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Non-invasive Physiotherapeutic Approaches in Biliary Dyskinesia

Elena Costescu [1,2], Gabriela Calin [1,†,*], Vlad Țîrlea [2,†,*] and Mihaiela Camelia Țabrean [2]

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1 "Apollonia" University of Iași, Faculty of Medicine, Iași, România;
2 "Alexandru Ioan Cuza" University of Iași; Faculty of Physics; Iași, România

* Correspondence: Gabriela Calin, m_gabriela2004@yahoo.com;
Vlad Țîrlea, tirleavlad1@gmail.com
† These authors have equal contribution to the paper as the first author

Abstract: Biliary dyskinesia seems to be an enigmatic, idiopathic but important pathology in terms of recurrent abdominal pain in the right upper quadrant, under the right costal border, in patients who feel the symptoms despite the non-detection of gallstones or tumors. The pathology can be the result of an improper response to hormonal stimulation, hypoactivity of the nerves that innervate the gallbladder or ineffective contraction of the sphincter of Oddi. The application of a non-invasive physiotherapy treatment with interference current, aiming to stimulate the motility of the gallbladder walls, resulting in a physiological activity but also an increase in the pain threshold. Periodic evaluations of the patients' condition to determine their condition. Increasing the quality of life of affected patients. In the study undertaken, the patients were subjected to a constant treatment with interference current therapy, following both the reaction to and the recording of possible adverse effects on the treatment of the late application, which appeared after the therapy. Consistent positive results were obtained in increasing the motility of the gallbladder in the medium and long term, decreasing the dysfunctional discomfort, considerably decreasing the pain threshold level of the patients, increasing the patients' quality of life with the resumption of productive activities. The application of interference current in biliary dyskinesias reveals an increased efficiency both after the first cure and after consecutive cures consistently applied at 5-month intervals for long-term effects and removing the perspective of a possible surgical intervention. Reducing pain and disconfort, increasing the quality of life of the affected patients is a wish fulfilled in the treated patients

Keywords: biliary dyskinesia, cholecyst, sphincter of Oddi, gallbladder, biliary dysfunction, interference, non-invasive, smooth muscle

1. Introduction

The dysfunction that affects the tone and motility of the gallbladder is called biliary dyskinesia and can be caused by an inadequate response to hormonal stimulation, exercise being produced by cholecystokinin, hypoactivation of the nerves that innervate the gallbladder or ineffective muscle contraction at the sphincter of Oddi. The gall bladder is an internal organ with smooth muscles with additional liver function and location. The cholecyst is innervated by the X - pneumogastric pair of the vague nerve, which has a complex structure, being the main nerve of the parasympathetic nervous system. It is a component of the autonomic nervous system with a major role in communication between the digestive tract (stomach, liver, pancreas, gallbladder, intestines), heart, lungs, spine, reproductive organs and brain. We can imagine the vague nerve as a kind of neural highway that stretches along the entire length of the body, having essential vital functions in maintaining the body's health.

The lazy cholecystitis, similar to the lazy individual, does not reveal any visible lesion on an ultrasound or microscopic examination. But it does not have a physiological function, leading to annoying symptoms and risks of constant discomfort. The laziness of the cholecyst occurs when there is a disturbance of the activity of the own muscle cells as well as of the epithelial cells that provide the outer covering of the cholecyst from the gallbladder wall. It is also important that the exhaust channel works within physiological limits.

The main function of the gallbladder is that of a hepato-biliary reservoir storing the hepatic bile secretion. Usually, when the gallbladder contracts, the gallbladder duct (cystic duct) should relax to allow the bile to escape.

The respective coordination does not work in the case of lazy, decontractible cholecystitis. Diminished contractions of the gallbladder are frequently encountered in medical practice, more frequently in women, respecting the rule of the majority of biliary pathologies, which brings us the perspective of endocrine changes. When stimulated, in the usual way, the gallbladder contracts, producing the postprandial release of bile in the small intestine for the digestion of fats, requiring the evacuation of at least 40% of the total (a normal gallbladder removes between 35 and 65% of its contents at the time of contraction).

With food intake, biliary stimulation occurs through a hormone called cholecystokin-in and electrical impulses on the nerve endings that cause the contraction of the gallbladder with the release of its contents into the duodenum.

In certain conditions such as stress, neurodegenerative or hormonal disorders, obesity, sex and age (often in women between 30-50 years old) or biliary malformations - the function is altered, emptying more or less, eliminating less than 35% from the content, thus resulting in the so-called lazy collector. The weakening of the contraction of the gallbladder walls and the exaggerated contraction of the musculature of the cystic duct make the physiological elimination of bile from the gallbladder difficult. The contraction of the cystic duct drastically limits the access to the gallbladder of the bile produced at the hepatic level, it is discharged into the duodenum from where it is absorbed into the blood, reaching the liver again, stimulating again the elimination of the bile which thus, recirculated, concentrates wake up.

