Int J Colorectal Dis (2000) 15:100–104

ORIGINAL ARTICLE

Ahmed Shafik
Olfat El-Sibai
Ali A. Shafik

Rectal pacing in patients with constipation due to rectal inertia: technique and results

Accepted: 1 February 2000

A. Shafik
Experimental Research, Cairo University, Cairo, Egypt

O. El-Sibai
Department of Surgery, Menoufia University, Egypt

A. Shafik · A.A. Shafik
Department of Surgery, Faculty of Medicine, Cairo University, Cairo, Egypt

A. Shafik (✉)
2 Talaat Harb Street, Cairo, Egypt
e-mail: shafisci@link.com.eg
Tel./Fax: +20-2-3498851

Abstract In a previous study we determined the rectal pacing parameters needed for rectal evacuation in patients with rectal inertia. Here we investigated the effect of rectal pacing on rectal myoelectric activity, motility, and evacuation in ten patients with constipation due to rectal inertia. A pacemaker was implanted in a subcutaneous pocket above the inguinal area, with a lead threaded in the anal submucosa to be hooked at the rectosigmoid junction. The effect of rectal pacing on rectal electric activity was investigated by inserting two recording electrodes to the rectal mucosa. The patients were then trained for home pacing. No waves were recorded from the rectum at rest. On rectal pacing, slow waves or pacesetter potentials (mean frequency 2.3±1.1 cpm, amplitude 0.86±0.1 mV, velocity 3.4±1.6 ms) were registered after a latency period of 5.2±1.6 min. Rectal evacuation, on pacing, occurred in seven of the ten patients. The three who showed no significant response exhibited low wave parameters. Three of seven patients were able to evacuate spontaneously without pacing after having performed daily pacing for 5–6 months. The pacemaker was removed in six patients (three failures and three after spontaneous defecation). Thus rectal pacing succeeded in inducing rectal evacuation in 70% of the patients. The procedure failed in three patients. Three had spontaneous defecation after a few months of rectal pacing. No complications were encountered, and the method was tolerated and acceptable. Further studies on a large group of patients are required.

Keywords Pacemaker · Rectosigmoid junction · Defecation · Slow waves · Pacesetter potentials · Motility · Electrode

Introduction

Rectal inertia is a disorder of rectal motility, and patients present with constipation. The intestinal markers accumulate in the rectum while electromyographic findings of the anal sphincter are normal [1–3]. Previous studies have demonstrated that the rectum possesses electric activity in the form of slow waves or pacesetter potentials (PPs) and action potentials [4–6] (Fig. 1). The waves have a regular rhythm, with a mean frequency of 2.6±0.4 cycles/minute (cpm, range 2–4), amplitude of 1.9±0.6 mV (range 1–3), and velocity of conduction of 4.2±0.9 cm/s (range 3–6). They are reproducible in the individual subject. However, they exhibit changes in the various pathological conditions of the rectum [7–11]. The PPs in patients with rectal inertia constipation are so scarce that a period of 30 min sometimes passes without an electric wave being recorded [9] (Fig. 2).

Rectal electric activity seems to regulate the motility [4–6], which is presumably impaired by a disorder affecting the electric waves. This is evidenced by the electrorectograms recorded in the various pathological lesions [7–11]. In these conditions the electric waves with low values (frequency, amplitude, and velocity of

conduction) are associated with diminished rectal motility.

Therapy of rectal inertia constipation is problematic, and the results of medical and surgical treatment are controversial and in most cases unsatisfactory [12–16]. Previous studies have postulated the existence of a pacemaker at the rectosigmoid junction (RSJ) [17–20]. Rectal electric waves have been demonstrated to start at the RSJ and to spread caudad along the rectum [17–20]. A RSJ pacemaker is thought to initiate and regulate rectal electric activity. We have investigated the effect of rectal pacing, i.e., electrical stimulation of rectal smooth muscles in patients with constipation due to rectal inertia, and the results were satisfactory [21–23]. In the most recent investigation we identified the rectal pacing parameters that are required to produce rectal evacuation in patients with rectal inertia [24].

