ROLE OF ELECTROMYOGRAPHY AND FUNCTIONAL ELECTRICAL STIMULATION IN THE TREATMENT OF ANORECTAL DISEASES

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Functional disorders of pelvic floor muscles are an important element of the many pathological conditions of the anal and rectal area. The problem is manifested by fecal incontinence, chronic anorectal pain, and chronic constipation, affecting a large heterogeneous group of patients. Amongst these patients one may observe young women after vaginal births, patients after proctological operations, extensive cancer surgery or minor pelvis radiotherapy, as well as patients with chronic non-malignant diseases of the anorectal area, including those diagnosed with unspecific inflammatory bowel diseases. For the majority of these patients, to find specialistic help or obtain information concerning therapy of functional disorders might pose a significant problem. The above-mentioned patients require specialistic diagnostics followed by specialistic rehabilitation by means of functional stimulation.

Rehabilitation using methods such as electromyography, EMG-biofeedback, and functional stimulation restores muscle strength, improves sensation and mucous vascularization, as well as restores the physiological mechanisms of sphincter activity control. The above-mentioned methods help reduce fecal incontinence symptoms, pain, and constipation. Considering operated patients, preoperative and postoperative rehabilitation improves surgical results, reduces the number of complications and shortens the recovery period. It remains a valuable and often only method considering the management of surgical diseases, especially when the patient is disqualified from surgery, due to numerous significant coexisting diseases.

The aim of the study was to present the diagnostic and therapeutic possibilities of electromyography and electrostimulation in the management of functional anorectal diseases.

The pathophysiology of functional disorders of the pelvic floor

The pathophysiology of functional pelvic floor muscles is complex and in many diseases remains unclear. Increased tension of pelvic floor muscles at rest and reduced number of active units significantly correlate with vascularization disturbances, which underlie with the many pathologies of the area, such as rectal ulceration, perianal infections, and chronic anal fissure (1).

They may also be associated with innervation disorders during the course of spinal degenerative changes (2), neurodegenerative diseases or iatrogenic damage, associated with surgical intervention in the area (3). Damage
Role of electromyography and functional electrical stimulation in the treatment of anorectal diseases

Motor units of pelvic floor muscles might be associated with chronic straining (lifting, previous births, perineal injuries), or pathologies disturbing blood flow in small vessels (diabetes mellitus, smoking). Denervation, similarly to long-lasting dysfunction (stomy) of a significant part of active units leads to gradual disturbances, since the remaining properly innervated muscles must deal with changes considering intraabdominal pressure and assure continence. In consequence, one may observe non-physiological compensatory mechanisms, abnormal defecation habits and muscle dyssynergia, which gradually leads to defecation disturbances, including incontinence.

Rehabilitation methods in proctology

Electromyography and EMG-biofeedback

Percutaneous electromyography is a non-invasive method determining the activity of pelvic floor muscles. The method enables to log and analyse action potentials, readable by means of rectal electrodes (fig. 1) from the neuromuscular synapse. The received signal is amplified and imaged on the screen in the form of a graph (fig. 2 and 3).

Electromyography (EMG) is a diagnostic method enabling to obtain information concerning muscular and neural activity of proper pelvic floor muscle functioning, as well as the patient’s ability to consciously control the contraction and relaxation of muscles. Basic EMG tests assess muscular functioning at rest and during activity. Therapeutic EMG enables to monitor the correctness of muscular contraction and relaxation performed by the patient (biofeedback). Using a two-channel rectal electrode and self-adhesive electrodes applied to the gluteus medius or abdominal muscles, one may mitigate their simultaneous tendency to become active during sphincter contraction. Placing the patient in the half-reclined position with the legs bent at the knees, feet laying flat on the couch with slightly spaced heels, allows maximum relaxation of examined muscles, reduced tendency of tightening of the buttocks, and possibility to monitor by the patient the functional potentials. The active participation of the patient is an important part of therapy (4).