Manifestations resulting from the inadequate release of bile at the level of the cholecyst thus favor the formation of gallstones over time through the sedimentation of bile salts or the accumulation of cholesterol, thus increasing the risk of obstruction of the main bile duct. Additionally, the increase in the concentration of bile acids in the gallbladder causes its muscles to contract less, aggravating the difficulty of emptying the gallbladder.

The pathological mechanisms favoring the appearance of a decrease in the motility of the gallbladder simultaneously generate its dilation, thus increasing the risk of super-infection with enteropathogenic germs, thus resulting in the appearance of bacterial cholecystitis. The main risk factors involved in the development of the pathology can be various malformations of the gallbladder, increased resistance of the sphincter of Oddi, hepatitis A or B, hepatic steatosis, sclerosing cholangitis, possible tumor formations of the hepatic ducts, diabetes, high-fat diet, imperfect disorders or neuro-hormonal defects that activate an inadequate response to the action of cholecystokin-in, dysfunctions at the level of dopamine receptors that prevent or distort the transmission of nerve signals at the level of the gallbladder, cryoglobulinemic vasculature, abdominal trauma, acute or chronic mesenteric ischemia, intestinal salmonellosis, hormonal disorders predominantly in the case of the female sex.

Also, obesity producing a chronic inflammatory status that favors the appearance of functional biliary dyskinesia, typhoid fever or oncological irradiation performed at the abdominal level can also be some of the favorable factors for the establishment of biliary dyskinesia over time.

In addition, biliary dyskinesia can also be found in the evolving clinical picture of patients diagnosed with hypothyroidism, pancreatitis, celiac disease, duodenal ulcer, gastritis, hemolytic anemia, leukemia, acute human immunodeficiency syndrome, infectious mononucleosis, systemic lupus erythematosus or fibromyalgia. The lazy ball mainly affects the female sex, with increased frequency in people aged between 40 and 60 years. The clinical variants can be: (1) hypertonic biliary dyskinesia characterized by the hyperreactivity of the gallbladder to cholecystokinetic stimuli, (2) hypotonic dyskinesia or "lazy ball" manifested by the inefficiency of the gallbladder contraction. The incidence of biliary dyskinesia is difficult to determine and measure considering that, sometimes, the symptoms can be vague or can lead to confusion with other digestive diseases. Estimates indicate that 10-20% of the general population is affected [1].

Over time, gallbladder dyskinesias have been a controversial topic that continues even now. The disputes sweep between minimizing the problem (in Anglo-Saxon specialized literature) and overstating the problem (in French literature). The exact cause of the functional disorder of the gallbladder is not known, so that the possible causes that lead to the appearance of the pathology cannot be strictly controlled. It is believed that there is a disturbance of the motility of the gallbladder. The muscles in the wall of the gallbladder contract abnormally either as a result of an initial metabolic disorder, such as a bile supersaturated with cholesterol, which increases its viscosity, or as a result of a primary motility disorder in the absence, at least initially, of any anomalies in the composition of the ball. The functional disorder of the gall bladder was associated with gastric emptying and an abnormal intestinal transit, suggesting a possible generalized disorder of gastrointestinal motility.

From an epidemiological perspective, the functional disorder of the gallbladder is rare compared to other functional digestive disorders. Historically, studies show us [2] that this condition represents only 0.2% of all functional digestive disorders, which in turn represent approximately 35% of all digestive pathology, which is why some authors question the existence of this diagnosis. Currently, 2-5% of patients undergoing laparoscopic cholecystectomy have a functional gallbladder disorder.

Biliary dyskinesia can be divided into two categories, depending on the manifestations: hypotonic, "lazy iron", more frequently encountered, resulting in incomplete and delayed evacuation that lead over time to stasis that predisposes to biliary infections and the formation of stones. It is manifested by heaviness in the right hypochondrium, bitter taste, bloating, migraine and hypertonia, "nervous iron", which occurs when the bladder contracts often and very strongly, but the sphincter does not relax completely, in this way the bile does not evacuate properly and appears violent pain to characteristic stimuli followed by bilious diarrhea (soft, greenish stools).

Life with biliary dyskinesia affects the activity as well as the posture of the individual, giving him a vicious position of the body inducing possible kyphosis, scoliosis or their interference [3] in the long term, just as it influences the breathing process, thus affecting the vertebral statics and the quality of life. Obviously, there are non-invasive physiotherapeutic treatment options for these pathologies as well [3], but without removing the cause, it would be useless and extremely expensive in time and money.