In the present study we examined the effect of rectal pacing on rectal myoelectric activity, motility, and evacuation in the patients with rectal inertia.

Material and methods

Subjects

Ten patients complaining of constipation of long duration (seven women, three men; age 35–55 years) were enrolled in the study. They had been on a high-fiber diet for a long period but with no improvement. Evacuation was achieved by laxatives, enemas, and/or digitation (Table 1). Physical examination and laboratory findings were normal. Intestinal transit measurement showed accumulation of the pellets in the rectum. Defecography and electromyography of the external anal sphincter, puborectalis, and levator ani muscles yielded normal findings. Proctoscopy, colonoscopy, and barium enema studies were also normal. Our Faculty Review Board and Ethics Committee approved the study, and the subjects gave informed consent.

Table 1 Clinical data of the 10 patients with inertia constipation

Patient no.	Sex	Age (years)	Stool frequency (per week)	Duration (years)	Treatment
1	F	42	0–1	8	Laxatives
2	F	35	0	15	Enemas
3	M	52	0–1	5	Digitation
4	F	38	0	10	Enemas
5	F	40	0–1	12	Laxatives
6	M	48	0	14	Enemas
7	F	43	0–1	6	Digitation
8	F	39	0–1	5	Laxatives
9	F	55	0	17	Enemas
10	M	42	0	12	Digitation

Application of the pacemaker and electrodes

The rectum was emptied by means of a saline enema. The pacemaker (Prevail, Medtronic, Minneapolis, Minn., USA) was implanted in a subcutaneous pocket in the inguinal area. Two leads were passed subcutaneously from this area to the anal orifice and then in the anal and rectal submucosa to be hooked to the RSJ. Under general anesthesia a 4-cm incision was performed 2 cm above and parallel to the middle one-third of the inguinal ligament (Fig. 3). Dissection was performed in the subcutaneous space to make a pocket for the pacemaker. A subcutaneous tunnel was then created by means of a dissecting forceps that passed subcutaneously from the pocket and alongside of the scrotum or labium majus to the anal orifice where a 1-cm incision was made at the mucocutaneous junction (Fig. 4). A long artery forceps was passed subcutaneously from this incision until it appeared in the pocket. The tip of the lead was grasped by the forceps and withdrawn subcutaneously to come out of the anal incision. A tunnel was then created in the submucous space of the anal canal and rectum by means of a long artery forceps passed through the anal incision. The lead was threaded through this tunnel until its tip reached just above the RSJ; it was then pulled back for a short distance so that its tip was hooked to the RSJ. The submucosal threading and hooking of the lead was performed under sigmoidoscopic and fluoroscopic control. The patient left the hospital 24 h after surgery. Analgesic (Voltaren, Novartis Pharma, Basel, Switzerland) was given on the 1st postoperative day together with a quinolone antibiotic for 2 days.

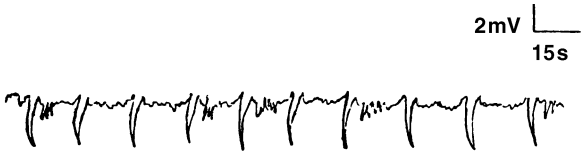

Fig. 1 Electrorectogram of a normal subject showing pacesetter and action potentials. (From [5])

Determination of the myoelectric activity: basal and after pacing

The patients were allowed 7–10 days to recover from surgery. To determine the effect of rectal pacing on the rectal myoelectric activity two electrodes were hooked in the rectum. On the day of the study the patient fasted for approximately 8 h. The electrodes were introduced through the anus and hooked to the rectal wall. The first electrode was applied to the rectal mucosa 3 cm below the RSJ and the second 2–3 cm above the anorectal junction. Recorded waves from the two rectal electrodes were amplified using an AC amplifier with a frequency response ±3 dB from 0.016 Hz to 1 kHz, and were displayed on a UV recorder at a sensitivity of 1 mV/cm. After 30 min of rest for the rectum to adapt to the electrode application, basal rectal myoelectric activity was measured for 20-min. This was followed by another 20-min recording during pacemaker stimulation. Rectal pacing parameters had previously

