Discrepancies in Anal Manometric Pressure Measurement—Important or Inconsequential?

Pedro J. Morgado, Jr., M.D., Steven D. Wexner, M.D., J. Marcio N. Jorge, M.D.

From the Department of Colorectal Surgery, Cleveland Clinic Florida, Fort Lauderdale, Florida

PURPOSE: Maximum resting and squeeze pressures have been the most widely employed parameters for manometric assessment of the anal sphincters. However, a single maximum value may not always be the best assessment. METHODS: The aim of this study was to compare mean and maximum resting and mean and maximum squeeze pressures in a large sample population. All manometric pressure profiles were reviewed by a single individual blinded to the patient's age and diagnosis. RESULTS: Four hundred sixty-six patients with a measurable high-pressure zone were included in this study. The study population was comprised of 279 females and 186 males. A significant difference was found between mean (56.26 mmHg) and maximum (79.2 mmHg) resting pressures ($P < 0.01$) and also between mean (81.25 mmHg) and maximum (119.50 mmHg) squeeze pressures ($P < 0.01$). A significant difference ($P < 0.01$) was also observed when compared by length of the high-pressure zone. CONCLUSION: The measurement, documentation, and reporting of mean resting and mean squeeze pressures provide a better perspective of anal manometric results, since the two sets of values are significantly different ($P < 0.01$), regardless of the anal canal length. Therefore, these data support the standardized evaluation of both mean and maximum pressures in individual patients and in published series. [Key words: Anal manometry; Anal sphincters; Constipation; Incontinence; Anorectal physiology]

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The study of the pressure profile of the anal sphincter complex both at rest and during squeezing has become a valuable tool in the understanding of anorectal physiology and its application in clinical practice.[1-4] Several reports indicated that pressures in the anal canal are not symmetrical and describe results in terms of maximum pressure, a parameter which is employed today in many institutions worldwide.[5-8] However, the use of the single highest pressure in the high-pressure zone (HPZ) may not always accurately reflect the functional status of the entire anal canal. If maximum pressures were representative of this functional status, then one should expect to find no significant differences between the mean and maximum pressures in the HPZ. Therefore, the aim of this study was to compare maximum and mean pressures at rest and during squeeze in order to determine the correlation between the two and, thereby, to establish whether the maximum pressures are representative of the entire anal canal pressure profile.

MATERIALS AND METHODS

Anal manometric profiles of 466 patients were reviewed for this study. The reviewer (PJM) was blinded to the patient's age and diagnosis to remove any potential bias in interpretation. Each patient served as his own control as comparisons were made between sets of values within single patients rather than between patients. Therefore, neither sex, age, nor diagnosis were relevant variables. Patients who failed to show a measurable anal canal high-pressure zone (HPZ) were excluded from the study.

Anal manometry was performed with the patient in the left lateral decubitus position. No enemas or other anal manipulations were permitted before manometry. The technique included a 4.8-mm outer diameter flexible water-perfused catheter (Arndorfer, Inc., Greenvale, WI) with four sensor ports radially oriented at 90° intervals 7 cm proximal to the latex distending balloon. Each channel was perfused with 0.5 ml/minute sterile water through a hydraulic microcapillary perfusion pump (Arndorfer, Inc.). The catheter transducer was interfaced to an IBM PC-80 (International Business Machines, Armonk, NY) computer for on-screen interpretation by a commercially available software package (Polygraph LGI, version 4.01; Synectics

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Address reprint requests to Dr. Wexner: Cleveland Clinic Florida, 3000 West Cypress Creek Road, Fort Lauderdale, Florida 33309.

Medical, Inc., Irving, TX). The catheter was advanced to 6.0 cm from the anal verge and was then manually withdrawn to rest at each 1-cm level to allow equilibration, followed by subsequent measurement of resting pressures. After resting pressure evaluation, a squeeze pressure profile was undertaken in an identical manner. Maximum voluntary contraction (MVC) pressures were defined as the total highest pressures during the squeeze effort. Squeeze pressures were then calculated by subtraction of the resting pressure at each station at the time of pressure measurement from MVC at that same time. This maneuver was undertaken because resting pressure is in a dynamic state; thus, specific calculation, although more laborious, provides a more accurate assessment of squeeze pressures. Thus, 24 resting, 24 squeeze, and 24 MVC pressures were recorded and documented for subsequent analysis.

The HPZ was defined as that length of the distal anal canal which at rest had at least a 50 percent increment with respect to the basal pressure. In addition, there must have been at least two pressures of 20 mmHg. The cephalad-most aspect was defined by a drop of at least 20 mmHg in at least two pressure channels at two adjacent stations. The mean resting pressure was then calculated as the mean pressure over the entire length of the HPZ. Maximum resting pressure was defined as the highest single value within the HPZ. Squeeze pressure was defined as the difference between maximum voluntary contraction and resting pressure at that moment in time. Squeeze pressure, therefore, represented almost exclusively the activity of the external anal sphincter. Statistical analysis was performed using Student's *t*-test and the analysis of variance test at a significance level of $\alpha = 0.01$. All data interpretation and statistical analysis were undertaken by the Department of Biostatistics and Epidemiology.

