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Paradoxical puborectalis contraction is associated with impaired rectal evacuation

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Abstract The role of paradoxical puborectalis contraction in the aetiology of constipation and how to best diagnose this condition is controversial. The aims of this study were to investigate whether absolute or relative paradoxical electrical activity during electromyography (EMG) are related to rectal emptying and to compare EMG, defecography and digital examination in the diagnosis of paradoxical puborectalis contraction. Included in the study were 171 consecutive patients with idiopathic constipation; 136 of these cases were also classified as paradoxical or unclear or not paradoxical at digital examination. Absolute amplitudes and a strain/squeeze index were used to grade the EMG activity in the puborectalis and external sphincter muscle. Rectal evacuation was analysed by defecography with image analysis of rectal area. The results showed that 142 patients had paradoxical EMG activity during straining. There was a correlation between rectal evacuation and amplitudes ($r=-0.20$ to -0.03 , $P<0.01$) and between evacuation and index ($r=-0.34$ to -0.39 , $P<0.0001$). Forty-two patients with an index of >50 had impaired rectal evacuation compared with those with an index ≤ 50 ($P<0.0001$). Thirty-three of 34 cases ($n=136$) with an index of >50 also were paradoxical at defecography whereas 19 were diagnosed digitally. In conclusion, paradoxical puborectalis contraction is associated with impaired rectal evacuation. The activity seems to be best reflected by a strain/squeeze index. The best correlation in diagnostic methods was between EMG and defecography.

Key words Anismus · Constipation · Electromyography · Defecography · Paradoxical puborectalis contraction

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Résumé Le rôle d'une contraction paradoxale de la sangle puborectale dans l'étiologie de la constipation et le meilleur moyen pour diagnostiquer cette condition sont sujets à controverse. Le but de cette étude est de déterminer si une activité électrique paradoxale absolue ou relative sur l'électromyographie peut être mise en relation avec l'évacuation rectale et de comparer l'électromyographie à la défécographie et au toucher rectal dans le diagnostic de la contraction paradoxale de la sangle puborectale. 171 patients consécutifs avec une constipation idiopathique ont été étudiés. 136 de ces patients ont été classés comme présentant une contraction soit paradoxale soit spécifique soit non paradoxale lors du toucher rectal. L'amplitude absolue et un index contraction/poussée ont été utilisés pour graduer l'activité électromyographique dans la sangle puborectale et dans le sphincter externe. L'évacuation rectale a été analysée sur la défécographie par mesure de la surface rectale. Les résultats ont montré que 142 patients avaient une activité paradoxale électromyographique durant la poussée. Il y a une corrélation entre l'évacuation rectale et l'amplitude ($r=-0.20-23$, $P<0.01$) et entre l'évacuation rectale et l'index d'activité ($r=-0.34-39$, $P<0.0001$). 42 patients avec un index supérieur à 50 avaient une évacuation rectale entravée en comparaison à ceux avec un index plus petit ou égal à 50 ($P<0.0001$). 33 des 34 patients ($n=136$) avec un index supérieur à 50 avaient également une contraction paradoxale sur la défécographie alors que 19 seulement étaient diagnostiqués au toucher rectal. En conclusion, la contraction paradoxale de la sangle puborectale est associée avec une évacuation incomplète. L'activité semble être le mieux appréciée par un index contraction/poussée. La meilleure corrélation dans l'approche diagnostique est obtenue entre l'électromyographie et la défécographie.

Introduction

Paradoxical puborectalis contraction (anismus, spastic pelvic floor syndrome) has been discussed as a pathogenic

factor in constipation, whereby a contracting or nonrelaxing puborectalis muscle and external sphincter muscle would cause an outlet obstruction during attempted rectal emptying. The paradoxical contraction has been associated with increased electromyographic (EMG) activity [1] and anal pressure during straining [2], inability to expel a rectal balloon [3], and prolonged segmental colonic transit [4]. Failure to increase the anorectal angle [5] or a distinct impression of the puborectalis muscle during evacuation have been used as diagnostic criteria on defecography [6]. These criteria have also been associated with impaired rectal evacuation at defecography [5, 6].

