# Electrical Stimulation of the Colon in Patients with Constipation

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## Abstract

**Objective:** The objective of this study is to present an overview of current treatments for constipation based on techniques to directly or indirectly stimulate the colon electrically.

**Sources:** This study is based on searches of PubMed, ScienceDirect.com, and ISI Web of Knowledge using the keywords electrical stimulation of the colon and constipation. We considered studies of these techniques in humans and experimental studies aimed at intervening in colon motility patterns in children and adults.

**Principal Conclusions:** Constipation is a disorder of gastrointestinal motility. Its etiology is multifactorial etiology, it has severe impacts on patient quality of life, and it is resistant to conventional therapy in many cases. Surgery, used in the most severe cases, has the risk of complications and the results are far from what is needed to cure the patients. Some drugs have been effective for treating milder cases, but have not been proven useful for more severe cases has. Other strategies have been developed to increase motility including various methods of electrical stimulation of the colon. This extensive review of the available literature is a starting point for focusing additional efforts in this area.

**Conclusion:** Electrical stimulation of patients with severe constipation is a promising therapy to achieve restoration of colon function from the physiological point of view in the least invasive manner possible.

## Keywords

Constipation, colonic inertia, electrical stimulation, colon, gastrointestinal motility, gastrointestinal transit.

Chronic constipation is a pathology that in different population evaluations has a prevalence of 2%. Other results show a prevalence of 21% for women and 8% for men (1), with an overall incidence between 2 and 30 % in the general population (2). It has been reported that chronic constipation in Latin America shows an estimated prevalence of 5-21%, with a 3:1 female:male relation (3), and with strong effects in the quality of life of patients and their families (4). Due to the large number of interpretations given to constipation and evacuation (5), there has been an attempt to classify the symptoms and characteristics of constipation, evacuation, and feces using the Rome III criteria (6). There are different spectra in the disease, which can be classified from the clinical point of view, or from the anatomical point of view, considering whether there is a diffuse intestinal condition or an evacuation disorder, although in some cases the diagnostic tests are normal, but the patient has significant symptoms. Then, overall chronic constipation is classified into slow transit constipation which is divided into colonic inertia and colonic hyper reactivity, evacuation disorder and irritable bowel syndrome with constipation prevalence (functional constipation) (7, 8). The therapeutic strategy is then based on determining the condition of the colon through laboratory tests, which will diagnose any of these variables (9). The most complex patients to be treated are those that present colonic inertia or slow transit constipation, which is described as the form of constipation with evacuations of low frequency of 2-4

 

weeks, and that is not associated with demonstrated dilatation of the colon or rectum (10). Multiple treatments have been proposed for managing constipation, from dietary treatment that may fail in up to half of the cases (11), until total colectomy (12), Therapies with medical devices have been developed, all based on electrical or magnetic stimulation of the colon or of the nerve trunks from their origin in the sacrum, and even the peripheral nerve trunks that can serve as stimuli for the nerves of the colon themselves (13). However, electrical stimulation devices have been designed for the heart muscle or nerve tissue, which quickly respond to electrical stimulation, while the gastrointestinal smooth muscle is slow to respond and therefore longer pulses are necessary to alter its function (14).

Chronic constipation is a disease of the gastrointestinal tract which can range from a nuisance to a serious disease with alterations in the quality of life of individuals and their families. Children with constipation may seem quiet, retracted, distressed and bad tempered in medical assessment (4) and this includes their caregivers (8) with equal impact on the quality of life of adults (15). The pathophysiology of primary chronic constipation is multifactorial and includes diet, absorption, and colonic motility, motor and sensory function, and psychological and behavioral factors (16). Therefore it is often difficult to guide treatment of these patients, even more when it is decided to make invasive treatments. Diagnosis of a condition with many variables is not easy, so different scales are useful to guide the diagnosis, they assess the severity of symptoms and their impact on quality of life, as well as the response to therapy and to changes in symptoms over time (17).

