Predictors of Response to Biofeedback Treatment in Anal Incontinence

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PURPOSE: Biofeedback is considered an effective treatment for anal incontinence, but a substantial proportion of patients fails to improve. The purpose of this study was to identify the key predictors of outcome. METHODS: We retrospectively analyzed the clinical and physiologic data of 145 patients consecutively treated in our unit for anal incontinence by biofeedback. Clinical evaluation was performed by means of a structured questionnaire that included previous history, symptoms of incontinence, and bowel habit. Anorectal evaluation measured anal pressure profiles, neural reflexes, defecatory dynamics, rectal compliance, and rectal sensitivity. Biofeedback treatment was performed by a manometric technique with reinforcement sessions scheduled every three months and daily exercising at home. Six months after the onset of biofeedback treatment the clinical response was evaluated as good (improvement of incontinence) or poor (no improvement or worsening). RESULTS: Of 126 patients (104 female; age range, 17–82 years) with at least six-month follow-up, 84 percent had a good response to treatment. By univariate analysis, several factors, such as age, history of constipation, abnormal defecatory maneuver, and rectal compliance, were significantly related to treatment response, but by multivariate logistic regression only age and defecatory maneuver were independent predictors of the response. The association of both factors provided the best sensitivity and specificity; 48 percent of patients younger than age 55 years and with abnormal defecatory maneuver had negative response to treatment, whereas 96 percent of patients age 55 years or older with normal defecatory maneuver had a positive response. CONCLUSION: In patients with anal incontinence scheduled for biofeedback treatment, potential alterations of defecation should be first searched for and corrected, particularly in younger patients. [Key words: Anal incontinence; Biofeedback treatment; Constipation; Rectal compliance; Functional outlet obstruction]

Fecal incontinence consists in the uncontrolled passage of rectal content through the anus that often becomes a chronic incapacitating disorder, severely impairing patients’ quality of life. Furthermore, fecal incontinence has important socioeconomic repercussions.1–3 For instance, it is the second most common cause of institutionalization in the elderly.1 Biofeedback is believed to be an effective treatment of incontinence, particularly in patients without major sphincteric damage susceptible of surgical repair. Reported improvement rates range between 50 and 92 percent,1,4–16 but it is recognized that some patients fail to improve.

The purpose of this study was to identify clinico-physiologic factors that determine the outcome to biofeedback treatment in patients with anal incontinence. We retrospectively analyzed the clinical and manometric data obtained in a large cohort of patients treated in our unit for fecal incontinence by means of biofeedback, with a follow-up longer than six months.

MATERIALS AND METHODS

Participants

A total of 145 patients with anal incontinence (118 female, 27 male; age range, 17–82 years) were included in the study. Incontinence was defined by previously established criteria.3 The study protocol was approved by the institutional review board of the Vall d’Hebron University Hospital.

Clinical Evaluation

Clinical evaluation before biofeedback was performed using a structured questionnaire that included three sets of data: 1) Previous history: anoperineal trauma or surgery, systemic diseases, obstetric injury (forceps delivery, perineal lacerations, multiparity ≥4, and/or birth weight ≥4 kg), and constipation; 2) Symptoms of incontinence: duration, type (i.e., gas,
liquids, or solids), frequency, and presence of stress incontinence, urge incontinence, unnoticed incontinence, nocturnal incontinence, or associated urinary incontinence; and 3) Bowel habit: frequency, stool consistency, difficult evacuation, (i.e., excessive straining, sensation of anorectal obstruction/blockade, or manual maneuvers to facilitate defecation), sensation of incomplete evacuation, and use of laxatives or enemas.

The response to biofeedback treatment was graded on the basis of the patients’ subjective assessment. Two grades were allowed: good response (improved continence) or poor response (no improvement or worsening).

**Evaluation of Anorectal Function**

Anorectal function was evaluated by a series of consecutive tests performed with the patients in lateral decubitus position. The following tests were performed.

