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Electromyographic Activity of the Anterolateral Abdominal Wall Muscles During Rectal Filling and Evacuation

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Background. **The role of the anterolateral abdominal wall muscles (AAWMs) at defecation has not received sufficient attention in the literature. We investigated the hypothesis that the AAWMs exhibit increased electromyographic (EMG) activity on rectal distension, which presumably assists in rectal evacuation.**

Materials and methods. **The effect of rectal balloon distension on the AAWMs EMG and on anal and rectal pressure was examined in 23 healthy volunteers (37.2 ± 9.4 SD years, 14 men, 9 women); this effect was tested before and after rectal and AAWMs anesthetization.**

Results. **The rectal and anal pressures increased gradually upon incremental rectal balloon distension starting at 70 mL balloon distension until, at a mean of 113.6 ± 5.6 mL, the balloon was expelled to the exterior. The AAWMs showed no EMG activity at rest or on rectal distension up to the time of balloon expulsion when they exhibited significant increase of EMG. This effect was abolished on individual rectal or AAWMs anesthetization but not with saline administration.**

Conclusions. **AAWMs appear to contract simultaneously with rectal contraction; this action seems to increase the intra-abdominal pressure and assist rectal evacuation. The AAWMs contraction upon rectal contraction appears to be mediated through a reflex, which we call the "recto-abdominal wall reflex". Further studies are required to investigate the role of this reflex in defecation disorders.**

Key Words: **oblique muscles; transversus abdominis; rectus abdominis; rectal pressure; electromyography.**

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INTRODUCTION

The anterolateral abdominal wall muscles (AAWMs) consist of the external and internal oblique (EOM, IOM), transverse abdominis (TAM), and rectus abdominis (RAM) muscles [1]. They consist of striated muscle bundles which contract voluntarily [1]. They act together to perform multiple functions some of which involve the generation of a positive pressure within the abdominal cavity [2]. Activities such as expiration, defecation and micturition may be assisted by the generation of a positive intra-abdominal pressure (IAP) [3]. Also parturition, coughing, and vomiting are usually aided by such a positive pressure.

Under normal resting conditions, the AAWMs provide support to the abdominal viscera and retain the normal abdominal contour [1, 2]. Congenital absence of these muscles as in "prune belly syndrome [4]" would lead to lack of support of the abdominal viscera. When the IAP is increased, AAWMs' contraction plays an important role in the maintenance of the abdominal wall tone [1, 2].

Defecation is initiated when rectal contents distend the rectum until, at a certain volume, the stretch receptors in the rectal wall are stimulated and evoke the recto-anal inhibitory reflex [5]. The latter results in rectal contraction and internal anal sphincter relaxation. While the role of the pelvic floor muscles, including the levator ani and puborectalis muscles, at defecation is well established [6–10], the function of the AAWMs at defecation is as yet poorly addressed in the literature. We hypothesized that the AAWMs exhibit increased electromyographic (EMG) activity on rectal distension, which presumably assists in rectal evacuation. This hypothesis was investigated in the current study.

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MATERIALS AND METHODS

Subjects

The study comprised of 23 healthy volunteers (14 men, nine women, mean age 37.2 ± 9.4 SD years, range 27 to 47 y). After receiving full information about the nature of and their role in the study, they gave an informed consent to participate in the tests to be done. The results of the physical examinations including neurological assessment were normal. Laboratory work-up composed of blood count, renal and hepatic function tests, as well as electrocardiography had unremarkable results. The Cairo University Faculty of Medicine Review Board and Ethics Committee approved the study.

Methods

Rectal distension was induced by a cylindrical latex balloon, which was constructed from 10 cm unstretched condom (London Rubber Industries Ltd., London, United Kingdom) and mounted to the distal part of a 16-French Nelaton catheter with multiple side holes. Two ties were applied to each end of the condom making a high compliance balloon. With the patient in the left lateral position, the lubricated catheter was introduced into the rectum so that the proximal end of the condom lay about 6 to 8 cm from the anal orifice. The catheter was connected to a Statham pressure transducer (Statham, 230 B; Oxnard, CA). Rectal balloon distension in increments of 10 mL of normal saline was performed.

