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A vital and disregarded anatomical landmark: Descending sigmoid colon flexure

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***Abstact*---**Background: During the colonoscopy, colon tortuosity is a vital factor to complete the procedure successfully. Endoscopy can be difficult in cases with acute angle bending of adjacent colon segments. Aim: To assess the relationship of descending sigmoid colon flexure to vital anatomical points on CT in adult subjects. Methods: 114 adult subjects with CT examination of the abdominopelvic region were retrospectively analyzed. In 114 subjects, the angle between proximal sigmoid and descending colon was evaluated in degrees along with descending-sigmoid flexure position concerning the anterior aspect of the 5th lumbar vertebra, the median plane, and left anterior superior iliac spine. Results: Descending sigmoid flexure was seen in all 114 subjects. the LV-DSF was significantly higher in male subjects, with a distance of 123.7±23.1mm compared to female subjects where it was 115.6±21.2. This was statistically significant with $p<0.005$. MP-DSF in male subjects was 97.8±15.6mm which was significantly higher than

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the female subjects having MP-DSF of 88.8±14.0mm. The minimum to maximum for males and females respectively were 52-149 and 44-116 which was a statistically significant difference with $p<0.001$. However, for ASIS-DSF, the distance did not differ significantly between males and females with $p=0.54$ Conclusions: The descending-sigmoid flexure is a vital landmark visualized during colonoscopy in the morphology of the large intestine. It is seen at nearly 9-10 cm from the median plane and 3cm from the left anterior superior iliac spine. In nearly one-third population, flexure is seen at $\leq 90^0$ angles which can lead to difficulties during colonoscopy.

Keywords---abdominopelvic, Colonoscopy, CT, DSF, sigmoid flexure.

Introduction

Optical colonoscopy is a widely effective and accepted tool used for the screening, evaluation, and surgical removal of colorectal polyps. However, in a few subjects, a complete examination of the colon is impeded by various physical conditions as colonoscopy is a challenging screening tool concerning the physical involvement of the subjects undergoing colonoscopy. This complete examination of the colon is usually considered a failure for cecum intubation that can be attributed to endoscopist factors, patient-related factors, and a combination of these factors.[1] Incomplete colonoscopy has been most commonly reported to patient-related factors including a previous history of abdomen surgery, diverticular disease, increased age, and female gender. These patient-related factors also include previous incomplete colonoscopy history, use of laxatives, constipation history, and low BMI (body mass index). Endoscopist-related factors that can affect the colonoscopy procedures completion include the use of apt equipment, use of specific techniques, and prior experience of the endoscopist. However, colon length has been previously estimated with the barium enema, CTC (CT colonography) has been a more accurate tool to assess the length and anatomy of the colon which is a 3D and complex structure.[2]

The colon anatomy has been studied for a long which made the anatomical landmarks very clear. In the colon anatomy, the intestine is narrated to be a tortuous tube having two main flexures: the left splenic flexure and the right hepatic flexure. Despite of detailed study of the colon anatomy, very little notice was given to the angle between the sigmoid colon and descending colon which is known as colosigmoid junction or DSF (descending-sigmoid flexure). Colonic anatomy can be assessed with both non-invasive and invasive techniques. In non-invasive methods, MRI (magnetic resonance imaging) and CT (computed tomography) are the two methods used commonly, whereas, invasive procedures include colonoscopy and colon capsule examination.[3]

For the colonoscopy procedure to be successful, colon tortuosity and morphology are the two vital factors. Very few incidences of bleeding and perforation have been reported in children and adult subjects following the colonoscopic assessment. In approximately 8-10% of cases, the colonoscopic assessment remains incomplete owing to aberrations in the anatomy of the colon. These failures are commonly attributed to supernumerary colon loops and fixed colon bending. The presence of additional flexures has been reported in the sigmoid colon and transverse colon.[4]

These differences in the morphology of the colon can make the examiner baffled concerning the placement of the endoscope tip during the colonoscopy. Least accurate assessment and results are usually seen when the endoscope tips are positioned in the splenic flexure after passing through the sigmoid colon.[5] The present study aimed to assess the relationship of descending sigmoid colon flexure to vital anatomical points on CT in adult subjects.

