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ORIGINAL ARTICLE

Rectum sizes: Assessment by ultrasonography in children with functional constipation

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Aim: This study aimed to compare the transverse diameter and thickness of the anterior wall of the rectum in children with normal bowel movement and children with functional constipation in different age groups. Another objective was to find correlations of rectum sizes with faecal incontinence and constipation duration.

Methods: In the study, we included children with normal bowel movement and functional constipation diagnosed based on the Rome III and Rome IV criteria. We collected clinical data from the parents. We measured the rectum transverse diameter and the thickness of the anterior wall by abdominal ultrasound.

Results: The study included 65 children, 31 with normal bowel movement and 34 with functional constipation. The rectum transverse diameter and the thickness of the anterior wall had statistically significant higher values in patients with constipation ($P < 0.05$). There was a moderate and significant correlation between the duration of the disease (mean ± standard deviation = 31.7 ± 33.1 months) and rectum transverse diameter ($r = 0.54$; $P = 0.0009$). The rectum transverse diameter correlated moderately with the presence of faecal incontinence ($r = 0.62$; $P = 0.003$), but the thickness of the anterior wall did not correlate with this symptom ($r = 0.02$; $P = 0.39$).

Conclusions: We found statistically significant differences between the transverse rectal diameter and thickness of the rectum anterior wall, measured by abdominal ultrasound, in children with functional constipation compared with normal defaecation patterns. Faecal incontinence and long-term constipation were correlated with the increased rectum diameter.

Key words: children; functional constipation; rectum; ultrasonography.

What is already known on this topic

1 Currently, there is not enough evidence to support the use of rectal ultrasound to diagnose functional constipation.
2 Children with functional constipation have a significantly larger diameter than healthy children.
3 Transabdominal ultrasonography of the rectum can be used to identify faecal impaction.

What this paper adds

1 Children with functional constipation and large rectum diameter have an increased thickness of the anterior wall of the rectum.
2 Faecal incontinence and long-term constipation correlate with increased rectum diameter.
3 Average ranges for rectum diameter and thickness of the anterior wall differ in different age groups.

Functional constipation is a condition often diagnosed in paediatric patients. The most important part of the diagnosis of functional constipation remains a thorough medical history and physical examination. In some particular situations, investigations are necessary to exclude organic diseases, given the presence of 'alarm signs and symptoms'. Since 2016, Rome IV criteria for functional gastrointestinal diseases[1,2] are used to establish the diagnosis of functional constipation. Rome IV criteria brought a few changes to the previous Rome III classification.[3,4] The purpose of these changes was to avoid delaying the diagnosis and hence the treatment. Furthermore, in the classification for neonate/toddler,[1] differentiation has been made between children who are toilet trained and those who are not, to ease the assessment of faecal incontinence.

The primary pathophysiological mechanism of functional constipation in children is faecal retention as a result of withholding behaviour. This leads to impairment of both motor and sensory functions of the rectum.[5] Faeces accumulate in the rectum, causing a progressive increase in the rectum size. In time, greater amounts of stool will be required to trigger the sensation of urge to defaecate.[5] The abnormalities of the rectal sensory and motor wall properties maintain and worsen faecal retention. Studies revealed a decreased rectal tone and decreased rectal contractility, concurring to the faeces' delayed evacuation.[6] However, some authors believe that the rectum motor and sensory dysfunction is the primary abnormality, leading to clinical symptoms.[5,6]

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Transabdominal ultrasonography is a non-invasive method used in a few studies to assess children with functional constipation.[7–11] The measured parameters are the transverse rectal diameter and the thickness of the anterior wall of the rectum. Klijn *et al.*[12] considered that the transverse rectal diameter measured by abdominal ultrasound is an accurate parameter that can be added in the diagnosis of constipation. Burgers *et al.*[8] and Joensson *et al.*[9] considered that transabdominal ultrasound is a reliable method to assess the rectal filling state or detecting a faecal mass, as an alternative to digital rectal examination, which is unpleasant and might increase the fear of the patient. In a recent study, Hatori *et al.*[10] also advocate for the usefulness of rectal ultrasound measurement to detect faecal retention in children. Lakshminarayanan *et al.*[13] suggest that abdominal ultrasound should replace plain abdominal X-ray in demonstrating the faecal loading.