The rectal and anal pressures were measured using two water-perfused open-tip catheters connected to another two pressure transducers. The first catheter was introduced into the rectum 8 to 10 cm from the anal orifice, and the second into the anal canal 2 to 3 cm from the anal orifice.

The EMG activity of each of the EOM, IOM, TAM, and RAM was recorded by means of concentric needle EMG electrodes (type 13L49; Disa, Copenhagen, Denmark) of 45 mm in length and 0.65 mm in diameter. One needle electrode was introduced into each of the EOM, IOM, TAM, and RAM. With the patient lying supine and under no anesthesia, the needle electrode for the RAM was inserted into the muscle 3 to 4 cm above the umbilicus and 1.5 to 2.5 cm away from the midline. For the EOM, IOM, and TAM, a needle electrode was inserted into each muscle 2 to 3 cm lateral to the lateral edge of the RAM (linea semilunaris), 3 to 4 cm above the umbilicus and 3 to 4 cm apart on the horizontal level. The needle electrode was introduced through the abdominal wall skin and the musculature to a depth of 0.75 to 1 cm for the EOM, 1 to 1.5 cm for the IOM, and 2 to 2.5 cm for the TAM. As the abdominal wall muscles were striated, no electric waves were recorded from them at rest. Only when the subjects strained or coughed, the muscles contracted and exhibited electric activity. The correct position of the needle electrode in the corresponding muscle was indicated by the different electric waves discharged from each muscle on coughing or straining; in terms of frequency and amplitude, the electric waves differed from one muscle to the other.

To define whether the AAWMs' response to rectal distension was a direct or reflex action, the test was repeated after individual anesthetization of the rectum and AAWMs. Rectal anesthetization was induced by rectal infusion with 10 mL of 2% lidocaine added to 50 mL of normal saline. The response of the AAWMs to rectal balloon distension in the aforementioned volumes was tested 20 min from rectal anesthetization and after 3 h when the anesthetic effect had waned. On another day, the AAWMs were anesthetized by the injection of 2 mL of 2% lidocaine in the muscle at the site of the electrode and the test was repeated 20 min later and again after 3 h. The aforementioned tests were repeated using normal saline instead of lidocaine.

Reproducibility of the results was ensured by repeating the aforementioned recordings at least twice in the individual subject, and the mean value was calculated. The results were analyzed statistically using the paired Student's *t*-test, and values were given as the mean ± SD. Differences assumed significance at $P < 0.05$.

RESULTS

No adverse side effects were encountered during or after performing the tests and all of the subjects were evaluated.

The resting rectal pressure recorded a mean of 7.6 ± 1.2 cm H_2O, and the anal pressure a mean of 72.4 ± 8.4 cm H_2O (Table 1). The EMGs of the EOM, IOM, TAM, and RAM recorded no basal activity as these muscles are striated: rectal balloon distension in increments of 10 mL of normal saline and up to 60 mL did not effect significant rectal or anal pressure changes or AAWMs EMG response ($P > 0.05$, Fig. 1). Rectal distension with 70 mL and in increments of 10 mL of normal

TABLE 1

Anal and Rectal Pressures on Rectal Balloon Distension in Increments of l0 mL of Normal Saline+

	Pressure (cmH_2O)			
	Anal		Rectal	
Rectal distension (ml)	Mean	Range	Mean	Range
0	72.4 ± 8.4	64–80	7.6 ± 1.2	6–9
60	74.2 ± 8.6●	63–84	7.7 ± 1.2●	6–9
70	83.6 ± 10.4*	72–98	36.3 ± 7.4**	27–46
80	96.7 ± 10.2*	86–108	73.4 ± 9.1***	61–82
90	102.4 ± 12.6**	92–118	92.6 ± 10.3***	82–104
100–120	18.6 ± 4.2***	14–22	116.5 ± 13.8****	98–131

Note. + Values were given as the mean ± SD.
● $P > 0.05$.
* $P < 0.05$.
** $P < 0.01$.
*** $P < 0.001$.
**** $P < 0.0001$.