Sphincter EMG has been considered a sensitive method to detect paradoxical puborectalis contraction [7] and is used in many centres in the work-up of severe constipation. In recent years, biofeedback training has been used most in the treatment of patients with a paradoxical sphincter response. However, the functional importance of these findings has been questioned, since it has been observed in other anorectal conditions [8] and in healthy subjects [9, 10]. It is also questionable whether the laboratory setting is suitable for the evaluation of paradoxical sphincter contraction. Measurements with ambulatory equipment in the home environment have led to a reduction in the proportion of patients with paradoxical EMG activity [11]. However, biofeedback training based upon laboratory test results and directed towards relaxing the sphincter muscles has been successful in several studies [12–14] and also associated with a reduction in sphincter activity during straining [15]. If paradoxical puborectalis contraction is clinically relevant, it would affect rectal emptying; however, the relationship between paradoxical EMG activity and rectal emptying is unclear.

The principal aim of this study was to investigate whether paradoxical EMG activity is related to rectal evacuation and to evaluate two different grading systems of paradoxical activity. The second aim was to compare EMG, defecography and digital examination in the diagnosis of paradoxical puborectalis contraction.

Materials and methods

Patients

A consecutive series of 171 patients with constipation referred to the Department of Surgery, University Hospital, Uppsala, during the time period 1992–1997 constituted the study population. The median age was 51 (range 20–93) years and 152 patients (89%) were women. The symptom duration varied between 0.5 and 60 years (median 10 years). Patients with neurological, connective tissue or active proctological disease were not included. Each patient had tried fibre supplements or other bulking agents without satisfactory results. At the first visit 24 patients did not use any laxatives regularly while 113 used bulking agents, 66 motorstimulants and 57 enemas. Manually assisted defecation was used by 109 patients. Thirty-four patients presented with infrequent defecation only, whereas the rest stated various degrees of emptying difficulties. There was a mixed symptomatology of both infrequent defecation and emptying difficulties in 51 patients. Seventeen patients had undergone surgery related to constipation (colectomy in one, anterior resection for pro-

lapse in one, rectopexy in five, rectopexy and sigmoid resection in five and rectocele repair in five patients). Twenty-one patients had a previous hysterectomy.

The work-up included a rigid proctoscopy and a barium enema or colonoscopy. The specific investigations included defecography, colonic transit time [16], EMG and anorectal manovolumetry [17]. Fifty-nine patients had prolonged colonic transit (exceeding the 95th percentile of controls), and 20 of them had markedly slow transit (retaining 90% of the markers after 7 days). The rectoanal inhibition reflex could be elicited in all patients.

Electromyography

Integrated EMG was recorded with hook electrodes (isolated lacquered steel wire, WE-100, Life-Tech, Houston, Texas, USA) in the external sphincter and puborectalis muscle. The electrodes were inserted posterolaterally on each side of the midline, 10 mm from the anal verge to a depth of about 15 mm in the external sphincter muscle. The corresponding distances in the puborectalis muscle were 12 and 35 mm, respectively. Both electrodes in each muscle were active. The muscles were examined sequentially; first the external sphincter was recorded in the left lateral position followed by the puborectalis muscle in the same position. The patient was then seated on a commode and a new recording was done in a similar manner. The puborectalis muscle was also examined while the subject was in the sitting position trying to expel a balloon (Foley catheter Ch 18 filled with 40 ml body-tempered water).

The recordings were performed with a standard EMG equipment (Neuromatic 2000, Dantec, Skovlunde, Denmark) and graphically displayed on a printset with a time constant of 50 ms. The registration represented the sum of recruitment of motor potential and the size of recruited motor units. The EMG was measured in millivolts (mV) relative to a baseline representing activity at rest. Negative values were not registered. A strain/squeeze index ($100 \times$ strain amplitude/squeeze amplitude) was calculated for each muscle and position, thus yielding five indices for each patient. The mean of the five indices and the peak index were used to grade the paradoxical sphincter activity. An index level above 50 has previously been used as a criterion of significant paradoxical activity [12] and this level was also used in this study. Mean and peak amplitudes were also calculated in a corresponding manner. The cut-off level for pathologic amplitudes was adjusted to create groups of similar numbers of patients when comparing indices and amplitudes. All EMGs were done by one investigator and analysed without knowledge of other test results.