This study aimed to compare the transverse diameter of the rectum and thickness of the anterior wall in children with normal bowel movement and children with functional constipation in different age groups. Another objective was to find correlations between these sizes of the rectum and faecal incontinence and duration of the disease.

Methods

Patients

The study included children with functional constipation and children with normal bowel movement, assessed prospectively between October 2014 and February 2020. All parents filled in questionnaires based on Rome III and Rome IV criteria for functional constipation. Informed consent was obtained from parents to include the data in this study. Local ethics committees have approved the study.

Inclusion criteria

In the study group, we recruited 34 children diagnosed with functional constipation based on Rome III[3,4] and Rome IV[1,2] criteria for functional gastrointestinal disorders. The Rome III[3,4] classification stated that the patient should have at least two of the following symptoms: two or fewer defaecations per week, excessive stool retention, painful or hard bowel movements, retentive posturing, large faecal mass in the rectum, large diameter stools that can obstruct the toilet and at least one episode of faecal incontinence for children older than 4 years of age. In the Rome IV classification for child/adolescent,[2] the time criterion has changed, and patients need to fulfil the criteria for at least 1 month (not 2 months as in the previous classification) in order to be diagnosed with functional constipation. The data that we analysed in children with functional constipation are from the first presentation in our department. Some of them had already been treated for functional constipation, but the treatment response was either temporary or not proper or the therapy was inappropriate.

Exclusion criteria

We excluded children with neurological diseases, malformations of the digestive system, hypothyroidism and other organic causes of constipation from the study. We also excluded children with empty rectal ampulla and those who had an enema before the abdominal ultrasound.

Control group

Children included in the control group did not fulfil the criteria for functional constipation. We excluded children with digestive (acute or chronic), neurological or psychiatric diseases from this group. The indications for abdominal ultrasound were various (urinary tract infection, haematuria, splenomegaly, dysmenorrhoea and so on).

Abdominal ultrasound

One abdominal ultrasound was performed in all children included in the study. Two skilled physicians performed the ultrasounds. The transverse rectal diameter and the thickness of the rectum anterior wall were measured. We also recorded the bladder filling and the time of the last defaecation before ultrasound was performed.

Technique

Abdominal ultrasound examinations were performed using a Toshiba Xario 200 (Toshiba Medical Systems Corporation, Otawara-Shi, Tochigi-Ken, Japan) ultrasound device. A transverse scan was performed at the pelvis level, posterior to the bladder, and the image of the rectal ampulla was detected. The largest section of the rectal ampulla was chosen, and the transverse diameter was measured (Fig. 1) with the convex probe (with frequencies ranging between 4 and 6 MHz) in older children and with the linear probe (with frequencies ranging between 7 and 14 MHz) in young children. The thickness of the anterior wall was measured with the linear probe (Fig. 2).

Statistical analysis

Results were reported as mean ± standard deviation (SD), median value and percentage. The Student's *t*-test was used to compare groups, a value of less than 0.05 being considered statistically significant. We used the Pearson and Spearman correlation tests to assess correlations between different variables.

Results

Demographic characteristics of the patients

A total of 65 children were included in the study, 34 with functional constipation and 31 without constipation.

The children's demographic characteristics are shown in Table 1. There were no statistically significant differences between the weight and the length or height of children in the control group and those diagnosed with constipation ($P > 0.05$).

In children without constipation, we found moderate correlations between age, weight, height/length and the rectum transverse diameter (r = 0.57–0.64; $P < 0.05$). The thickness of the anterior wall also correlated positively with age (r = 051; $P < 0.05$).

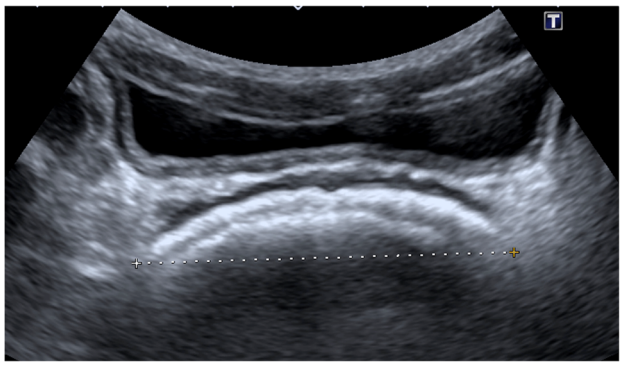

Fig 1 Measurement of the transverse rectal diameter of the rectum.