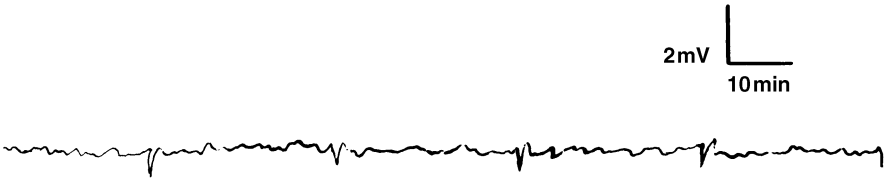

Fig. 2 Electrorectogram in a patient with constipation due to rectal inertia. Observe that recording occurred in minutes not in seconds as in normal subjects. (From [9])

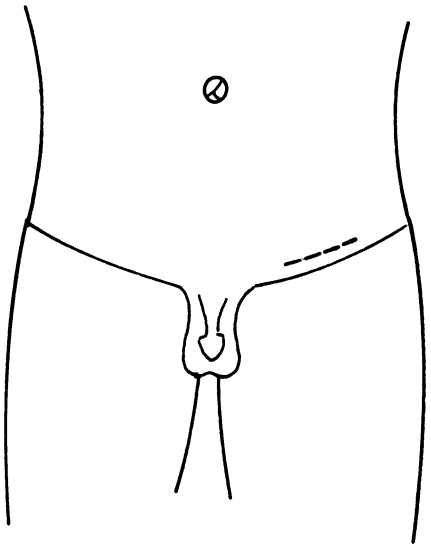

Fig. 3 Incision along the middle one-third of the inguinal ligament

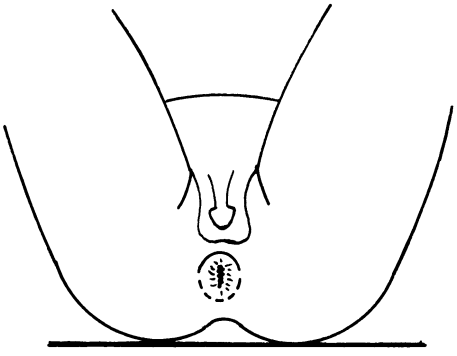

Fig. 4 Incision at the mucocutaneous junction of the anal orifice

been defined and consisted of an amplitude of 5 mA and a pulse width of 200 ms [24]. The pacemaker was programmed at the pace rate and time.

Home pacing

When the effect of rectal pacing on the rectal myoelectric activity had been determined, the two rectal electrodes were removed. The patient was then trained for use of the pacemaker at home, with the instruction to perform rectal pacing 30–60 min after breakfast and lunch and to record the daily number of induced and spontaneous bowel evacuations and the need for using laxatives or enemas, or for inducing defecation by digitation. The patient was asked to return for follow-up at 2-month intervals. He or she was assessed clinically regarding the daily recordings. The pacemaker and leads were also examined. The results were analyzed statistically using Student's *t* test. Differences of $P<0.05$ were taken as statistically significant.

Results

Basal rectal waves were not recorded from the two electrodes applied to the rectal mucosa, and a "silent" electrorectogram was achieved in all the patients (Fig. 5). During rectal pacing PPs were recorded with a mean frequency of 2.3±1.1 cpm (range 1.6–3.2), amplitude of 0.86±0.2 mV (0.5–1.2), and velocity of 3.4±1.6 ms (2.2–4.8; Fig. 5). The waves appeared after a mean latency period of 5.2±1.6 min (range 2.1–6.3). These variables were reproducible from the two electrodes in the individual subject (Fig. 5). The PPs were followed by bursts of action potentials represented by negative deflections (Fig. 5) The action potentials were inconsistent and occurred randomly. The waves disappeared immediately after pacing cessation.

