ed. Ankara: Güneş Tıp Kitapevi; 2011. p. 1430–8.
5. Kavic MS, Kavic SM, Kavic SM. Laparoscopic Appendectomy. In: Wetter PA, editor. Prevention and management of laparoendoscopic surgical complications. 3th ed. Florida: Society of Laparoendoscopic Surgeons; 2010. p. 239–48.
6. Williams GR. Presidential Address: a history of appendicitis. With anecdotes illustrating its importance. Ann Surg 1983;197:495–506.
7. Mishra VK, Joshi P, Shah JV, Agrawal C, Sharma D, Aggarwal K. Amyand's hernia: a case of an unusual inguinal herniace. Indian J Surg 2013;75:469–71.
8. Balthazar EJ, Birnbaum BA, Yee J, Megibow AJ, Roshkow J, Gray C. Acute appendicitis: CT and US correlation in 100 patients. Radiology 1994;190:31–5.
9. Malone AJ Jr, Wolf CR, Malmed AS, Melliere BF. Diagnosis of acute appendicitis: value of unenhanced CT. AJR Am J Roentgenol 1993;160:763–6.
10. Young P. Appendicitis and its history. [Article in Spanish]. Rev Med Chil 2014;142:667–72.
11. Craig S. Appendicitis. Available at: http://emedicine.medscape.com/article/773895-overview. Mar 03, 2020.
12. Ashraf K, Ashraf O, Bari V, Rafique MZ, Usman MU, Chisti I. Role of focused appendiceal computed tomography in clinically equivocal acute appendicitis. J Pak Med Assoc 2006;56:200–3.
13. Moteki T, Horikoshi H. New CT criterion for acute appendicitis: maximum depth of intraluminal appendiceal fluid. AJR Am J Roentgenol 2007;188:1313–9.
14. Balthazar EJ, Rofsky NM, Zucker R. Appendicitis: the impact of computed tomography imaging on negative appendectomy and perforation rates. Am J Gastroenterol 1998;93:768–71.
15. Sirik M, Olt S. The value of the ileocolic vessels in acute appendicitis- a cross sectional study. Annals of Medical Research 2018;25:656–9.
16. Incesu L, Yazicioglu AK, Selcuk MB, Ozen N. Contrast-enhanced power Doppler US in the diagnosis of acute appendicitis. Eur J Radiol 2004;50:201–9.
17. Kim MY, Kim Y, Ryu JA, Kim TY. How to evaluate appendices with borderline diameters on CT: proposal of a quick solution to overcome the limitations of the established CT criteria. Acad Radiol 2014;21:1573–8.