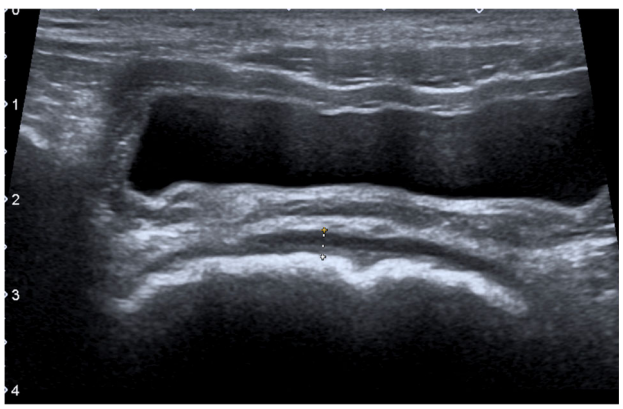

Fig 2 Measurement of the thickness of the anterior wall of the rectum.

Clinical data of the patients

The clinical data of the patients with constipation are summarised in Table 2. These children were divided into two groups, under and over 4 years of age. We compared the results of the rectum sizes measured by abdominal ultrasound in all children with and without constipation depending on the age (Tables 3,4). The rectum transverse diameter and the thickness of the anterior wall had statistically significant higher values in patients with constipation.

Transverse diameter of the rectum

Of the 34 children with constipation, 23 (67%) had a rectum transverse diameter larger than 30 mm. Half of the children under 4 years of age (7/14) had a diameter of the rectum larger than 30 mm.

Table 2 Clinical characteristics of patients with constipation

	0–4 years, n = 14	Exceeding 4 years, n = 20
Two or fewer defaecations per week	12 (86%)	14 (70%)
Excessive stool retention	10 (71%)	10 (50%)
Painful or hard bowel movements	13 (93%)	16 (80%)
Large diameter stools	9 (64%)	10 (50%)
Blood in the stool	5 (36%)	4 (20%)
At least one episode of faecal incontinence/week	—	11 (55%)
Duration of symptoms, mean ± SD (median), months	9.4 ± 8.4 (6)	43.7 ± 35.1 (43)

Thickness of the anterior wall of the rectum

Eleven constipated patients (32%) had a thickness of the rectum anterior wall higher than 3 mm.

Correlations of the rectum sizes with the disease duration and faecal incontinence

In children with constipation, the mean ± SD of the disease duration was 31.7 ± 33.1 months and the median was 23 months. There was a moderate and significant correlation between the duration of symptoms and the rectum transverse diameter (r = 0.54; P = 0.0009) (Fig. 3), but only a slight and statistically non-significant correlation of the persistence of constipation with the thickness of the rectum anterior wall (r = 0.20; P = 0.2) (Fig. 4).

The rectum transverse diameter correlated moderately with the presence of faecal incontinence (r = 0.62; P = 0.003), but the thickness of the anterior wall of the rectum did not correlate with this symptom (r = 0.02; P = 0.39).

Discussion

The ESPGHAN and NASPGHAN guideline[14] regarding the management of functional constipation in children mentions four studies in which rectal diameter was measured[9,12,15,16] (Table 5). They conclude that it is a simple and non-invasive method

Table 1 Demographic characteristics of children included in the study

	Children without constipation	Children with functional constipation	P value
Number	31	34	
Boys : girls ratio	14:17	22:12	
Age, mean ± SD (median value), years	5.4 ± 4.3 (5)	5.6 ± 3.6 (5.5)	0.05
Weight, mean ± SD (median value), kg	22.7 ± 16.5 (19)	21.5 ± 11 (20)	0.05
Length/height, mean ± SD (median value), cm	109.6 ± 33.8 (116)	110.6 ± 25.3 (104)	0.05