Biliary dyskinesia is more frequent in women than in men and in people aged between 40-60 years.

From the point of view of clinical manifestations, the discomfort registered at the level of the right hypochondrium, the bitter taste, the feeling of nausea and migraine indicate biliary dyskinesia with hypotonia manifested in the form of a contraction deficit of the gallbladder [4]. The association between the presence of bilious vomiting, the feeling of nausea, bitter taste, bloating and epigastric burning accom-

panied by pain in the right hypochondrium indicates biliary dyskinesia with hypertonia manifested by the contraction of the gallbladder after the ingestion of cholecystokinetic foods.

The gastroenterologist establishes the diagnosis following the anamnesis, the clinical examination of the patient and the paraclinical investigations represented by laboratory analyses, endoscopic retrograde cholangiopancreatography (ECRP), transhepatic cholangiography, HDA radiography or cholescintigraphy, abdominal ultrasound and computer tomography (CT), cholecystokinin test [5], as the case may be.

The diagnosis of biliary dyskinesia is based on some well-defined diagnostic criteria: abdominal pain that manifests itself for more than 30 minutes at the level of the right hypochondrium that does not improve with the adoption of antalgic positions and does not go away after antacid medication or after intestinal evacuation and the absence of imaging changes specific to biliary obstruction, without the identification of gallstones or biliary sludge that would determine the appearance of the manifestations.

In the situation where the patient's clinical picture includes painful discomfort with colicative character and the imaging investigations do not detect an obstructive cause of them, the diagnostic criteria of biliary dyskinesia include: pain with an evolution of more than 30 minutes that does not go away as a result of the administration of antacid medication or when changing the position, which presents a long evolution and chronicity, intermittent symptomatology that appears at various time intervals, painful discomfort of the patient that interferes with daily activities, the manifestations are not determined by other pathologies with a similar evolution (gastric and/or duodenal ulcers, gastroesophageal reflux, liver tumor processes, gallstones, laboratory investigations show normal values of liver enzymes, bilirubin, amylase and serum lipase [6].

Usually, the first-line treatment consists of changes in the diet in order to avoid cholecystokinetic foods: fats, spices, game meat, chocolate, ice cream; of certain fruits: kiwi, figs; fresh vegetables: dark radishes, tomatoes, onions, cucumbers, dried beans, cabbage, mushrooms, eggplant; walnuts almonds hazelnuts; alcohol [7]. Symptoms that do not go away after adopting a suitable diet can be improved with the help of analgesic medication and non-steroidal anti-inflammatory drugs prescribed by the attending physician.

Biliary dyskinesia caused by the dysfunction of the sphincter of Oddi can be initially treated with medication by administering calcium blockers and later, if it does not subside, by endoscopic sphincterotomy.

Patients who show unrelieved clinical symptomatology following changes in diet and drug treatment and register an evolution that exceeds 3 months have a recommendation for surgical intervention - cholecystectomy. In the case of patients with a bile ejection fraction below 40% (determined with the help of HIDA scintigraphy) or who have acute cholecystitis due to bacterial causes, cholecystectomy is reordered, which involves the total surgical removal of the gallbladder.

However, until the surgical approach, we propose non-invasive physiotherapeutic treatment approaches aimed at electrostimulation of the gallbladder through an antero-posterior approach, thereby making more efficient the multiple ways of transmitting the electrical impulse, respectively the nerve, which acts on the tone of the smooth muscles of the gallbladder, through the application of electrodes on the anterior anatomical area corresponding to the gallbladder and posteriorly on the area related to the nerves that innervate it, imprinting its physiological motility.

2. Results

2.1. Statistical data of the study group (age, gender, environment)

Table 1. Statistical evaluation of the study group

	No.	Percentage (%)	Min/Max age (years)	MD±DS
Gender (w/m)	27 women 7 men	79.42 % 20.58 %		
Age (years)			40-60	56.76 ± 5.73
Environment (U/R)	22 urban 12 rural	64.70 % 35.30 %		