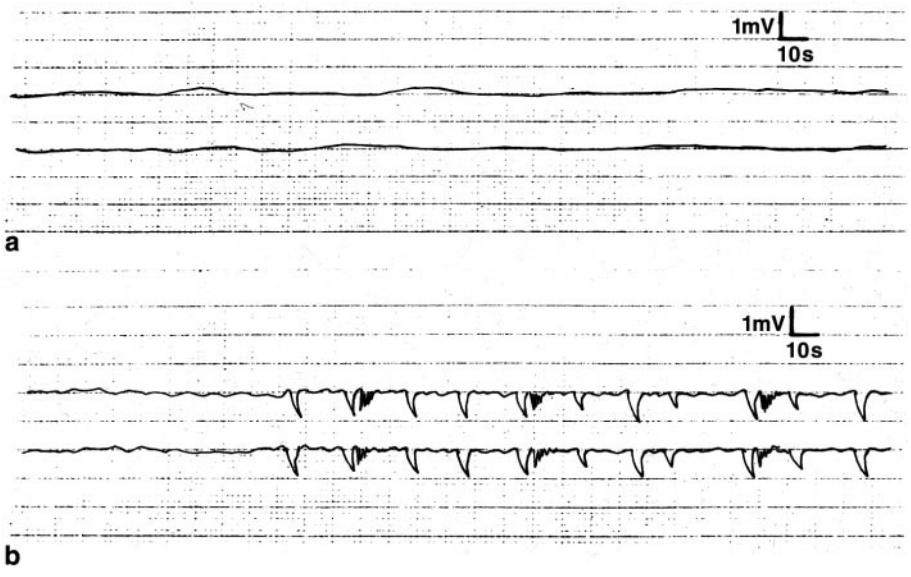

Fig. 5a,b Electorectogram in inertia constipation patient. **a** Before rectal pacing: no waves recorded. **b** During rectal pacing: waves were recorded and were similar from the two electrodes

Effect on rectal evacuation

Rectal pacing induced rectal evacuation in seven of the ten patients with constipation. The number of weekly evacuations varied from one patient to the other (Table 2). All patients performed rectal pacing twice per day. However, bowel evacuation was not achieved after each pacing. The maximum frequency of paced defecation was 12/week. Three patients (nos. 2, 4, and 10; Table 2) did not show significant improvement from the prepacing condition. Their frequency was in each case maximally one per week. On reviewing the PP recordings of the three patients we found that the recorded waves had lower frequency, amplitude, and velocity of conduction than those of the other patients (Fig. 6). Table 3 presents the PP variables of these three patients, which were probably not sufficient to effect rectal contraction and evacuation. The three patients continued to use enemas or laxatives, and asked for removal of the pacemaker and leads 2 months after the trial.

Table 2 The frequency of rectal evacuation/week with rectal pacing of twice daily

Patient no.	Frequency (per week)		Quality of life	Adjuvant methods
	Mean	Range		
1	8.3±1.2	6–10	Satisfied	–
2	2.8±0.9	0–1	Not satisfied	Enemas
3	6.6±1.1	5–8	Satisfied	–
4	0.9±0.3	0–1	Not satisfied	Enemas
5	7.2±1.2	5–8	Satisfied	–
6	7.3±2.1	6–9	Satisfied	–
7	8.3±2.2	5–10	Satisfied	–
8	5.6±1.8	4–8	Satisfied	–
9	10.6±1.3	8–12	Satisfied	–
10	0.6±0.2	0–1	Not satisfied	Laxatives

Table 3 Frequency, amplitude, and velocity of conduction of PPs during pacing of the three patients who showed no significant improvement on rectal pacing

Patient no.	Frequency (cpm)	Amplitude (mV)	Velocity (ms)
2	1.7	0.5	2.3
4	1.6	0.5	2.2
10	1.6	0.7	2.3