Based on the different types and etiologies of constipation, treatment should be guided by different diagnostic methods: colonic transit using radiopaque markers or isotopes, tests of anorectal function: balloon expulsion test, defecography, pelvic MRI, scintigraphy of evacuation, anorectal manometry, electromyography (18), and the wireless capsule to evaluate colonic transit and the whole intestine (19). Various levels of therapy have been developed: increasing fiber intake and changes in lifestyles (7), laxatives which show varying results in the management of special groups of patients (20, 21), polyethylene glycol (1, 22), transanal irrigation (23, 24), and new drugs such as prucalopride, lubiprostone and linaclotide which are effective for treatment of constipation when they are used with different action mechanisms (25, 26).

Several surgical procedures for treatment of colonic inertia or elimination disorders have also been proposed, but they bear the risk of surgical complications. Malone's technique involves tunneling the cecal appendix to the skin to place antegrade enemas and facilitate the evacuation (27, 28), however, the procedure is not free of complications and requires surgical revisions during the follow-up (29). Total colectomy is a major surgical procedure that is used in patients with colonic inertia that resists conventional treatment (30), however, a significant proportion of patients also have abnormalities in the upper digestive tract or small intestine motility (6), which allows to perpetuate the abdominal symptoms. Antroduodenal manometry has been used to try to differentiate this group of patients that not normally will continue with symptoms like bloating and abdominal pain, which will lead to a less satisfactory result (31). Regarding evacuation disorders or obstructions to evacuation, that reveals pelvic floor dysfunction, constipation alludes to a prolonged effort for evacuation, evacuation pain, and the need for perineal support or sensation of incomplete evacuation (32). It is difficult to categorize these patients due to the interposition of etiologies, irritable bowel syndrome, pudendal neuropathy or dysfunction of the pelvic floor, which makes difficult to define the real cause of symptoms (33). Several surgical techniques are used for these patients to correct the etiological factor causing obstruction: rectal prolapse correction or internal intussusception, enterocele or sigmoidocele correction, rectal trans-anal resection with staples (34), and finally the stomata as a last resort (35). The transanal resection with staples increases rectal sensation and decreases the symptoms which improve the quality of life of patients (36). This is considered the procedure of choice for rectocele and internal intussusception, however there are persistent symptoms in up to 11% of patients after 11 months of follow-up (37).

Constipation has a wide range of causes. Once secondary causes including medications, metabolic disorders, neurological disorders and obstructive colorectal cancer are discarded, functional alterations of the colon and rectum should be evaluated (6). More basic and clinical research on colonic motility is still required to identify which type or subtype of not responsive to medical treatment constipation could respond successfully to electro-stimulation and which is the best way to achieve it (38).

Electrical stimulation is used clinically to effectively control pain, strengthen muscles, mobilize soft tissue, and heal wounds. Interferential therapy is a form of electrical stimulation that uses median frequency currents, typically with a sine wave (39). Interferential current therapy alters intracellular enzymes and other molecules that are important in many metabolic processes and may help explain the effects of this therapy (40). The control of gastrointestinal tract motility depends on the extrinsic sympathetic and parasympathetic innervation and the intrinsic innervation originated in the enteric nervous system (41). Motility can be altered by multiple reasons. Different strategies for stimulating the colon were then developed: by transabdomi-

nal stimulus (42, 43), by direct stimulation of the afferent nerve trunks, or by direct stimulation in the colonic wall (38, 44), and even, based on animal studies, by functional magnetic stimulation at the cervical level with stimulation of the vagus nerve (45).

Several methods of gastrointestinal electrical stimulation have been developed (14):

1. Intramuscular electrodes, usually placed in the muscularis of the colon, with the advantage that they guarantee direct contact with the organ to intervene, and the disadvantage that it is an invasive surgical procedure.
2. Intraluminal or mucous electrodes. Their main disadvantage is that contact between the electrode and the mucosa cannot be guaranteed.
3. Serosal electrodes.
4. Electro-acupuncture which is electrical stimulation with electrodes (needles).