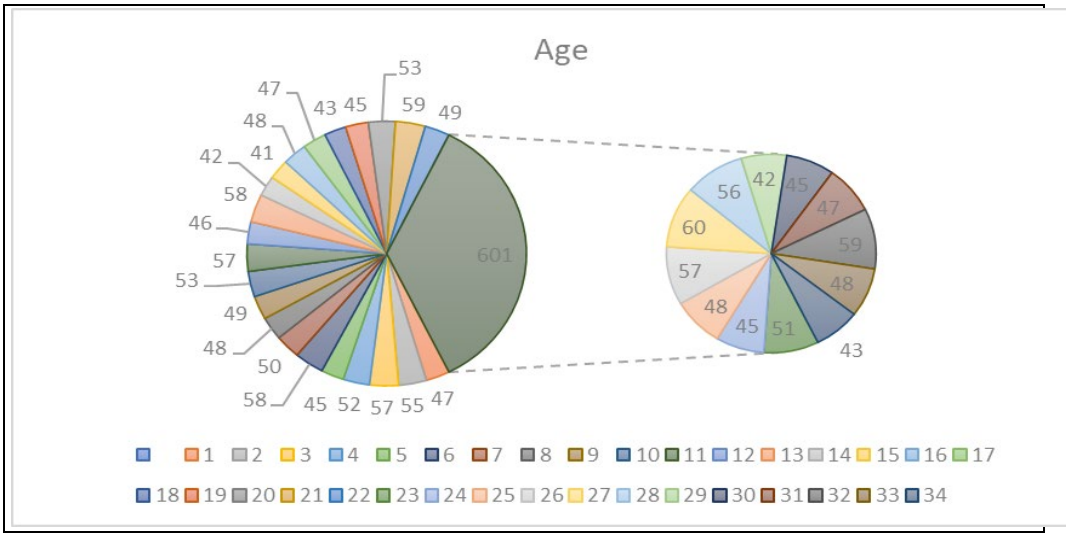

Figure 1. Age component of the studied group

2.2. Results obtained after using the treatment

In the study, optimistic results were obtained in the therapeutic approach to the pathology of biliary dyskinesia, presented graphically in the following table and images. The simple release of the patient from the discomfort felt in biliary dyskinesia is representative and relevant in the evolution of biliary dyskinetic pathology, the final result being the increase in the quality of life of these patients. At the same time, the pain threshold increases, allowing the reintegration of these patients into productive daily activities. Surgical intervention is avoided for the short, medium or long term, avoiding its inherent stress and possible complications.

Table 2. Pain/discomfort level throughout the treatment and observation period

Pacient	1 day	15 day	day 1 - day 15	40/ 45 day	day 15 - day 40/45	170/ 175 day	190/ 200 day	day 1 - day 190/200
1	7	3	-4	3	0	5	0	-7
2	8	4	-4	3	-1	4	1	-7
3	8	3	-5	2	-1	5	1	-7
4	9	4	-5	3	-1	6	0	-9
5	6	3	-3	2	-1	3	1	-5
6	8	4	-4	2	-2	3	1	-7
7	7	2	-5	2	0	4	0	-7
8	7	3	-4	2	-1	3	1	-6
9	8	4	-4	3	-1	5	1	-7
10	8	3	-5	3	0	4	1	-7
11	9	3	-6	2	-1	3	1	-8
12	7	2	-5	2	0	4	1	-6
13	9	3	-6	2	-1	5	1	-8
14	7	2	-5	1	-1	4	0	-7
15	7	1	-6	1	0	3	0	-7
16	8	2	-6	2	0	4	1	-7
17	9	4	-5	3	-1	5	1	-8
18	7	2	-5	1	-1	2	0	-7
19	7	1	-6	0	-1	2	0	-7
20	7	2	-5	1	-1	3	0	-7
21	7	2	-5	1	-1	3	1	-6
22	8	2	-6	2	0	4	2	-6
23	9	2	-7	2	0	3	1	-8
24	7	3	-4	1	-2	5	1	-6
25	7	2	-5	2	0	2	1	-6
26	8	3	-5	2	-1	2	1	-7
27	7	2	-5	2	0	3	0	-7
28	8	1	-7	1	0	3	1	-7
29	9	3	-6	2	-1	3	1	-8
30	8	2	-6	2	0	4	1	-7
31	8	3	-5	3	0	5	1	-7
32	7	2	-5	2	0	4	0	-7
33	7	1	-6	1	0	3	1	-6
34	8	2	-6	2	0	4	1	-7

Following the application of the physiotherapy treatment consisting in the antero-posterior application in the perimeter area of the right hypochondrium, respectively the right paravertebral T4 of the four electrodes specific to the interference current in the first 14 sessions, we measured and found on the 15th day of observation consistent decreases of 3 to to 7 points on the VAS scale of pain and discomfort revealed by patients undergoing quadripolar interference current treatment compared to the complaints recorded on the first day of treatment.