Fig. 1. Rectal electrodes used for EMG registration (with the consent of INNOMED)

Fig. 2. EMG activity at rest - examples; A – increased tension at rest (mean value 8.1 µV), B – proper tension at rest (mean value 0.6 µV)
In case of difficulties with normal sphincter contraction one may use the ETS (Electromyographic-Triggered Stimulation) method, which combines electromyography, muscular electrostimulation, and the biofeedback method. Overcoming a certain performance threshold during conscious sphincter contraction leads to automatic stimulation, strengthening the neural circuits, and teaching proper muscular tensioning. The ETS method is also helpful in the ability to control muscular relaxation during dyssynergia therapy in patients with severe constipation during the course of puborectal muscle syndrome (fig. 4).

Electromyographic evaluation at rest and physical activity during MVC (Maximal Voluntary Contraction) brings a number of important data concerning muscular functioning, and enables not only their diagnostic evaluation but also the possibility to monitor changes observed during treatment (pharmaco-therapy, surgery, rehabilitation). EMG tests show tension values during the relaxation and contraction phases (expressed in µV-microvolts), relaxation ability after exersion (muscular adaptation to exercise), reaction time after contraction and relaxation, and MVC value (contraction stability) (4).

**Functional electrostimulation**

The concept of functional electrostimulation (FES) concerns the use of electrical impulses of low intensity and well-defined stimulation frequency of nerve and muscle structures. The role of FES is to strengthen the synaptic circuits, normalize action potentials, improve muscular vascularization, remyelination of damaged nerves and stimulation of the nervous system to trigger neuroregeneration processes (5, 6).

In patients with neurogenic pathologies of the anorectal area, transcutaneous electrical nerve stimulation (TENS), direct stimulation of sphincter muscles, and sacral nerve stimulation (SNS) using a special transcutaneous implant are applied, after a positive external stimulation test. Transcutaneous electrostimulation is most widely used, being easy and non-invasive, and will be the subject of future discussion.

Transcutaneous electrostimulation is performed using self-adhesive electrodes placed at the site of the dermatome disturbances. Direct muscular stimulation using electrodes applied to the rectum or vagina is referred to as NeuroMuscular Electrical Stimulation (NMES). Considering muscle stimulation, low-
frequency currents are primarily used, being adequate to the type of muscular fibers subject to therapy. Pelvic floor muscles are mostly type I striated fibers requiring significant vascularization (7). As a result of ongoing pathology in the connective tissue and fasciomuscular structures of the pelvic floor, one may observe restricted blood flow, and thus, trophic changes and increased number of type II fibers with a relative deficit of type I fibers. This in turn intensifies vascularization disturbances leading to future pathologies.

The reconstruction of neural structures and proper proportion of motor fibers, as well as the development of correct reflexes by means of the FES method requires time (several to a dozen months), regularity (several times a week) and patient compliance. FES therapy is long-lasting, performed by the patient at home, after a diagnostic visit and training considering the scope and therapeutic techniques. Consecutive visits take place every 1-3 months. Treatment results are monitored by means of EMG, which enable to visualize even small, subclinical changes in muscle activity.

Electromyography and functional electrostimulation in the treatment of pelvic floor muscle disorders

Stool incontinence

Loss of control considering stool continence and in consequence its incontinence may be the result of the following: morphological sphincter muscle defect, denervation of muscle structures, and disturbances in the sensory perception of the rectum and anal canal. The contribution of each of these elements is different, depending on the mechanisms of injury that may result from the following: complicated child birth, proctological procedures, extensive cancer surgery, minor pelvis radiation, non-cancer intestinal diseases, as well as neurological and systemic diseases.

Regardless the cause of stool incontinence, diagnostic electromyography, EMG-biofeedback and electrostimulation, and their combination in the form of ETS therapy, are the basis for therapeutic management. The above-mentioned are preferred in nearly 90% of patients with incontinence, and treatment results are considered as satisfactory in 85% of cases (8).