**Anal Manometry.** Contraction of anal sphincters was evaluated using a low compliance manometric perfusion system (0.1 ml/min perfusion rate) and a four-radial-lumen polyvinyl catheter (2.4 mm OD, ES4X®, Arndorfer Medical Specialties, Greendale, WI) by a stationary pull-thorough technique at 1-cm steps. The tonic contraction of the internal anal sphincter was evaluated by the basal anal pressures (at each level of the anal canal mean radial pressure referenced to intrarectal pressure), and the phasic contraction of the external anal sphincter by the squeeze pressures (pressure increment from basal at each level). The length of the anal canal from orad (basal pressure ≥10 mmHg) to caudad (anal verge) was measured.

**Neural Reflexes.** Reflex responses were evaluated using a five-lumen polyvinyl catheter (4.8 mm outside diameter, ARM®, Arndorfer Medical Specialties) with four manometric ports 1-cm apart and a distal tip latex balloon located 5 mm from the distal port. The recto-anal inhibitory reflex was triggered by inflation of the rectal balloon with air as follows: phasic rectal distensions of 10-second durations were performed at 1-minute interval and in 10-ml increments while measuring the reflex relaxation of the internal anal sphincter (anal pressure drop). This is an intrinsic reflex driven by fibers in the myenteric plexus. Abnormal reflex was defined as absent relaxation with distending volumes up to the level of discomfort. The cough reflex was evaluated with the intrarectal balloon inflated with 25 ml of air. Patients were asked to cough, and the reflex contraction of the external anal sphincter (anal pressure increment) in response to the abdominal compression (intrarectal pressure peak) was measured. This is a sacral reflex driven by the pudendal nerves. Abnormal cough reflex was defined as anal pressure peak lower than both the intrabdominal pressure peak and the voluntary squeeze pressure.

**Defecatory Maneuver.** The dynamics of defecation was studied by means of a manometric technique. The same catheter as described for evaluation of neural reflexes was used with the intrarectal balloon inflated with 25 ml of air and the manometric ports located in the anal canal. Patients were asked to attempt defecation, and both the abdominal compression (intrarectal pressure increment) and the anal relaxation (anal pressure drop) during straining were measured. Normally the four manometric ports exteriorize recording atmospheric pressure. Abnormal defecatory maneuver was defined as incomplete anal relaxation during straining (pressure above atmospheric in one or more proximal ports).

**Rectal Compliance and Sensitivity.** An electronic barostat was connected by a double-lumen polyvinyl tube (12-F, Argyle®, Sherwood Medical, Tullamore, Ireland) to a flaccid, oversized polyethylene bag (600 ml capacity, 28-cm maximal perimeter) introduced into the rectum. Rectal distention was produced at fixed pressure levels in 4 mmHg stepwise increments every 15 seconds while measuring intrarectal pressure and subjective sensations. Rectal compliance was expressed as the intrarectal volume at 20 mmHg and rectal sensitivity as the pressure levels that induced first sensation and urge to evacuate.

**Biofeedback Treatment**

Biofeedback treatment of anal incontinence was primarily directed toward anoperineal striated muscle strengthening, but sensory training and synchronization of rectoanal reflexes were not targeted. In patients with abnormal defecatory maneuver, no specific biofeedback treatment for impaired defecation was attempted, because the primary complaint and referral reason was incontinence, and no patient presented fecal retention and overflow incontinence. Biofeedback was performed by means of a manometric technique. Using the above-mentioned
five-lumen tube (intrarectal balloon plus four anal recording ports), intrarectal and anal pressures were recorded and displayed on a monitor in view of the patients. Under visual control, the patients were instructed to squeeze for five seconds trying to increase anal pressure as much as possible without abdominal compression, i.e., without intrarectal pressure increments. Each session lasted 30 to 45 minutes. Patients then were instructed to exercise twice daily for ten minutes, alternating five-second squeeze and ten-second resting intervals. After one to three initial sessions, reinforcement sessions were scheduled at three-month intervals.