Materials and Methods

The present retrospective observational study was conducted to assess the relationship of descending sigmoid colon flexure to vital anatomical points on CT in adult subjects. The study was done at Darbhanga Medical college, Darbhanga, Bihar, after clearance was given by the concerned Ethical committee. The study population was comprised of the subjects reported for colonoscopy to the institute. Informed consent was not required for the study as the study was based on retrospective analysis.

A total of 114 subjects were recruited for the study from genders, males and females. The subjects included in the study were referred from various clinics and departments for elective colonoscopy to the institute. Among 114 subjects, there were 48 females and 66 males. The inclusion criteria for the study were subjects with no previous history of abdominopelvic cavity surgery and chronic or acute colonic diseases.

The CT examination was performed for all the subjects by two examiners expertized in the field. All CT scans were done on the same single CT scanner that could produce 320 slices. A single machine was used to perform CT scans of all the subjects to avoid any technical variability that can result in bias.

Measurements done for Descending-sigmoid flexure (DSF) were analyzed retrospectively acquired with window width in the pelvic and abdominal non-contrast CT phases. The data assessment was also done by two different radiologists expertized in the field with a minimum of 10 years of experience. For the Descending sigmoid flexure, the two parameters assessed were acute or obtuse angles of descending sigmoid flexure and the position of descending sigmoid flexure in the abdominopelvic cavity.

The measurements made were split into three main steps. For the first step, the middle part of descending sigmoid flexure was taken at the midpoint between the proximal sigmoid colon segment and the distal end of descending colon. In the second step, the distance between the anterior surface of the 5th lumbar vertebra (LV) and MP (median plane), left anterior superior iliac spine (ASIS), and descending sigmoid flexure was evaluated. The median plane was the body-related feature, whereas, the 5th lumbar vertebra and anterior superior iliac spine was the bony fixed point. The distances measured were respectively DSF-ASIS, DSF-MP, and DSF-LV. These measurements of descending sigmoid flexure were assessed related to BMI, height, age, and gender. The values for DSF were divided into two categories obtuse (more than 90^0) and acute (less than 90^0). All the measurements were taken thrice, and the mean values were assessed whenever required.

The collected parameters and data were assessed with appropriate statistical tests using SPSS software version 20.0. The results were expressed in number and percentage for the categorial variables, whereas, mean and standard deviation were utilized for the categorial variables. The statistical tests utilized were the Kruskal-Wallis test, chi-square test, Mann-Whitney U test, and Kolmogorov-Smirnov test. Pearson's coefficient was used to assess the correlation. The significant level for the study was taken at $p<0.05$. Reliability and reproducibility of the data were also assessed.

Results

The present study results identified and located DSF in all 114 participants. The assessed DSF was acute in 30.70% (n=35) of subjects where 13 were males and 22 were females. The DSF angle was obtuse in 69.29% (n=79) of study subjects where 35 were females and 44 were male subjects. However, the obtuse angle was not >120^0C in any of the study participants.

For the present study, colonoscopy in 20.17% (n=23) subjects was done owing to unclear ultrasonography findings in subjects with lower digestive tract bleeding, in 20.17% (n=23) subjects for diagnosis of acute cholecystitis subjects, and a majority of 59.64% (n=68) subjects for the diagnosis of undefined abdominal pain. The age and BMI were lesser in female study subjects compared to the male subjects. Concerning BMI, it was slightly higher in males with 60.8±12.5kg/m2 compared to females who have a mean BMI of 58.4±13.9kg/m2 and a range of 19-84 from minimum to maximum. The height was higher in males with 87.3±14.7 compared to 74.4±18.8 with females having lesser height. The weight was also higher in males (174.5±6.5kg) compared to females (161.4±6.1kg). The mean age was comparable in males and females with a respective mean age of 28.9±4.5 years and 28.8±6.7 years as shown in Table 1.