The interest in electrical stimulation of the colon has been derived from studies of side effects, such as diarrhea, that patients go through when electrical stimulation is used to treat urinary incontinence (46). When discussing electrical stimulation of gastrointestinal organs, we have in mind the concept of a pacemaker because stimulation happens at a similar frequency or slightly higher than the intrinsic frequency of the organ (47), and a real presence of a pacemaker site in the colon and rectum with electrophysiological responses that identify them is being searched for (48, 49). Electrical stimulation of colon strips induces acetylcholine release from enteric neurons, which in turn starts contractions that can initiate and generate contractions that support colonic propulsion (50) and also, an increase of colonic transit speed has been found based on animal studies where electrodes have been directly placed (51). Different techniques have been used to accomplish this with varying results. Transabdominal electrical stimulation probably stimulates cutaneous nerve fibers, sympathetic fibers and transcutaneous that go to the intestine or to the intestinal nerves (39). However, the operating mechanism of the current is not known (52, 53), although it is referred to as neuromodulation (54, 55). It has been found that this is a promising technique that should be used before getting surgery (56), and also reduces the need for surgical procedures for the treatment of patients with slow transit constipation (44). The technique of transcutaneous stimulation in adult patients has shown improvement in the number of bowel movements per week and constipation measurement scales (57). We investigate now what is the best way to deliver this electricity if long pulses or pulse train and have found a better response with trains of pulses in animals (16). Isolated studies on the use of transanal electrical stimulation have been reported in patients with impaired evacuation basically due to the absence or decreased sensation of evacuation. Electrical stimulation in constipated patients may have some effect on reviving the rectal pacemaker, regulating anorectal coordination, increasing colonic motility or improving of rectal sensation (58, 59). The technique to stimulate colonic motility through nervous substitution of the colon, that produces a physiological effect, is currently done through electrodes in the sacral foramen, based on the technique used to manage detrusor irritability and urinary retention (60). The spinal magnetic stimulation studies also show increased colonic transit in studies conducted in the elderly (61). These noninvasive techniques are also able to improve the quality of life of patients, which is the ultimate goal of this technology (57, 62).

The current trend is then divided into several possibilities to achieve stimulation of the colon and tries not reach invasive procedures. The stimulation that uses low frequency current through 4 electrodes attached to dermatomes S2 - S3 has shown that it significantly increases daily and weekly intestinal movements in patients with idiopathic constipation (63). A special group of patients is made up of those that have evacuation dysfunction associated with rectal hypo-responsiveness, pelvic floor functional dyssynergia or mechanical obstruction of the outflow tract. For them, abdominal or perineal surgery is not an option, therefore, sacral neural stimulation allows a minimally invasive trial with low morbidity and should be the first choice for those with slow transit constipation and/or rectal hyposensitivity. So, sacral neural stimulation is an effective procedure in the treatment of chronic constipation (64). Research has also been directed towards using the option of direct stimulation of the colon by means of electrodes inserted into the muscle layer at the laparoscopic vial recto-sigmoid junction, connected to a stimulator placed in a subcutaneous inguinal pocket to increase the total number of bowel movements (65). Methods of peripheral stimulation have also been used to stimulate the muscles of the abdominal wall, with functional electrical stimulation at the external oblique and abdominal transverse level. This has shown an increasing evacuation pattern and a reduction in the use of laxatives (66). Another method is the stimulation of the posterior tibial nerve, which showed an increase in the frequency of spontaneous bowel movements after 2 weeks of treatment, including reducing the time of the evacuation event, with subsequent improvement in the quality of life (67).

It is clear then that for the group of patients with slow transit constipation there are different options before subjecting the patient to procedures with significant morbidity, and which in most cases complications are generated, and do not meet the goal to heal the ill. There are several methods that can be explored before reaching surgical procedures.

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