Statistical Analysis

Data are presented as mean (± standard error). The Kolmogorov-Smirnov test was used to check normality of data distribution. Comparisons of parametric data were performed by the Student’s t-test if normally distributed and otherwise by the Mann-Whitney U test. Contingency tables were analyzed by the chi-squared or Fisher’s exact test, as pertinent. In the group of incontinent patients with more than six-month follow-up, univariate analysis and multiple logistic regression analysis were performed to establish the independent variables from the pool of depen-

<table>
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<th>Table 1. Clinicophysiologic Data Relevant to Response to Treatment in Anal Incontinence</th>
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<td><strong>Response to Treatment</strong></td>
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<td>Age (yr)</td>
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<td>Duration of symptomatic incontinence (yr)</td>
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<tr>
<td>Cough incontinence, n(%)</td>
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<td>Urge incontinence, n(%)</td>
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<td>Unnoticed incontinence, n(%)</td>
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<td>Nocturnal incontinence, n(%)</td>
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<td>Urinary incontinence, n(%)</td>
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<td>Prior history</td>
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<tr>
<td>Major anal surgery, n(%)</td>
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<td>Obstetric injury, n(%)</td>
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<td>Constipation, n(%)</td>
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<td>Anal manometry</td>
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<td>Anal canal length (cm)</td>
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<tr>
<td>Basal pressure (mmHg)</td>
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<tr>
<td>Squeeze pressure (mmHg)</td>
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<tr>
<td>Anal reflexes</td>
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<td>Rectoanal reflex threshold (ml)</td>
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<td>Impaired cough reflex, n (%)</td>
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<td>Defecatory manoeuvre</td>
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<tr>
<td>Abdominal compression (mmHg)</td>
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<tr>
<td>Impaired anal relaxation, n (%)</td>
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<tr>
<td>Rectal compliance and sensitivity</td>
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<td>Rectal volume at 20 mmHg (ml)</td>
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<td>First perception (mm Hg)</td>
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<td>Urge to defecate (mm Hg)</td>
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</table>

Figures are number and (percentage) or mean ± standard error unless otherwise specified. Significance levels were equivalent by univariate analysis.

* Chi-squared.
† Student’s t-test.
‡ Mann-Whitney U test.
§ Fisher’s exact test.
dent variables. The cutoff point of variables found to be significant predictors was determined using receiver operating characteristic curve analysis. Statistical significance was considered as $P < 0.05$.

**RESULTS**

**Multivariate Analysis of Response to Treatment**

Of 145 incontinent patients included in the study, 126 (104 female; age range, 17–82 years) were followed by means of regular outpatient visits for at least six months after the onset of biofeedback treatment (mean 10.8 ± 0.2 months), and of them 84 percent manifested a good clinical response to treatment. Several factors (age, history of constipation, abnormal defecatory maneuver, and rectal compliance) seemed to be related to the response to treatment and exhibited statistically significant differences in patients with good compared with those with poor response to treatment (Table 1). Variables with statistical significance at $P < 0.3$ level by univariate analysis were included in a multiple logistic regression analysis, which showed that only age and an abnormal defecatory maneuver were independent factors predictive of the response (Table 2). The presence of both predictors provided the best combination: 48 percent of patients younger than age 55 years (calculated cutoff value for age) with an abnormal defecatory maneuver had a negative response to treatment, whereas 96 percent of the patients age 55 years or older with a normal defecatory maneuver had a positive response.