Defecography

Our routine for defecography have been previously described in detail [6]. Briefly, the anorectal angle was measured as the angle between the axis of the anal canal and the posterior border of rectum. The size of a rectocele was calculated during straining as the distance between the maximal anterior outbulge and the axis of the anal canal. The length of a circular intussusception and the position of the anorectal junction relative to the ischial tuberosities was measured. Perineal descent was defined as the change in position of the anorectal junction during straining compared with rest. The defecographic evaluations were performed blindly and X-ray magnification was corrected for in all measurements.

A paradoxical puborectalis contraction was diagnosed when there was a marked impression of the puborectalis muscle and/or a failure to increase the anorectal angle during straining compared with rest. Rectal emptying was evaluated with a computer-based image analysis method [6, 18]. The area with homogeneous contrast in the lower 8 cm of rectum was calculated at rest, after initial evacuation (initial or first straining episode, 0–30 s) and after the total evacuation period. The time was noted and rectal emptying was expressed as: (1) percentage evacuated area per second during the initial evacuation; (2) percentage evacuated area per second during the total evacuation period; (3) percentage evacuated area.

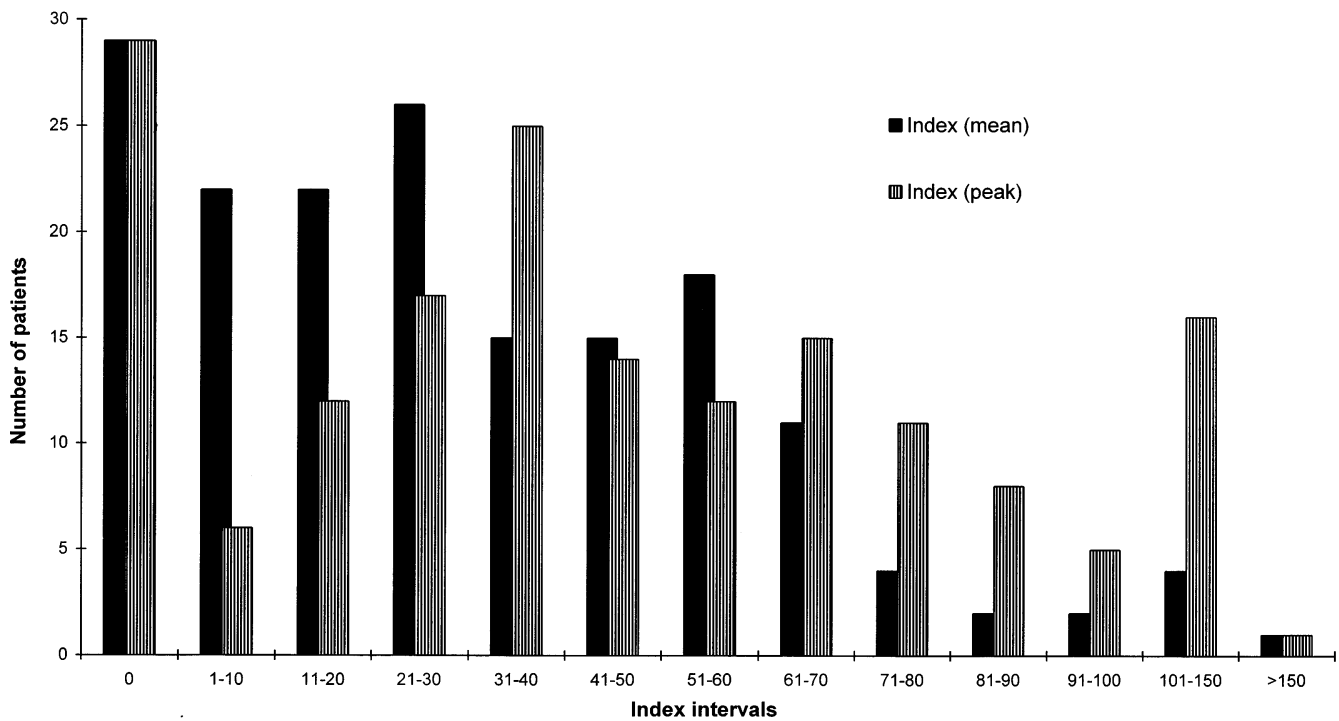


Fig. 1 Distribution of EMG activity during straining measured with a strain/squeeze index in 171 constipated patients