Thus, there were 2 patients who reported a drastic decrease in discomfort by 7 points, 10 patients who reported a significant decrease by 6 points in reported discomfort, 15 patients who reported a decrease by 5 points, another 6 patients who reported a decrease of 4 points and another patient who reported a less drastic but consistent decrease of 3 points compared to the initial value. Moreover, on days 40-45, the consistency and continuity of the evolution of the obtained results was recorded, the patients reporting relatively the same level of pain and discomfort as that reported on the 15th day of observation, with small intensifications of 1-2 points reported by 18 patients who can be registered within the margin of error of the reports. Obviously, a medium-term maintenance of the effects obtained in the applied physiotherapy treatment was recorded (Figure 2).

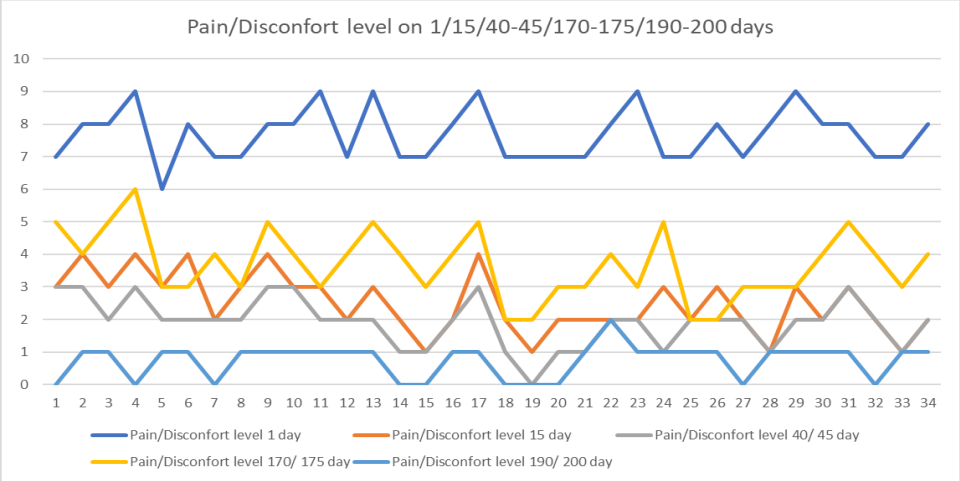

Figure 2. Pain/Disconfort level on 1/15/40-45/170-175/190-200 days

Later, after the application of the second cure, at 170-175 days with measurement on days 190-200 of the treatment and observation, an additional decrease in the discomfort of the patients included in the study was obtained, compared to day 1, the day of entering the taratement.

Finally, one patient reported a decrease of discomfort by 5 points (out of 10), 7 patients reported a decrease of 6 points in the hard-red level, 20 patients reported a decrease of 7 points (out of 10) in the level of discomfort, 5 patients reported a decrease in discomfort by 8 points and 1 patient even reported a decrease in discomfort level by 9 points out of 10. We show these data visually in Figure 2.

The drastic decrease in the level of discomfort expressed by the manifestations following the application of the treatment obviously reflects a consistent improvement in the quality of life of the patients and the resumption of the activity of the gallbladder within physiological limits, giving back to the patients the freedom to exercise their daily activities in an optimal state of health and moving away consistently in time the probability of the need for surgical intervention.

We also found the absence of adverse effects recorded both during the application of the interference current therapy and after its completion, during the entire period of the study and the application of the measurements within the studied group, both after the first course and after the second course of treatment . No incident or adverse effect was reported by any of the patients included in the study.

3. Discussion

We observe notable results obtained relevant from the significant alleviation of pain to the significant and consistent disappearance of discomfort in all patients included in the study group who received treatment with interference current. Also, we found the recording of beneficial effects in the medium and long term regarding the functioning of the gall bladder and the frequency of the occurrence of acute crises. The results obtained in this way also led to an increase in the quality of life of the patients in the study group, significantly delaying the need for surgical intervention.

We maintain that, prior to any invasive surgical approaches, it is indicated to go through types of therapeutic or conservative treatments or any other type of therapies available that offer notable, consistent, long-term results, that bring the patient to a stage of the lack of discomfort and pain (or their significant reduction), to offer them comfort in carrying out their daily activities and in their everyday life. Continuation of the treatment in similar physiotherapy courses carried out at intervals of a maximum of 5-6 months ensures the comfort of the patients, the eradication/alleviation of pain and, implicitly, the stabilization over time of the results obtained after the first course. It is obvious that the early presentation to the doctor in order to get

the correct evaluation, the detection of the correct diagnosis and the entry into regular effective non-invasive therapy is the key to success in the management of biliary dyskinesia.

4. Materials and Methods

The present research represents a longitudinal cohort study, interventional, which covered a period of 12 months. It was carried out in the Rehabilitation Department of the "Domenico" Iasi Medical Center between January 1 and December 31, 2018. It involved the initial and final evaluation, treatment and follow-up of the evolution of 34 patients, 7 men and 27 women coming from both from the rural environment (12 patients: 2 men and 10 women) as well as from the urban environment (22 patients: 5 men and 17 women) during the 12 months of the study.