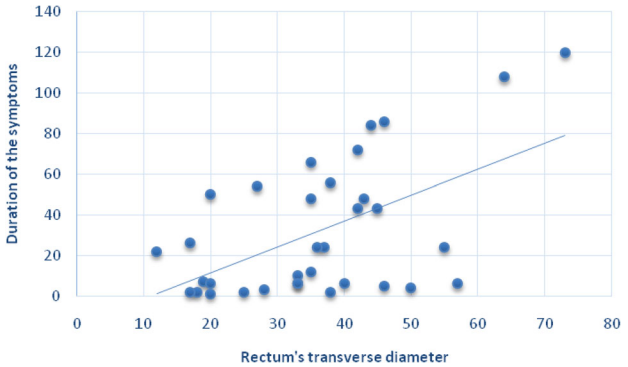

Fig 3 Correlations between the duration of symptoms (months) and the rectum transverse diameter.

applied in children with constipation, but the data were not enough to establish average values and identical measurement conditions. The guideline does not recommend rectal ultrasound in diagnosing functional constipation.

The values of the rectum transverse diameter measured in our patients with functional constipation (mean ± SD = 35.9 ± 14.1 mm) are comparable with the results reported in most of the studies (Table 5), except those reported by Bijoś *et al.*[15] and Doniger *et al.*[18] which were higher. Rectum transverse diameter in children without constipation (mean ± SD = 24.2 ± 7.1 mm) was comparable only with the results of Singh *et al.*[16]

Our results show that the rectum sizes, namely the diameter and the thickness of the anterior wall, increase with age, weight and height. The values have to be compared with those of children from the same age group, so we also compared the measurements separately for children under and over 4 years of age. The criteria for functional constipation in the Rome classification are developed independently for these age groups. Nevertheless, we should look separately at the results of the rectum sizes in narrower age ranges, such as children under 1 year and adolescents.

Interestingly, in the group of children under 4 years of age, 50% had a significantly enlarged rectal diameter, exceeding 30 mm. Studies show that children are prone to postponing

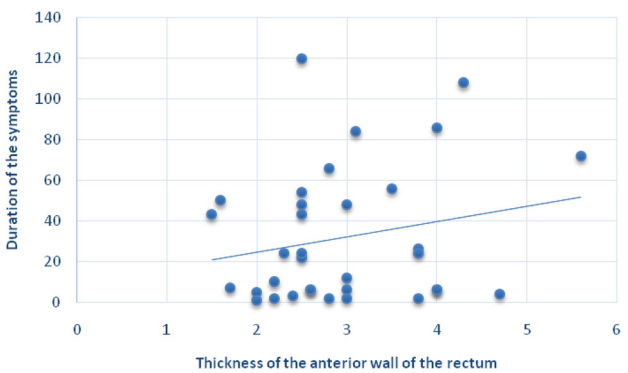

Fig 4 Correlations between the duration of symptoms (months) and the thickness of the anterior wall of the rectum.

Table 3 Values of the rectum's transverse diameter

	Transverse diameter of the rectum in children without constipation, mean ± SD (median), mm	Transverse diameter of the rectum in children with constipation, mean ± SD (median), mm	*P* value
Children under 4 years of age	21.2 ± 6.7 (21)	28.2 ± 6.7 (30.5)	0.03
Children older than 4 years of age	26.7 ± 6.6 (25)	41.3 ± 14.4 (42)	0.0005
Children of all ages	24.2 ± 7.1 (24)	35.9 ± 14.1 (35.5)	0.0001

defaecation while distracted by their games.[5] If the rectum enlarged diameter is associated with the diminished perception of rectal distention, these children are much more likely to go on retaining large faecal masses, which will dry and become painful to eliminate. In 17–40% of children with functional constipation, the symptom onset is in the first year of life.[4] During this period, children are toilet trained. A rectal motor and sensory dysfunction in a toddler with functional constipation will impair this physiological process making the treatment of functional constipation more difficult.