Digital examination

One hundred and thirty-six of the patients were prospectively assessed with a digital examination according to a protocol. The examination was performed with the patient in the left lateral position. After identifying the puborectalis and external anal sphincter muscles during squeeze and relaxation, the patient was instructed to strain as to evacuate. The procedure was repeated at least three times. The muscle activity during straining was classified as: (1) paradoxical sphincter contraction; (2) unclear; or (3) not paradoxical. All digital examinations were performed by three surgeons with a special interest in the field.

Statistical methods

Nonparametrical methods were used. The Kruskal-Wallis test was used for comparison of several independent groups of patients and Mann-Whitney *U* test was used when comparing two groups of patients. Proportions were analysed with Fisher's exact test. Spearman's rank correlation test was used for analysis of correlations.

In a comparison of diagnostic methods, sensitivity was calculated as (true positive/true positive + false negative)×100; specificity as (true negative/true negative + false positive)×100; positive predictive value as (true positive/true positive + false positive) ×100; and negative predictive value as (true negative/true negative + false negative) ×100. The "assumed best method" was used to compare the three diagnostic methods.

Results

Electromyography

Paradoxical activity was found in 142 patients (83%) i.e. an increment over baseline, during stain. There were 68 patients (39%) with a peak index >50 and 42 patients (25%) with a mean index >50 (Fig. 1). The corresponding amplitude levels, discriminating equal number of patients, were >0.9 mV (*n*=68) and >0.76 mV (*n*=42). There was an overall correlation between amplitudes and rectal emptying, but the correlation was stronger between indices and emptying (Table 1). There was also an inverse relation

Table 1 Overall correlations between EMG activity during straining (amplitude and index) and rectal evacuation measured at defecography in 171 constipated patients

	Amplitude (mV)		Index	
	Mean	Peak	Mean	Peak
Rectal evacuation				
% Area evacuated	$r=-0.23, P<0.01$	$r=-0.18, P<0.05$	$r=-0.39, P<0.00001$	$r=-0.39, P<0.00001$
%/s (initial)	$r=-0.20, P<0.01$	$r=-0.04, P=ns$	$r=-0.34, P<0.00001$	$r=-0.36, P<0.00001$
%/s (total)	$r=-0.22, P<0.01$	$r=-0.16, P<0.05$	$r=-0.39, P<0.00001$	$r=-0.39, P<0.00001$

Correlations were calculated using Spearman's rank correlation test

Table 2 Defecographic findings and rectal evacuation according to sphincter muscle activity during straining measured as mean amplitude or mean index levels at EMG ($n=171$)

	Mean amplitude (mV)		Mean index	
	>0.76 ($n=42$)	≤0.76 ($n=129$)	>50 ($n=42$)	≤50 ($n=129$)
Anorectal angles				
Rest	97 (68–135)	100 (44–143)	95 (44–124) ^a	101 (57–143)
Strain	119 (53–150)	125 (25–160)	92 (28–138) ^b	128 (25–160)
Perineal descent (cm)	2.3 (0–4.8)	2.5 (0–5.7)	2.0 (0–4.9) ^a	2.7 (0–5.7)
Intussusception (cm)	0 (0–3.6)	0.7 (0–3.9)	0 (0–2.1) ^b	0.9 (0–3.6)
Rectocele (cm)	2.5 (0–3.9)	2.1 (0–5.1)	2.4 (0–4.2)	2.1 (0–5.1)
Rectal evacuation				
% Area evacuated	74 (0–100)	83 (0–100)	47 (0–100) ^b	90 (0–100)
%/s (initial)	2.5 (0–12.5)	4.2 (0–16.6)	1.2 (0–10.3) ^b	5.2 (0–16.6)
%/s (total)	1.3 (0–12.5)	2.1 (0–16.6)	0.6 (0–5.6) ^b	2.7 (0–16.6)