The 34 patients presented themselves at the rehabilitation center with a definite diagnosis of biliary dyskinesia, with a history of the pathology limited to between 1 and 2 years. Most of them presented discomfort and pain in the area of the right hypochondrium, with or without irradiation and with indications and guidance to the surgery department in order to perform cholecystectomy.

Inclusion criteria in the study: patients who received a definite diagnosis of biliary dyskinesia, who experienced pain located in the right hypochondrium that lasted for at least 30 minutes and abdominal discomfort.

Exclusion criteria: patients diagnosed with tumors of the gallbladder or bile ducts, patients with pain manifested in the abdominal area and/or right hypochondrium without having a definite diagnosis of biliary dyskinesia, patients with an unclear diagnosis; patients with psoriasis or other dermatological pathologies with manifestations in the treatment area.

All patients received prior to the presentation or in their history approaches such as diet modification, or usual drug therapies such as calcium blockers, but after a period of administration/treatment no longer registering improvements in discomfort and immediate pain, in the short, medium or long term, the pain and discomfort reappearing within a maximum of 48 hours from the administration of the medication, so they were referred to the surgery specialty for classical or laparoscopic surgical approaches, as the case may be.

The 34 patients included in the study received physiotherapy treatment consisting of the application of two consecutive courses performed at an interval of 5 months consisting of anteroposterior applications of interference current with four electrodes in the anterior anatomical area of the gallbladder (right hypochondrium) and posterior paravertebral on the route of the nerve branches responsible for the innervation of the gallbladder T4.

The objective of the present study was to stimulate the motility of the gallbladder wall by applying the interfering current in successive courses and measuring the comfort index before (at the time of entering the study), later (at the end of the treatment, the 15th day of observation), at 40/ 45 days and then 190 days after the application of the interference current treatment.

For the applied therapy, quadripolar interfering current was used, which is recognized to have depth and increased action in the tissues. An interfering current with a medium frequency between 12-50 Hz at subliminal intensity was used to obtain a vasculotrophic and decontracting effect on the smooth muscles of the gallbladder directly and indirectly through the action on the branch that innervates it. The dorsoventral application with a right orientation positioned the interventional plane of application and stimulation in the sagittal plane, acting both directly on the walls of the gallbladder and on the nerve that through nerve impulses impresses the motility of the walls of the gallbladder. Thus, the two-way treatment was implemented, thus increasing the organ's response to the applied treatment.

Interferential current is a current obtained by crossing two medium frequency sinusoidal currents. At the place of interaction of the two currents, a current is thus generated that has the characteristics of a low-frequency current, in other words, the interference of the two mimics the effects of low-frequency stimulation. The exact frequency of the resulting interaction of the two average frequency currents can be controlled by imputing the frequencies of the input currents as we can see in Figure 3.

At frequencies between 0-10 Hz exercised for 15 sec. with a linear variable frequency, increasing and decreasing, we obtain an excitation on the motor nerves, a real muscular gymnastics with indications in the muscular hypotonias of inactivity in the post-traumatic joint pains. At the medium frequency between 12-50 Hz with the sub-liminal intensity, decontracting and vasculotrophic action is obtained on the smooth muscles as well as sympathetic inhibition and vagal stimulation, influencing the vegetative dysfunctions of the internal organs. At a spectrum modulation between 90-100 Hz-time of 15 sec. an analgesic effect is obtained. At a spectrum modulation between 0-100 Hz for 15 sec. there is a rhythmic alternation of the inhibitory effects with the excitatory effects, i.e. states of relaxation alternating with states of stimulation.

The duration of a treatment session varied between 15 and 20 minutes, the sessions being carried out daily during the first course for 12-14 days, after the first course the treatment sessions were carried out every 2-3 days for a period of 2 weeks. After a break of 4 months, the treatment cycle was resumed: 12-14 days, 1 session per day, the next 2 weeks, cures every 2-3 days. The running of the therapeutic series were customized according to the individual and his particularities.

To produce smooth muscle stimulation via the responsible nerve, the current must cross the integument, subcutaneous tissue and interposed muscles to reach its target. Astel, flow resistance intervenes, requiring the use of increased intensity to reach the desired result. But the impedance of the skin is inversely proportional to the frequency of the current [8]. Low-frequency currents (galvanic, diadynamic current with its forms, TENS, etc.) which have proven effectiveness in nerve stimulation meet a high resistance of the skin and the underlying tissues. For palpable results, a higher current intensity is needed which can cause pain at increased intensities. Conversely, high-frequency currents result in low skin resistance and pass without causing pain [9].