Table 4 The weekly stool frequency of the three patients who showed spontaneous defecation after rectal pacing for 3–5 months

Patient no.	Bowel evacuation (frequency per week)		
	Before-pacing	during pacing	No pacing
3	0–1	5–8	2–4
7	0–1	5–10	3–5
8	0–1	4–8	2–4

The technique was well tolerated and accepted. No infection of the pacemaker or leads occurred in any of the ten patients. None of the remaining seven patients asked for pacemaker removal. Three of seven patients showed an increase in the weekly bowel motions without rectal pacing; this spontaneous evacuation occurred after having performed daily pacing for 3, 4, and 5 months, respectively (Table 4). The pacemaker was removed 3 months after spontaneous evacuation. Pacemaker removal in the six patients (three failures and three after spontaneous evacuation) was effected by pulling the leads gently to free them from the rectal wall. The embedded pacemaker was removed under local anesthesia, and the skin incision was sutured. No complication occurred with pacemaker removal.

Discussion

Rectal pacing was effective in inducing rectal evacuation in 70% of the patients with inertia constipation. The absence of basal electric activity in these patients seems to suggest deficient motility, which probably is responsible for noncontractility of the rectum and for inertia. Previous studies have demonstrated that rectal electric waves are initiated at the RSJ and proceed caudad [4–6]; RSJ anesthetization resulted in disappearance of the rectal waves. It has been postulated that a pacemaker exists at the RSJ, and that in rectal inertia constipation this rectosigmoid pacemaker is not functioning [21–23].

The present study attempted to activate this disordered rectosigmoid pacemaker. After insertion of the ar-

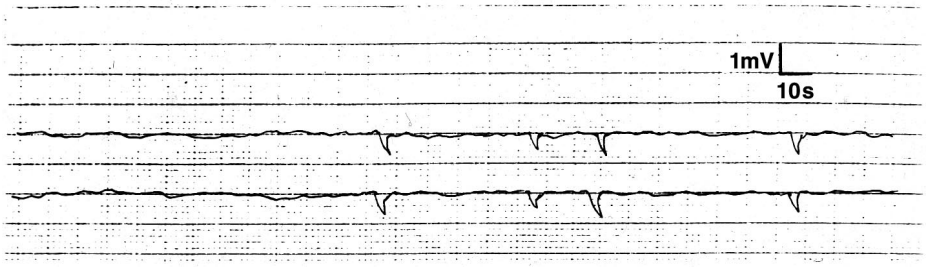

Fig. 6 Pacesetter potentials recorded from a patient in whom rectal pacing failed to induce rectal evacuation

tificial pacemaker at the RSJ, rectal pacing succeeded in producing electric waves from the two electrodes applied to the rectal mucosa. Although all the patients exhibited electric activity, the wave parameters differed from one patient to the other and led to the difference in the effect of the rectal pacing on evacuation. Three patients failed to defecate on rectal pacing, probably due to the low values of the electric waves. The remaining seven patients achieved a weekly rectal evacuation frequency that was comparable to that of healthy volunteers in our laboratory. The seven patients who responded to rectal pacing had high wave parameters; they were satisfied with the results. Three of these seven patients had spontaneous defecation after a few months of rectal pacing. It is probable that repeated rectal electric activation exercised the rectal musculature or reactivated the RSJ pacemaker so that spontaneous evacuation could be achieved without pacing. However, this spontaneous evacuation did not occur in all of the seven patients in whom pacing induced evacuation. Reviewing the clinical data of the three patients with spontaneous evacuation, it appeared that they had a stool frequency of maximally one per week, but their constipation history was of a shorter duration than that of the other patients.

The pacemaker was removed in six of the ten patients: three failures and three after spontaneous defecation. Four patients still have their pacemakers, functioning and effecting rectal evacuation. In conclusion, rectal pacing succeeded in inducing rectal evacuation in 70% of the patients with rectal inertia. No complications were encountered. Rectal pacing is suggested as a treatment for rectal inertia constipation when other simpler methods have failed to cure the condition.