RESULTS

Four hundred sixty-six consecutive patients were studied. This group included 186 males with a mean age of 51 (range, 12–94) years and 279 females with a mean age of 56 (range, 5–91) years. Nineteen patients had a HPZ length of 1 cm, 122 patients had a HPZ length of 2 cm, 202 patients had a HPZ length of 3 cm, 104 patients had a 4-cm long HPZ, and 19 patients had a 5-cm HPZ length.

Resting Pressures

The overall mean resting pressure in the study group was 56.26 mmHg, while the overall maximum resting pressure was 79.20 mmHg. These values were significantly different ($P < 0.01$). Table 1 summarizes mean and maximum resting profiles compared with the HPZ length.

Squeeze Pressures

A significant difference ($P < 0.01$) was also observed between the overall mean squeeze pressures and the overall maximum squeeze pressures of 81.25 mmHg and 119.50 mmHg, respectively. These pressure profiles were also significantly different ($P < 0.01$) when compared by HPZ length (Table 2).

DISCUSSION

The study of pressures within the anal canal and their relevance for clinical and research purposes has been widely acknowledged.[9-13] Many techniques and highly sophisticated equipment have been developed to obtain as much accurate manometric data as possible.[14-16] However, there has been widespread disparity in terms of both methodology and reporting format. Major differences can be found in terms of catheter design (perfused, microballoon, macroballoon, solid state), method

Table 1.
HPZ Mean and Maximum Resting Pressures

		N	Mean Resting Pressure (mmHg)	Maximum Resting Pressure (mmHg)	Significance (*P*)*
	Overall	466	56.26	79.20	<0.01
	1	19	49.72	61.84	<0.01
HPZ Length (cm)	2	122	48.12	64.66	<0.01
	3	202	56.70	81.06	<0.01
	4	104	63.98	91.18	<0.01
	5	19	67.94	102.11	<0.01

* Analysis of variance test, Student's *t*-test.

Table 2.
HPZ Mean and Maximum Squeeze Pressures

		N	Mean Squeeze Pressure (mmHg)	Maximum Squeeze Pressure (mmHg)	Significance (*P*)*
	Overall	466	81.25	119.50	<0.01
HPZ Length (cm)	1	19	57.50	81.77	<0.01
	2	122	64.41	96.11	<0.01
	3	202	80.80	120.24	<0.01
	4	104	97.91	139.27	<0.01
	5	19	116.52	178.42	<0.01

* Analysis of variance test, Student's *t*-test.

of measurement (station, manual pull-through, mechanized pull-through), method of interpretation (manual polygraph, computer assisted, vector volume analysis), method of reporting (single highest values, mean values, both maximum and mean values, resting, squeeze, MVC, vector volume symmetry), and units of measurement (mmHg, cm H_2O, k pascals).[17–19] Such vast differences have made interpretation of data difficult. It is perhaps naive to aspire to standardize either equipment, methodology, or even units of measurement. Such changes would be costly in terms of capital outlays and personnel retraining. However, it is quite reasonable to strive to provide those values which are ultimately reported as those which most accurately reflect the true sphincter profile. Specifically, the asymmetry of the sphincters has been well documented.[20–22] Furthermore, the dynamic flux of pressures has also been established. Such variables are contingent upon the patient's age, sex, and anatomic and physiologic factors.[23–25] In addition, patient position and activity may also alter the sphincter profile.[26]

This study was designed not to assess the clinical correlation of either set of values but to test their relationship. The results clearly showed that rather than being reflective of each other, mean and maximum pressures were statistically significantly different. Because of these differences noted in both resting and squeeze pressures, the routine measurement and reporting of both sets of values are indicated. Although maximum pressures by definition are only single values, mean pressures may be comprised of up to 24 values. Thus, the maximum pressure can contribute as little as 4 percent to the mean pressure, thus accounting for the relative independence of the two sets of values.

CONCLUSIONS

Although there is no general consensus on which parameters are most useful for anal manometry assessment, there is a trend toward reporting only maximum pressures, both at rest and at squeeze. However, one must query whether the reporting of a single isolated value is representative of the entire circumference and length of the anal canal. This study clearly demonstrated that a significant difference exists between the maximum pressure and the mean pressure of the HPZ in the anal canal during both rest and squeeze regardless of the length of the HPZ. Therefore, isolated maximum pressures do not accurately represent the functional status of the entire HPZ. These findings support the evaluation and reporting of both mean and maximum pressures in individual patients and in published series.

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