**Independent Factors Predictive of the Response**

**Defecatory Maneuver.** Among the 145 patients included in the study, 64 patients had abnormal defecatory maneuver (incomplete anal relaxation during straining). In this group, 30 percent of patients did not respond to treatment ($16 \%$ of patients with normal defecatory maneuver; $P < 0.05$). Conversely, the proportion of abnormal defecatory maneuver in patients with a poor response to treatment was significantly larger than in those with a good response (Table 1). A significantly greater proportion of patients with impaired defecatory maneuver, compared with those with normal maneuver, gave a history of constipation (61 vs. 10 percent, respectively; $P < 0.0001$; see below), higher rectal compliance (188 ± 11 ml vs. 134 ± 8 ml rectal volume at 20 mmHg intrarectal pressure, respectively; $P < 0.05$), and lower proportion of impaired cough reflex (20 vs. 41 percent, respectively; $P < 0.05$). The rest of the parameters were similar regardless of the defecatory maneuver.

**Age.** Patients with a poor response to treatment were younger than those with a good response, but no gender differences were detected by our analysis (Table 1). Patients age 55 years or older had better response to treatment than those younger than 55 years (good response in 94 vs. 71 percent, respectively; $P < 0.05$).

**Dependent Factors Related to the Response**

**History of Constipation.** Forty-seven patients (32 percent) had previous history of constipation, defined by established criteria and 17 still were constipated at the time of the study. Most patients with a history of constipation (83 percent), but only 26 percent of patients without had an abnormal defecatory maneuver ($P < 0.001$). Consequently, history of constipation predicted a poor response to treatment: 28 percent of patients with history of constipation had a poor response vs. 10 percent of patients without ($P < 0.05$). Treatment proved to be even less effective in patients with current constipation, that is at the time of the study, but the difference was not significant (36 per-

<table>
<thead>
<tr>
<th>Variable</th>
<th>$P$ Value</th>
<th>Odds Ratio</th>
<th>95% CI</th>
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<tbody>
<tr>
<td>Abnormal defecatory maneuver</td>
<td>0.006</td>
<td>15.19</td>
<td>2.21–104.13</td>
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<tr>
<td>Age</td>
<td>0.025</td>
<td>0.93</td>
<td>0.87–0.99</td>
</tr>
<tr>
<td>Squeeze pressure</td>
<td>0.11</td>
<td>0.96</td>
<td>0.92–1</td>
</tr>
<tr>
<td>Rectoanal reflex threshold</td>
<td>0.13</td>
<td>0.94</td>
<td>0.87–1.01</td>
</tr>
<tr>
<td>Gender</td>
<td>0.14</td>
<td>6.04</td>
<td>0.55–66.5</td>
</tr>
<tr>
<td>Constipation</td>
<td>0.79</td>
<td>2.33</td>
<td>0.48–11.32</td>
</tr>
<tr>
<td>Impaired cough reflex</td>
<td>0.5</td>
<td>0.53</td>
<td>0.87–3.29</td>
</tr>
<tr>
<td>Rectal volume</td>
<td>0.55</td>
<td>1</td>
<td>0.99–1.01</td>
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</table>

CI = confidence interval.
cent poor response vs. 29 percent in patients with previous but not current constipation; not significant) Conversely, the frequency of constipation was higher in patients with poor than with good response to treatment (Table 1), and patients with history of constipation compared with those without had higher rectal compliance (180 ± 12 ml vs. 147 ± 8 ml at 20 mmHg intrarectal pressure set by the barostat, respectively; P < 0.05). No other difference was detected between patients with history of constipation (present and/or previous) and those without.

Rectal Compliance. Patients with poor response to treatment had larger rectal compliance (volume measured at 20 mmHg intrarectal pressure by the barostat) than those with good response (Table 1). Patients with reduced rectal compliance had a greater incidence of unnoticed incontinence events (38 percent in patients with rectal volume ≤100 ml vs. 17 percent in those with rectal volume >100 ml; P < 0.05). Rectal sensitivity measured by the barostat was unrelated to the response to treatment (Table 1).