Acknowledgements Waltraut Reichelt and Margot Yehia assisted in preparing the manuscript.

References

1. Krishnamurthy S, Schuffler MD, Rohrmann CA, Pope CE (1985) Severe idiopathic constipation associated with a distinctive abnormality of the colonic myenteric plexus. Gastroenterology 88:26–34
2. Shoulder P, Keighley MRB (1986) Changes in colorectal function in severe idiopathic chronic constipation. Gastroenterology 90:414–420
3. Corman ML (1986) Disorders of defecation. In: Corman ML (ed) Colon and rectal surgery, 4th edn. Lippincott-Raven, Philadelphia, pp 368–400
4. Shafik A (1994) Study of the electrical and mechanical activity of the rectum. Experimental study. Eur Surg Res 26:87–93
5. Shafik A (1993) Study of the electromechanical activity of the rectum. II. Human study. Coloproctology 15:215–218
6. Shafik A, Nour A, Abdel-Fattah A (1995) Transcutaneous electrorectography. Human electrorectogram from surface electrodes. Digestion 56:479–482
7. Shafik A (1993) Electrorectogram in chronic proctitis. World J Surg 17:675–679
8. Shafik A (1995) Electrorectogram in Hirschsprung's disease. Pediatr Surg Int 10:478–480
9. Shafik A (1995) Electrorectography in chronic constipation. World J Surg 19:772–775
10. Shafik A (1995) Electrorectogram in the neuropathic rectum. Paraplegia 33:346–349
11. Shafik A (1994) Electrorectogram in chronic constipation, ulcerative proctitis, Hirschsprung's disease and neurogenic rectum. Dis Colon Rectum 37:P10
12. Schang J-C, Devroede G, Pilote M (1993) Effects of trimebutane on colonic function in patients with chronic idiopathic constipation: evidence for the need of a physiologic rather than clinical selection. Dis Colon Rectum 36:330–333
13. Keighley MRB, Williams NS (1993) Constipation. In: Keighley MRB, Williams NS (eds) Surgery of the anus, rectum and colon. Saunders, Philadelphia, pp 609–638
14. Hill J, Stott S, MacLennan I (1994) Antegrade enemas for the treatment of severe idiopathic constipation. Br J Surg 81:1490–1493
15. Turnbull GK, Rivo PG (1992) Anal sphincter biofeedback relaxation treatment for women with intractable constipation symptoms. Dis Colon Rectum 35:530–536
16. Loening-Baucke V (1991) Persistence of chronic constipation in children after biofeedback treatment. Dig Dis Sci 36:153–160
17. Shafik A (1996) Functional activity of the sigmoid colon and rectum. A study during fecal storage in the sigmoid (abstract). Gut 3[Suppl]:39
18. Shafik A (1996) Sigmoido-rectal junction reflex: role in defecation mechanism. Clin Anat 9:391–394
19. Shafik A (1999) A study of the effect of distension of the rectosigmoid junction on the rectum and anal canal with evidence of a rectosigmoid-rectal reflex. J Surg Res 82:73–77
20. Shafik A (1998) Rectosigmoid junction. Anatomical and physiological considerations with identification of rectosigmoid pacemaker and sigmoido-rectal junction reflex and the role in constipation and incontinence. Coloproctology 20:45–57
21. Shafik A (1992) Artificial pacemaker for rectal evacuation. Coloproctology 14:96–98
22. Shafik A (1992) Rectosigmoid pacemaker. Role in defecation mechanism and constipation (abstract). Dis Colon Rectum 35:5
23. Shafik A (1993) Rectosigmoid pacemaker. Role in defecation mechanism and constipation. Dig Surg 10:95–100
24. Shafik A (2000) Rectal pacing: pacing parameters required for rectal evacuation of normal and constipated subjects. J Surg Res 88:181–185