Biofeedback is the method of choice in case of sphincter muscle asthenia and disturbed rectal sensation (9). It allows not only to reduce the severity of clinical symptoms (less "sudden urge" episodes, improvement in the number of stools and incontinence episodes) (1,10), but also improves anorectal functioning parameters measured by means of manometry: systolic rectal pressure, time of contraction, ability to hold fluid contents, and anorectal coordination (11). Unfortunately, to date there are no standards considering biofeedback techniques. It is usually recommended to perform exercises 2 to 5 times a week for 10-30 minutes, usually for a period of 6-12 months.

The combination of biofeedback and electrostimulation increases its efficacy (12). Studies confirm the significantly greater reduction of stool incontinence symptoms, both considering solid and liquid contents, following therapy (15 minutes of biofeedback, 5 minutes of electrostimulation, twice a week) (13), as compared to patients subjected to biofeedback therapy only. More than 80% of patients thus treated, reported satisfactory clinical improvement, and 54% regained control of their sphincters (14).

The functional electrostimulation method is used in patients with coexisting damage in the innervation of pelvic floor structures. They mostly concern the pudendal nerve, autonomic innervation of the pelvis, or may result from central nervous system diseases. Usually, it is recommended to apply electrostimulation 1-2 times a day with the use of specially designed rehabilitation programs with variable frequency electrical impulses lasting 15-20 minutes. The duration of therapy depends on the extent of damage and lasts between several weeks and several months; often needs to be continued for several years.

Perinatal damage to pelvic floor muscles

Vaginal birth can cause damage to the continence mechanism following direct injury to the pelvic floor muscles, innervation damage, or the combination of both of the above-mentioned (15). With age, after entering menopause, one may observe additional innervation disorders often correlating with spinal degenerative changes (16), which may exacerbate incontinence symptoms many years after the
injury. Such a risk is significantly greater in patients after multiple births (17).

Pelvic floor muscle injuries occur more often in patients giving birth for the very first time, especially when the child is big or in an unfavorable position, when it is necessary to use oxytocin or in case of instrumental delivery (18, 19, 20). Some authors believe that age >35 years, family history of incontinence and episiotomy are also of significance. The latter increases the risk of incontinence by two-fold, as compared to women with perineal protection (21).

Perinatal anal sphincter damage may be evident when it comes to perineal laceration (grade III or IV), or latent, invisible and unrecognized during childbirth. The diagnosis of sphincter muscle continuity rupture requires emergency surgery, within 24 hours at the latest. After preparation, the edges of the muscles can be approached by means of the “end-to-end” or “overlap” techniques. The non-managed sphincter muscle rupture requires a protective stomy and delayed reconstructive surgery, usually after six months.

Patients with symptoms of postpartum gas/stool incontinence, both after primary ruptured muscle surgery, and those with neurogenic injuries require intensive rehabilitation. Apart from the recommended daily pelvic floor muscle exercises, randomized studies demonstrated the efficacy of EMG-biofeedback. Applied in case of patients with sphincter damage (grade III), it enables significant improvement considering incontinence symptoms and quality of life, as well as in terms of objective functional parameters evaluated by means of manometry (22) without the need to implement electrostimulation.

In the event of dominating neurogenic mechanism damage and significant sphincter muscle denervation, it seems necessary to implement functional electrostimulation. The degree and rate of improvement considering pelvic floor muscle functioning depends on proper selection of stimulation parameters and regularity of therapy. The time from injury too initiation of treatment is also important, as well as the duration of therapy. It is a mistake to use a series of short-term procedures and unjustified interruptions in therapy. A randomized, prospective study considering patients with post-delivery stool incontinence (23) showed lack of improvement after biofeedback and electrostimulation methods, after a too short, 8-week treatment period. Experience has shown that the time required to regain sphincter function ranges between a few and several months.

Sphincter insufficiency after proctological operations

Despite reports of satisfactory proctological surgery functional results amounting to almost 93% (24), a third of patients treated in specialistic centers have a history of proctological surgery (25). These are patients mostly after perianal abscess incisions, fistula and anal fissure surgery, hemorrhoid surgery, excision of condyloma and rectal tumors, as well as those after stool incontinence and rectal prolapse. Most suffer from various degrees of stool incontinence and severe constipation.