On assessing the DSF position in male and female study participants using the Mann-Whitney U-test, the LV-DSF was significantly higher in male subjects, with a distance of 123.7±23.1mm compared to female subjects where it was 115.6±21.2. This was statistically significant with $p<0.005$. The minimum-maximum distance for males and females was 82-204 and 10-49 respectively. MP-DSF in male subjects was 97.8±15.6mm which was significantly higher than the female subjects having MP-DSF of 88.8±14.0mm. The minimum to maximum for males and females respectively were 52-149 and 44-116 which was a statistically significant difference with $p<0.001$. However, for ASIS-DSF, the distance did not differ significantly between males and females with $p=0.54$ as depicted in Table 2.

Concerning the influence of age on DSF in study subjects, a correlation was done between the age of the participants and the distances assessed. It was seen that a significant distance was seen for DSP-MP distance with r=0,2 and $p<0.05$. For

DSF-LV and DSF-ASIS, the correlation was statistically non-significant with p>0.05 for both the distances as assessed by Pearson's correlation coefficient. These results depicted that with an increase in age, the distance between DSF and assessed landmarks also increased.

For the influence of height on the assessed distances and their correlation assessment, it was seen that a significant correlation was seen in the DSF-MP distance with r=0,3 and the p-value of >0.05 and DSF-LV with r= -0,1 and p<0.05. However, the DSF-ASIS distance was statistically non-significant with p>0.05. These results showed that the subjects with more height have a greater distance between the assessed landmarks and DSF.

On assessing the influence of BMI on the assessed distances and their correlation assessment, it was seen that a statistically significant correlation was seen for DSF-MP and DSF-LV with r=0.1 and 0.1 respectively, and the p-values of <0.05 for both. However, for DSF-ASIS, the r was 0.1 and the p was >0.05 which showed the non-significant correlation depicting that subjects with higher BMI have more distance between assessed landmarks and DSF.

No significant correlation was seen between the gender of the subjects and DSF angle with p >0.05. For BMI, height, and age, no significant relation was seen with the DSF angle value. The r for BMI, height, and age respectively was 0,0, 0,1, and 0,0, whereas, the p-values were >0.05 for all three parameters as assessed with the Pearson correlation coefficient.

For BMI categories comparison, the categories were obese, overweight, normal, and underweight. No significant association was seen in the DSF angle and the BMI categories with p=0.6. In the study subjects, obtuse angles were commonly encountered.

Discussion

The present study results were compared with the existing previous literature data based on colon identification. From the previously available data from the cadaveric studies. The available data is focused on the abdominal anatomy with a major focus on the abdominal vessels and the nervous system as assessed recently in 2021 by Juszczak A et al.[6] This data was taken from the previous assessment by Chung BS et al[7] in 2016 where authors assessed the gut and adjacent structures from the virtual anatomic models.

The morphology of the large intestine has been described in detail by the previously available literature data. However, scarce data is available concerning colon bending and associated variations in the DSF. Near the end of fetal time, the fixation of descending colon occurs. Sigmoid colon variations in the intrauterine life have been described in detail by Malas MA et al[8] in 2004. They described normal type sigmoid colon in 47% of subjects as the part between the end of descending colon and the beginning of the rectum folded downwards on the left, 22% as the superior type which is curled upwards, and 25% as left deviation when the sigmoid colon is turned towards the right side. These findings were consistent with the results of the present study where 1/3rd of study subjects had acute DSF and 2/3rd had the obtuse bending of the colon.

The present study assessed the anatomical features and position of connection between the sigmoid colon and descending colon termed the DSF. The study focused on the relationship between DSF and bony landmarks namely MP, 5th LV body, and left ASIS. The DSF angles were also recorded as acute or obtuse angles. The study results were against the findings of Herp et al[9] in 2021where authors did not assess DSF when assessing the colon. However, another study by Verra M et al[10] in 2020 reported that gut anatomy can be accurately described by DSF assessment and study which supported the present study.