Values are median and range; ^a $P<0.05$, ^b $P<0.001$, Mann-Whitney U test

between indices (mean and peak) and length of intussusception ($r=-0.23$ to -0.22 , $P<0.01$), perineal descent ($r=-0.25$ to -0.22 , $P<0.01$) and anorectal angle during straining ($r=-0.39$ to -0.37 , $P<0.001$). The anorectal angle during straining was also inversely related to mean amplitude ($r=-0.20$ $P<0.05$), otherwise there were no statistically significant relations between amplitudes and defecographic findings. Those with a mean index >50 had significantly impaired rectal emptying, less intussusception, perineal descent and more acute anorectal angles at rest and at straining, whereas no particular defecographic features were found in those with the highest mean amplitudes (Table 2). In a corresponding analysis, peak index levels >50 related significantly to the same defecographic parameters, whereas peak amplitudes (>0.9) did not (data not shown). Expressing the paradoxical puborectalis contraction as index levels rather than amplitudes was more in agreement with the defecographic diagnosis of paradoxical contraction (proportion positive at defecography: mean index >50, 41/42 vs. mean amplitude >0.76, 19/42; $P<0.0001$, Fisher's exact test).

Defecography

A paradoxical puborectalis contraction was diagnosed in 50 patients (29%). The diagnosis was related to a short circular intussusception ($P<0.00001$), little perineal descent ($P<0.008$) and an acute anorectal angle at rest ($P<0.002$, data not shown). Paradoxical puborectalis contraction was also highly related to all rectal evacuation parameters, EMG amplitudes and EMG indices (Table 3).

Fifty-four patients evacuated all contrast whereas five patients could not evacuate at all. All patients in the latter group had a paradoxical puborectalis contraction. Twenty patients did not evacuate anything during the first 30 s (initial %/s=0) and 18 of them were diagnosed as having a paradoxical contraction at defecography. Of the 25 patients that evacuated less than 0.5%/s during the whole investigation, there were 17 with a paradoxical puborectalis contraction. In the remaining eight cases the poor empty-

Table 3 Rectal evacuation and results of EMG in patients with and without a paradoxical puborectalis contraction at defecography

	Paradoxical ($n=50$)	Not paradoxical ($n=121$)
Rectal evacuation		
% Evacuated area	48 (0–100)	92 (10–100) ^a
%/s (initial)	1.1 (0–7.2)	5.6 (0–16.6) ^a
%/s (total)	0.7 (0–2.0)	2.9 (0.1–16.6) ^a
EMG		
Mean index	56 (4–306)	16 (0–67) ^a
Peak index	85 (10–420)	30 (0–129) ^a
Mean amplitude	0.7 (0.05–3.7)	0.2 (0–5.9) ^a
Peak amplitude	1.0 (0.1–6.7)	0.5 (0–17.8) ^a

Values are median and range; ^a $P<0.001$, Mann-Whitney U test

ing could be explained by a nonemptying rectocele in seven, whereas there was no clear reason for the poor emptying in one patient.

Digital examination

Of 136 patients, 31 (23%) were judged to have a paradoxical puborectalis contraction at rectal examination, and 15 cases (11%) were classified as unclear. The digital examination separated patients with higher indices and higher amplitudes (Table 4). A digitally diagnosed paradoxical contraction was associated with the same defecographic findings as a paradoxical contraction diagnosed with EMG indices or with defecography (Fig. 2, Table 4).

Comparison of diagnostic methods

A comparison between diagnostic methods was made undertaken in the 136 patients who were prospectively assessed by EMG, defecography and digital examination. The proportions of patients with a paradoxical puborectalis contraction were: defecography 30%, EMG (mean index >50) 25%, and at digital examination (clearly para-

Table 4 Digital classification in relation to results of EMG and defecography (*n* = 136)

	Paradoxical (<i>n</i> =31)	Unclear (<i>n</i> =15)	Not paradoxical (<i>n</i> =90)	Kruskall-Wallis <i>P</i> value
Anorectal angles				
Rest	91 (56–120)	100 (74–133)	102 (44–137)	0.008
Strain	88 (28–150)	134 (25–134)	126 (37–160)	<0.0001
Perineal descent (cm)	1.9 (0–4.2)	3.2 (0.6–5.7)	2.7 (0–5.1)	0.017
Intussusception (cm)	0 (0–1.8)	1.2 (0–2.7)	0.6 (0–3.6)	0.0009
Rectocele (cm)	1.8 (0–4.2)	2.4 (0–4.8)	2.3 (0–5.1)	0.58
EMG				
Mean index	53 (0–306)	37 (0–94)	17 (0–81)	<0.0001
Mean amplitude	0.7 (0–3.7)	0.4 (0–1.2)	0.3 (0–5.0)	0.003