Regular and relatively long-lasting rehabilitation in these patients shows high efficiency. According to Corno et al. (25), anorectal function and significant quality of life improvement were observed in most patients (even up to 87%). Positive rehabilitation effects were observed in patients with incontinence and constipation, regardless whether previous proctological surgery comprised the anal sphincters.

Anterior resection syndrome

The growing number of patients with functional disorders of the pelvic floor after colorectal cancer surgery is associated with radical changes observed in recent decades, considering oncological management. Thanks to the possibilities of effective combined therapy, one may observe a reduction in the number of extensive abdomino-perineal operations, in favor of low anterior resections. It turns out, however, that 50-90% of patients after low resections complain of stool incontinence, chronic constipation, or other defecation disturbances (26,27), referred too as the anterior resection syndrome, significantly impairing their quality of life (28). Stool incontinence was reported by 20 to 43% of operated patients (29-32), constipation or incomplete defecation concerned 16% (30), and “sudden urge” even 45% (31) of patients. The pathophysiology of these disorders is multi-
factorial, including damage to the sphincters and their innervation, due to muscle stretching and intramuscular neural plexus damage by means of rectal instruments; loss of reservoir function, due to a small neorectum; as well as long-lasting intestinal and neorectum peristalsis disturbances.

There is no specific treatment method considering anterior resection syndrome. Management is empiric, based on therapy of stool incontinence and defecation disorder symptoms. Study meta-analysis (33) showed the effectiveness of rehabilitation in the treatment of the anterior resection syndrome, considering functional and clinical parameters, as well as the patients’ quality of life. Therapy consists in the use of biofeedback exercises and functional stimulation, especially of the sacral nerves. Biofeedback is the most widely used method.

Retrospective analysis has shown a more than 70% improvement, considering incontinence, neorectum functional parameters, as well as the quality of life (34), regardless the time elapsed from surgery to rehabilitation (35). Patients who underwent adjuvant radiotherapy significantly benefited from biofeedback therapy, as compared to those only after surgery. This is probably associated with the same negative impact of radiotherapy on pelvic floor muscle functioning.

Sphincter insufficiency after minor pelvis radiation

Radiation therapy followed by local excision of the tumor is an alternative to extensive surgery of rectal tumors. However, functional results after such sparing operations are nearly as poor as after extensive surgery (36). According to Górnicki et al. (36) gas incontinence was reported by 51%, stool incontinence by 46%, and “sudden urge” defecation by 49% of patients subjected to radiation therapy. More than one third of patients (38%) complained of significant deterioration in the patients’ quality of life during the postoperative course.

Lorenzi et al. (37) showed the direct negative effect of radiochemotherapy on the sphincter muscle and pelvic floor neural structures. Both sphincter relaxation and contraction were significantly impaired after radiation therapy. Additionally, the ability of muscular relaxation was impaired, due to the influence of chemotherapeutics (N-nitro-L-arginine, carbachol). The authors suggest that in situations when it is not possible to protect the anorectal area from radiation, patients should be subjected to neuromuscular rehabilitation by means of functional electrostimulation.

Perianal lesions during the course of non-specific inflammatory bowel diseases

In a population of patients with inflammatory bowel diseases (IBD), at least one fourth of patients present with fecal incontinence (38). According to Norton et al. (38), 74% of questioned patients complained of fecal incontinence, and only 38% sought help. This is evidence of the fact that patients are not conscious of the available therapeutic possibilities, considering treatment of pelvic floor muscle functional disorders. The problem more often concerns patients with Crohn’s disease, especially of perianal location (20-30%). The long-lasting course of the disease in conjunction with numerous surgical anorectal interventions lead to gradual sphincter damage and intensification of stool incontinence symptoms. Surgical treatment results considering perianal lesions are improved when combined with biological and immunomodulation therapy (39), significantly reducing stool incontinence symptoms.