Previously the term used was colosigmoid junction as also used in 2012 by Bourgouin S et al.[11] However, very recently DSF had been used for descending-sigmoid flexure. The present study found DSF as a more appropriate name as it denotes the boundaries between flexure (acute in 1/3rd of study subjects) and distal and proximal colon. This flexure has not been described by previous anatomy books including one by Paulsen F and Waschke J[12] in 2011. However, few authors including Shafik AA et al[13] in 2009 described it as a vital feature in colon morphology as evaluated on 18 endoscopic examinations, 10 morphometric specimens, 15 histological, and 15 cadaveric specimens where he described a colosigmoid canal of 5.2 ± 1.1 cm. This sphincter was not assessed in the present study.

During the colonoscopy, assessing the position of the endoscopic tip passage through the bend can be helpful, especially with new endoscopists having no additional access to visualization during colonoscopy including magnetic endoscopic imaging described in 2017 by Pasternak A et al.[14] From the measurements of the present study, it would be easier to palpate MP and ASIS during estimation of endoscope tip position to DSF. Also, other diagnostic modalities had a drawback with variation in the position and morphology of the colon in the pelvic and colon cavity. It was challenging to reconstruct the curvatures and segments of the entire colon as also seen in the present study of Herp et[9] al in 2021 where the present study is an improvement.

In a previous study by Bourgounin S et al[11] in 2012, they assessed CT on 3D coordinates to create customized gastrointestinal tract models for surgery simulation. The authors reported a connection of sigmoid and descending colon to right and left colonic flexures. However, in the present study, 2 bony landmarks, LV and ASIS, and one anatomical landmark, MP were used to locate the DSF which made it easier to locate. Koppen IJN et al[15] in 2017 used the 2nd lumbar vertebra in child subjects to describe colosigmoid junction, whereas, the present study used the 5th lumbar vertebra which is more reliable in adults.

Increased BMI was seen in the majority of the study subjects with increased DSF-LV and DSF-MP distance while the DSF-ASIS was constant. This can be attributed to an enlarged abdominal cavity in both depth and width owing to the increase in BMI. These results were in agreement with the study of Hounnou G et al[16] in 2002 where authors reported body weight to be the most vital factor correlating gut parameters along with age, whereas, gender was not found to be vital for bowel length. Another study by Mirjalili SA et al[17] in 2017 reported no association between gender and colon characteristics in the children.

Conclusion

Considering its limitations, the present study concludes that the descending-sigmoid flexure is a vital landmark visualized during colonoscopy in the morphology of the large intestine. It is seen at nearly 9-10 cm from the median plane and 3cm from the left anterior superior iliac spine. In nearly one-third population, flexure is seen at ≤90^0 angles which can lead to difficulties during colonoscopy. The study had few limitations including few subjects and geographic area biases.

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Tables

Characteristics	**Females (n=66)**		**Males (n=48)**	
	Mean± S. D	**Min-Max**	**Mean± S. D**	**Min-Max**
BMI (kg/m2)	58.4±13.9	19-84	60.8±12.5	26-81
Height (cm)	74.4±18.8	45-162	87.3±14.7	50-130
Weight (kg)	161.4±6.1	146-180	174.5±6.5	155-196
Age (years)	28.8±6.7	19.2-59.7	28.9±4.5	18.2-41.0

Table 1: Demographic parameters of the study subjects

DSF position	**Males (n=66)**		**Females (n=48)**		**p-value**
	Mean± S. D	**Min-Max**	**Mean± S. D**	**Min-Max**	
LV-DSF	123.7±23.1	82-204	115.6±21.2	10-49	**<0.005**
MP- DSF	97.8±15.6	52-149	88.8±14.0	44-116	**<0.001**
ASIS- DSF	32.3±12.6	6-99	30.4±8.2	10-49	0.54

Table 2: DSF position in male and female study subjects