Values are median and range

Table 5 The sensitivity, specificity and positive and negative predictive values of EMG, defecography and digital examination versus assumed best method in the diagnosis of paradoxical puborectalis contraction

Reference method	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Defecography ^a				
EMG (mean index >50)	80	99	97	92
Digital examination	54	91	71	82
EMG (mean index >50) ^a				
Defecography	97	92	80	99
Digital examination	56	88	61	86
Digital examination ^a				
Defecography	71	82	54	91
EMG (mean index >50)	61	86	56	88

Values are percentages; ^a assumed best method

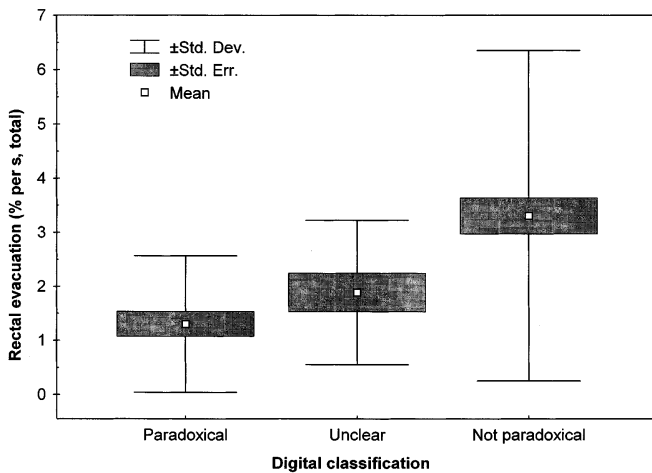


Fig. 2 Relationships between rectal evacuation and digital classification of paradoxical puborectalis contraction in 136 patients (Kruskall-Wallis test *P* < 0.001)

doxical) 23%. Nineteen patients were diagnosed as having a paradoxical contraction with all three methods and 17 with two methods, while 14 were diagnosed with one of the methods (Fig. 3).

Sensitivity, specificity and positive and negative predictive values for each method are depicted in Table 5. In these comparisons each method is also taken as a reference method (assumed best method). Sensitivity and negative predictive value for digital examination increased to 66%

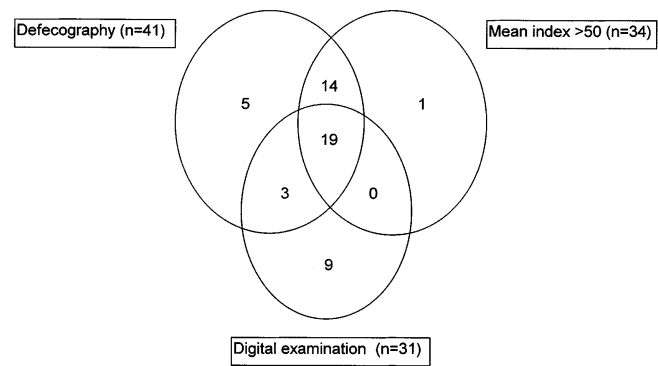


Fig. 3 Distribution of patients diagnosed by defecography, EMG (mean index >50) and digital examination as having a paradoxical puborectalis contraction (*n* = 136)

and 84% (vs defecography) and 68% and 88% (vs EMG), respectively, if patients with an unclear muscle activity were included in the paradoxical group. Correspondingly, specificity and positive predictive value decreased to 80% and 59% (vs defecography) and to 77% and 50% (vs EMG), respectively.