There are few studies demonstrating rehabilitation results with the use of EMG-biofeedback and functional electrostimulation methods, considering the above-mentioned patient group. However, the efficacy of sacral nerve stimulation has been shown in patients with both sphincters damage (40).

The use of functional electrostimulation requires the consideration of perianal lesions during the course of IBD, especially that surgery as an alternative is a high risk procedure. According to Mueller et al. (41), 30% of patients with perianal lesions required stoma exteriorization procedures during the 8-year observation period. In 53% of patients stoma exteriorization was initially assumed as transient, however, in 47%, gastrointestinal continuity was eventually restored.
Outlet obstruction

Impairment of the defecation mechanism is manifested by clinically significant constipation, possibly as a result of an anatomical pathology, such as rectocele, rectal prolapse, internal rectal intussusception, or pelvic functional disturbances, including the puborectal muscle syndrome. Considering therapy of the latter group rehabilitation by means of EMG-biofeedback and functional electrostimulation plays the major role. Although surgery plays the key role in the treatment of the first group, both EMG-biofeedback and electrostimulation are inherent considering postoperative management. In the above-mentioned group one may find patients where rehabilitation is the method of choice. This is true in case of advanced rectocele and rectal prolapse in elderly patients with multiple coexisting diseases, disqualifying from surgical intervention.

During control examinations performed after 6 months biofeedback applied regularly five times a week showed elimination of dyssynergia symptoms in 91% of patients, 76% of patients reported more than three defecations per week, and 71% reported satisfaction from treatment. However, it is not as effective in case of slow transit constipation (42). According to the author's opinion, the effectiveness of biofeedback is increased by Th10-L2 segment functional electrostimulation, within the neural structures innervating the bowels, supplemented by low-frequency motor stimulation with self-adhesive electrodes applied to the abdominal integuments.

Amongst patients with chronic severe constipation during the course of outlet obstruction, 6 months of EMG-biofeedback (at least twice a week, 15 minutes) and electrostimulation therapy (5 minutes) (43) lead to improvement considering all parameters of anorectum physiology, reduced the feeling of incomplete defecation (from 72% to 29%) and difficulties with defecation (from 76% to 19%), significant reduction in the amount of drugs and rectal ingots, as well as mechanical emptying of the rectum by approximately 50%. More than 77% of patients expressed satisfaction following treatment. Privitera et al. (43) confirmed the efficacy of the biofeedback and electrostimulation methods in reducing symptoms of severe constipation during the course of outlet dysfunction, and underlined the importance of anorectal function tests in the selection of appropriate treatment.

Anorectal area functional pain

Chronic proctalgia consists in episodes of recurrent anorectal pain of functional character diagnosed in the absence of any clinical abnormalities in the area. They can be either chronic or recurrent episodes of pain located in the anal canal. They intensify after defecation and when sitting. Some authors distinguish amongst them the puborectal muscle syndrome, when symptoms are accompanied by painful muscle tension upon palpation of the puborectal muscle. There is no consensus as to the etiology and management of the above-mentioned disease entity. Therapy consists in the administration of tricyclic antidepressants, botox injections, biofeedback, electrostimulation, manual massage, and sacral nerve stimulation (44,45). Biofeedback therapy seems to be most effective (44). One may observe positive effects, especially when the pathology is accompanied by defecation mechanism disorders. Electromyography with the application of rectal electrodes often reveals the presence of increased resting tension and relaxation disturbances during exercise tests.

Conclusions

Electromyography and electrostimulation methods play an important role in the treatment of functional disorders of the anorectal area. They allow to achieve significant improvement not only in the field of clinical symptoms, but also when considering objective functional parameters and quality of life in patients with stool incontinence, severe defecation disorders, and chronic pain of the anorectal area. The above-mentioned has great potential and in case of many pathologies, proven efficacy. However, the possibilities of their application remain unused. The key element seems to consist in spreading knowledge amongst physicians and patients, keeping in mind that in order to achieve good results, one must consider time, regularity and close cooperation of the patient with the physician and rehabilitation specialist.
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