Our study is one of the few that assessed the thickness of the anterior wall of the rectum. The study of Karaman *et al.*[17] also assessed this parameter (Table 6), finding higher values in children with functional constipation. We found comparable values with those reported by Karaman *et al.*,[17] with a statistically significant difference between constipated children and children with normal bowel movement. In a recent study, Momeni *et al.*[19] found lower values for the rectum anterior wall thickness in patients with functional constipation than those recorded by us. Patients with constipation had a thinner anterior wall of the rectum than patients without constipation. Patients with functional constipation assessed in their study were with uncomplicated constipation, without faecal incontinence.

The fact that we found large diameters of the rectum in children diagnosed with functional constipation who did not have long-term symptoms raises a point about the arguments that

Table 4 Values of the thickness of the anterior wall of the rectum

	Thickness of the anterior wall of the rectum in children without constipation, mean ± SD (median), mm	Thickness of the anterior wall rectum in children with constipation, mean ± SD (median), mm	*P* value
Children under 4 years of age	1.8 ± 0.5 (1.75)	2.6 ± 0.7 (2.45)	0.001
Children older than 4 years of age	2.3 ± 0.6 (2.5)	3.1 ± 1 (3)	0.007
Children of all ages	2.1 ± 0.6 (2)	2.9 ± 0.9 (2.7)	0.00008

Table 5 Comparison of the values of the rectal diameter (mean ± SD or median) found in other studies in children with or without constipation

Source	Number of children with functional constipation	Mean ± SD of the rectal diameter (children with functional constipation), mm	Mean ± SD of the rectal diameter (control group), mm
Klijn *et al*. (2004)[12]	23	49	21
Singh *et al*. (2005)[16]	95	34 (median)	24 (median)
Bijoś *et al*. (2007)[15]	120	43.06 ± 9.6	31.83 ± 8.24
Joensson *et al*. (2008)[9]	27	39.6 ± 8.2	21.4 ± 6
Karaman *et al*. (2010)[17]	35	30.2 ± 10.4	19.8 ± 6
Doniger *et al*. (2018)[18]	32	41.9 ± 11	30.6 ± 25.1
Momeni *et al*. (2019)[19]	30	31.7 ± 9.6	19.8 ± 4.3

explain the pathophysiological mechanism most frequently found in children with constipation and on the arguments we have for using this non-invasive tool for investigating the patients with constipation and monitoring their treatment. Are the rectum sizes related more to the moment of defaecation than to duration of constipation? Is the primary pathophysiological mechanism in some patients an altered sensory and motor function of the rectum?

Faecal incontinence is associated in children with functional constipation, often being the symptom that makes parents seek medical help. The muscles used to withhold the faeces become fatigued and overflow incontinence occurs.[20] Medical history shows that constipation has been present for a long time, sometimes even years, in many cases.

Some studies argue that the rectum diameter depends on the moment of defaecation.[9,13,21] We did not take into consideration this factor. The parents were asked about the time of the last defaecation. The responses varied from 12 h to 7 days before the ultrasound was performed. Some parents could not remember the exact time of the last defaecation.

Lakshminarayanan *et al*.[13] proposed an ultrasound scoring system to assess the improvement in the patient's condition during follow-up. Joensson *et al*.[9] also used rectal diameter to observe the treatment's efficiency, noticing a decrease in the rectal diameter in more than half of the constipated patients after 4 weeks of treatment. Di Pace *et al*.[20] even encourage the idea of continuing therapy until the normal rectal diameter is achieved.

Table 6 Mean ± SD (median) of the thickness of the anterior wall of the rectum (mm)

	Children with constipation	Children without constipation
Karaman *et al*. (2010)[17]	2.9 ± 0.9	2.1 ± 0.6
Momeni *et al*. (2019)[18]	1.7 ± 0.3	1.9 ± 0.2

Our study has some limitations. The measurements performed by abdominal ultrasound were independent of some factors that might influence the results: bladder filling, time of last defaecation, previous treatment. The number of children included in the study is small. The physician who performed the measurements was not blinded to the diagnosis.

Conclusions

We found statistically significant differences between the transverse rectal diameter and the thickness of the rectum anterior wall, measured by abdominal ultrasound, in children with functional constipation compared with normal defaecation patterns. Faecal incontinence and long-term constipation were correlated with the increased rectum diameter.

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