Factors Not Related to the Response
to Treatment

Surgical and Obstetric History. Forty-two patients had previous anal surgery for anal fistula, fissure, and/or hemorrhoids, and 82 percent of them had a good response to biofeedback treatment. Seven patients had previous major anopercineal surgery, four for anal trauma, and three for atresia, and six of them had a good response to treatment (Table 1). Forty-one patients had history of obstetric injury and exhibited lower basal anal pressures (24 ± 2 vs. 32 ± 2 mmHg in patients without obstetric damage; P < 0.05), suggesting internal sphincter damage, as well as a higher incidence of urinary incontinence (44 vs. 17 percent in patients without obstetric damage; P < 0.05). Squeeze pressures produced by external sphincter contraction were not affected (23 ± 2 and 26 ± 2 mmHg without obstetric damage). A history of obstetric injury did not influence the response to treatment (good response in 86 percent of the patients with and in 79 percent of those without obstetric damage; Table 1).

Clinical Presentation of Incontinence. All patients had chronic incontinence, with a mean duration of symptoms of 5.3 ± 0.7 years. Overall, 49 patients reported urge incontinence, 34 cough incontinence, 26 unnoticed episodes of incontinence, and 9 nocturnal incontinence, but none of these clinical features influenced the outcome to treatment (Table 1). Associated urinary incontinence was reported by 35 patients, but it did not affect the therapeutic response (Table 1). In patients with urinary incontinence there was, however, a higher incidence of obstetric injury (51 percent with vs. 21 percent without respectively; P < 0.005) and a lower rectal compliance (128 ± 12 mmHg vs. 169 ± 8 ml at 20 mmHg intrarectal pressure respectively; P < 0.01).

Anal Pressures. The response to biofeedback treatment was not influenced by basal anal pressures, length of the anal canal, or squeeze pressures (Table 1). Innervation Pathways. The rectoanal inhibitory reflex, indicative of myenteric plexus function, was normal in all patients. The cough reflex was impaired in 46 patients, but had no relation with the response to treatment (Table 1). However, an impaired cough reflex was associated to a higher proportion of cough incontinence (47 vs. 26 percent in patients with normal reflex; P < 0.05). Patients with impaired cough reflex, indicative of pelvic floor dysfunction, had lower squeeze pressures (18 ± 2 vs. 34 ± 2 mmHg with normal reflex; P < 0.001), and had lower proportion of impaired defecatory maneuver (28 vs. 51 percent in patients with normal reflex; P < 0.05).

DISCUSSION

By performing a logistic regression analysis of multiple clinical and physiologic parameters in a large population of incontinent patients, we have for the first time identified two independent factors, the defecatory maneuver and age, that determine the long-term response of anal incontinence to strengthening biofeedback treatment. We acknowledge the subjective outcome measured in our study, but nevertheless, the response rate to treatment was similar as in previous studies with different outcome measures. 4–7,9–13

The normal defecatory maneuver entails a voluntary abdominal compression associated to anopercineal relaxation that allows complete rectal evacuation. 17,18,20 In the present study we have found, first, that despite its apparently paradoxical coexistence with incontinence, a large proportion of such patients have an abnormal defecatory maneuver that may not be even associated to constipation. Second, this abnormal defecatory maneuver is an independent predictor of the response to strengthening biofeedback treatment in these patients. The defecatory maneuver in the present study was evaluated by manometry, because it is a well-established technique; however, other tests, i.e., electromyography, balloon expulsion,
and defecography, also have been used.\textsuperscript{27–30} The correlation of results from different tests is variable (70 percent concordance between manometry and electromyography, and 61 percent between manometry and defecography), in part because not exactly the same aspects are evaluated.\textsuperscript{31} Furthermore, it remains debatable to what extent an abnormal maneuver constitutes a reliable indicator of altered physiology or it represents behavioral reaction to laboratory environmental conditions.\textsuperscript{28,32} However, the fact that an abnormal defecatory maneuver was altogether associated to poor response to treatment, constipation, and large rectal compliance suggests an underlying physiologic abnormality.