Discussion

The high incidence of patients with a paradoxical sphincter activity at EMG during straining and the wide range in

amplitudes suggest that grading needs to be more detailed instead of just considering an increase as a pathological response. The observation of a paradoxical puborectalis contraction in healthy subjects and in patients with various anorectal conditions [8–10] supports this view. Use of absolute amplitudes for grading makes the placement of electrodes crucial; a suboptimal positioning might give false low amplitudes. The electrode placement is corrected for when using the strain/squeeze index. The muscle strength, another potential source of error, is also adjusted for with the use of an index. In the present study, indices had a closer overall relation than amplitudes to all rectal evacuation parameters. A comparison between a number of patients with an index cut-off level of 50, which has been used previously [12], and the same number of patients with the highest amplitudes showed that amplitudes were not as clearly related to evacuation as mean and peak index. Furthermore, the index levels were related to other defecographic findings such as more acute anorectal angles and less perineal descent. There was also a close correlation between a defecographic diagnosis of paradoxical puborectalis contraction and high index levels. A corresponding correlation was not found regarding amplitudes.

The incidence of defecographic paradoxical contraction was 30%, which is higher than in a previous study [6]. This might be explained by increased referrals of patients with outlet obstruction and by the fact that failure to increase the anorectal angle during straining was accepted as a diagnostic criterion in this study. A prominent impression of puborectalis is not always present or detectable in patients with a more vertically positioned rectum even if the anorectal angle during strain actually decreases. The incidence of paradoxical puborectalis contraction in other consecutive series of constipated patients has ranged between 29% and 37% [19–21].

Intussusception has been associated with the solitary ulcer syndrome in which paradoxical puborectalis contraction has also been implicated as a contributing factor [22]. In the present study, a pronounced intussusception was uncommon with paradoxical puborectalis contraction, irrespective of whether diagnosis was made with defecography, EMG or digital examination. It seems logical that contracting sphincter muscles cause a reduced mobility of the perineum, and if the contraction grossly impairs rectal emptying, this will contract intussusception, since intussusception at defecography usually implies some emptying. A rectocele has also been indicated as a cause of impaired rectal emptying. The size of the rectocele did not differ between patients with or without paradoxical puborectalis contraction, suggesting that rectocele formation is independent of paradoxical contraction.

From these results it is concluded that paradoxical sphincter activity at EMG is related to rectal evacuation and that this is more accurately reflected by the use of a strain/squeeze index than by absolute amplitudes. Both mean and peak index also correlated better than amplitudes with the diagnosis of paradoxical puborectalis contraction at defecography.

A paradoxical puborectalis contraction assessed by digital examination was related to higher indices and also to higher amplitudes, which makes the digital assessment clinically relevant. It was also clearly related to impaired rectal evacuation. It has been suggested that clinical examination is sufficient in most patients with defecatory difficulties [23]. In this study, 15 patients (11%) were difficult to classify because of varying contraction–relaxation patterns or not fully relaxing muscles during straining. There were also two patients with weak muscles and were therefore difficult to categorise. However, an unclear diagnosis might also have some relevance since patients with this finding had intermediate levels of indices and rectal evacuation.

Although both defecography and EMG are established methods, none of them can act as a reference method. All comparisons must be done with the assumption that each method could be the best. Poor agreement between defecography and EMG has been reported [24, 25]; however, only a few studies have focused on the methods of diagnosing paradoxical puborectalis contraction. Jorge et al. [26] found suboptimal correlations between defecography and EMG when defining the paradoxical contraction as a failure to achieve a decrease in electrical activity during attempted defecation. They found a sensitivity and specificity of about 70% and 80%, respectively, for each method. With the use of a strain/squeeze index (mean index >50) as in the present study, the sensitivity and specificity was improved. Correlations between manometry, EMG and defecography in the diagnosis of paradoxical puborectalis contraction, which have been studied by Ger et al. [21], were found to be suboptimal but improved with the use of a manometric strain/squeeze index.

The agreement between digital examination and EMG/defecography was not as good as between EMG and defecography. Embarrassment at first visit may explain some of the false positive results at digital examination. Siproudís et al. [23] found a negative predictive value of 96% for clinical diagnosis of anismus vs manometric anismus. The corresponding figures in this study were 82% (vs defecography) and 86% (vs EMG). If unclear diagnoses were included in the paradoxical group the figures were 84% and 88%, respectively. The results suggest that a finding of normal relaxing sphincter muscles at digital examination can be used to exclude the diagnosis of paradoxical puborectalis contraction in most patients. A positive diagnosis or an unclear finding requires further evaluation with other methods.

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