Interferential current therapy has been tested compared to placebo in studies examining the response to pain in healthy subjects considering the known status that interference current therapy significantly increases the pain threshold [9,10]. It has been revealed as a non-tagada therapeutic option for a number of ailments with a variety of actions including vasodilation, analgesia, sympatholytic and anti-inflammatory effects.

Unfortunately, high frequency currents do not have a notable action for nerve stimulation. Interferential current therapy aims to overcome these limits. Interferential current is produced when two medium frequency alternating currents that are slightly out of phase are crossed [10]. It is believed that this new modulated current is produced at the bisection of the two diagonally opposite currents through their interface [11]. The use of interference current in therapy has its history in 1950 when it was found that the use of an interference current exceeded or bypassed the skin impedance that was usually experienced with low frequency currents. This allowed to show the benefits of a low frequency current that allowed the development of an amplitude modulated current within the target [12,13].

It has been demonstrated that an interfering current can reach the target tissue deeper if the target tissue is located on a diagonal path between the circuits outside the electrode border [9]. Going beyond these, the interference stimulation is probably more complex in reality. Interestingly, despite the growing popularity of interference

current therapy in different clinical settings, there are few studies on its effectiveness or dispersion through tissues.

The picture becomes more complicated in the context where there are two types of interfering currents used in therapy: the so-called "true" interfering current which is generated by applying 4 electrodes placed in X and the "pre-modulated" interfering current which is generated within a device that supplies the current and transmits through only 2 electrodes [9]. As expected, the true interference current registers an increased voltage at depth, in depth, thus demonstrating its superiority in stimulation efficiency at a deeper level [9,14]. In the application of the "true" current, the orientation and location of the nerve fibers in relation to the electrodes affects whether the nerve fibers experience continuous or unmodulated, fully modulated or partially modulated stimuli [15].

Orienting the fibers along a current path results in zero modulation. The efficiency of the modulation happens in the opposition position, that is, when the fibers are oriented at the bisection point of the stimulation axes, in the context of the application on the striated muscles [12,15]. However, it is not known how the stimulation is applied to intra-abdominal structures that are currently physiologically mobile. In general, it is believed that the therapy with interference current in X, applied with 4 electrodes, produces its maximum stimulation at the intersection of the 2 currents, while the pre-modulated one acts superficially, in the immediate vicinity of the electrodes, without penetrating deeply to characteristics that would produces excitement [11]. Consequently, we will apply in the study the "true" interference current, the one applied with 4 electrodes placed in X, being the one that penetrates deep and stimulates the deep tissues.

At the same time, we must mention that it was found that a carrier frequency of 4 kHz for the two currents is more effective than 8 or 10 kHz in producing an analgesic effect in back pain, the setting being frequently used in a variety of scenarios regarding the application of therapy with interference current [11,16], at this frequency a more efficient penetration of the deep tissues is registered, simultaneously overcoming the problem of the impedance of the skin and the underlying tissues.

The mechanism of action of interference current therapy in gastro-intestinal disorders seems not to be fully understood yet [7]. It still remains to be seen whether the application of the interfering current stimulates the interstitial cells of Cajal, the stimulating cells of the intestine or the stimulation of the enteric or extrinsic autonomic nerves. However, the delay in the manifestation of the effects of its application was found, with a duration of several months after the cessation of stimulation, which leads us to think that they are determined by the alteration of neuronal function rather than by the direct cause of myogenic contractions [17]. It is already known at the postulate level that the interfering current can influence the neuroplasticity of the enteric nerves, inducing intrinsic or synaptic structural changes that influence the alteration of the neuronal function. What has definitely been revealed is the fact that motility disorders in intestinal inflammatory pathology as well as in irritable bowel syndrome are associated with neuroplasticity transformations [18].

Although evidence regarding the precise mechanism of action has not yet been detected, it was found that the interferential induces an increase in the propagation and implicit sequences of the colon's motility, thus confirming the effectiveness of its application on the smooth muscles [16]. One of the formulated hypotheses is that the interference stimulation has an effect by acting on electrically stimulated excitable cells (Cajal interstitial cells) that induce slow wave activity in the intestine affected by peristalsis or that it directly stimulates the nerves of the enteric nervous system [14]. From another perspective, the location of the electrodes in the vicinity of the spinal cord suggests the exercise of effects on it, acting on the autonomic (extrinsic) nervous system through afferent or efferent pathways. It is also possible that in stimulating applications in the case of bladder dysfunction, the sinusoidal current created by the

interferential exercise its action on the spinal cord in the T12-L1 and L2-L3 areas responsible for the innervation of the internal organs ab dominal [19].