Impaired defecatory maneuver may produce functional outlet obstruction and constipation.\textsuperscript{27,29,33} Furthermore, if the anus does not relax properly, rectal evacuation may require a stronger abdominal compression, which may lead to perineal damage.\textsuperscript{34,35} Hence, we speculate that impaired defecatory maneuver may be a cause of incontinence via anoperineal damage, and this may explain their association.\textsuperscript{35}

Constipation was associated to poor response to treatment, but only in relation to impaired defecation. However, in the present and previous studies,\textsuperscript{36,28} some patients with an impaired defecatory maneuver do not complain of constipation. In such patients it remains unclear whether the defecation test is unreliable, i.e., false positive, or whether the defecatory dysfunction, albeit subclinical, may still lead to perineal damage and long-term complications. The analysis of the situation is particularly challenging, because constipation is clinically defined both by objective signs, such as reduced frequency and increased stool consistency, and by subjective sensations, such as excessive straining and anal blockade,\textsuperscript{26} and patients with lifelong constipation may not be even aware that they are straining inappropriately and excessively.

The poor response of anal incontinence to biofeedback therapy in the presence of impaired defecatory maneuver may involve two different mechanisms. First, normal defecation completely evacuates the rectum, but an impaired defecatory maneuver is associated with incomplete rectal evacuation,\textsuperscript{36} and rectal residues may leak if anal closure fails. Second, the pelvic floor stress produced by excessive straining may counterbalance the progress of muscular rehabilitation. In the present study, impaired defecatory maneuver was not specifically treated, because no patient had obvious overflow incontinence and clinical constipation was absent or just a minor complaint with respect to incontinence.

Increased rectal capacity was related to poor treatment outcome, but this also was associated to impaired defecatory maneuver.\textsuperscript{37} On the other hand, patients with reduced rectal capacity had higher incidence of unnoticed incontinence episodes. Impaired rectal reservoir associated to impaired anal closure conceivably determined this effect.

In our study we also found that young age negatively affected the responsiveness of anal incontinence to treatment. Using the mean age of our incontinent population as cutoff, we found that patients younger than age 55 years did worse than older ones. A similar association has been previously reported.\textsuperscript{11} Such inverse relation between age and treatment response is intriguing. It could be simply related to the unfulfilled higher expectations of younger patients. It also may be that subjective improvement in anal incontinence is heavily influenced by nonspecific effects on patients’ well-being and confidence.\textsuperscript{2,8}

As previously reported, neither rectal sensitivity\textsuperscript{5,12} nor sphincteric activity\textsuperscript{5–8,10–12,15} determined the response to treatment in our study group. However, we emphasize that none of our patients had known neurologic disorders, severe rectal hypoesthesia, or major muscular disruption with anal asymmetry, conditions that could have influenced the outcome.\textsuperscript{3,6,11,13,15,38}

The reflex innervation of the striated external sphincter was evaluated by the cough reflex. Normally, an intra-abdominal pressure increment induces a sacral reflex, which contracts the striated anal and perineal musculature, and thus, prevents rectal leakage.\textsuperscript{21,39} Impaired cough reflex was associated to decreased squeeze pressures, and, as expected, to cough incontinence. However, an impaired cough reflex had no impact on the response to treatment. Neural damage has been associated to poor treatment response,\textsuperscript{4,15,38} but conceivably, the neuropathy detected by this reflex in our patient population was much less severe than in other reported series.

**CONCLUSIONS**

Anal incontinence is frequently associated to impaired defecatory maneuver, which may play a pathophysiologic role in the process. Biofeedback is an effective therapy for incontinence, but impaired defecatory maneuver and young age are predictive factors of poor outcome. Hence, in patients with anal incontinence, particularly young patients, a proper
evaluation should be performed to detect potential alterations of defecation even if they have only mild or no constipation, because correction of the defecatory dysfunction could potentially improve the outcome of incontinence treatment.

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