Actions and effects on the hormonal systems that would pragmatically justify the persistence of long-term effects after the application of treatments are also considered to be possible. At the same time, the possibilities are also considered that the increased endogenous levels of gamma-aminobutyric acid and opioid agonists can also be induced by the interference stimulation that induces antispastic effects for a short period of time [20]. The revelation of this variant was considered in a case report consisting of the simultaneous administration of tramadol with the consequence of the manifestations of the effects of opioid consumption (decreased vigilance, coordinated concentration for several hours, drowsiness) for several hours after the application of the interfering current [21]. It resulted in issuing the hypothesis of stimulating the production of endorphins and/or enkephalins, being associated with the effect of tramadol. All this in the context where there are still no confirmations of these theories and a placebo response has not been excluded.

In the study, a 2-channel Physiomed IF-Expert device was used, manufactured in 2015, with an emitted power of 75 mA at 500 Ohm and a stimulation current G=25 mA at 500 Ohm, the image of which is reproduced in Figure 4.

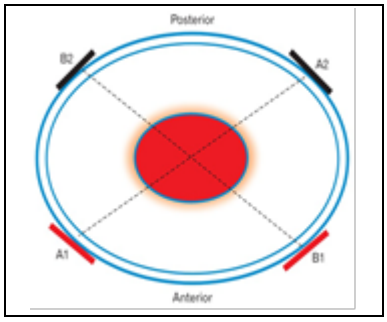

Figure 3. Electrode positioning scheme [22]

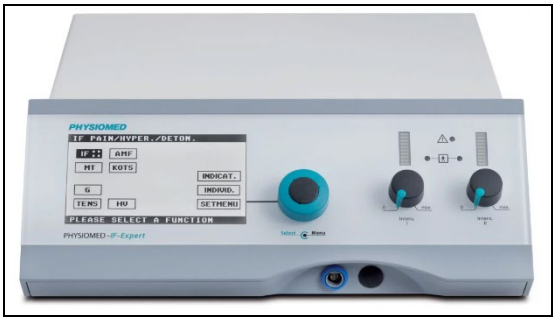

Figure 4. Physiomed IF-Expert device

This study is considered to be a pilot study in the specialty of medical rehabilitation, a preliminary check that approaches the assessment of its feasibility and the identification of possible aspects and potential problems prior to conducting a larger study on the non-invasive physiotherapy treatment that could be effectively used in the treatment of dyskinesias biliary before considering the option of undergoing a surgical intervention, the stress that the body bears during and after such an intervention is well known.

In this study, the statistical analysis was carried out by using Office Excel 2021.

An attentive investigation of the Medline/PubMed electronic database was performed for dates up to August 2024. "biliary dyskinesia", "cholecyst", "sphincter of Oddi", "gallbladder", "biliary dysfunction", "interferential", "non- invasive", "smooth muscle" were the terms used in the searches. The existing literature on the management of biliary dyskinesia addresses conservative treatments, diet modifications, drug treatments or surgical approaches, depending on the level of the patients' impairment, the authors' field of activity (general medicine, internal medicine or surgery). Weak mentions to cover the difference between diet, drug treatment and surgery, methods found at antipodes.

Thus, a study by Blaut et al. published in 2003 mentions the effects of transcutaneous nerve stimulation on intraductal pressure in post-cholecystectomy patients with T drainage [23]. The results reveal that the application of TENS reduced the basal IDP (internally displaced person) in all patients included in the study with an

average of 3.95 +/- 1.6 mmHg. In 13 patients a further decrease in IDP was observed 15 minutes after the cessation of TENS. In session 2, morphine administration produced an obvious increase in IDP in all subjects by 6.9 +/- 2.7 mmHg. TENS decreased IDP in 13 patients. In session 3, after administration of a test meal, IDP decreased within 30-40 minutes by an average of 4.89 +/- 1.29 mmHg. The conclusions reveal that TENS decreased basal and IDP in most patients with T drainage studied, but also the fact that the effect of TENS persisted after the cessation of its application. It is predicted that the increased IDP is responsible for the pain perceived by patients with sphincter of Oddi dysfunction (SOD), as a result it launches the vision according to which TENS can be used effectively and safely as an optional therapeutic method in the state of biliary dyskinesia.

Carrington et al. [24] published a study in 2014 showing that sacral nerve stimulation is provided through a percutaneous transforaminal approach by applying electric current directly to the sacral nerve roots known to control the pelvic viscera.

In another study, Jarett et al. reveals the fact that fecal incontinence episodes are reduced by stimulating the sacral nerve, thus improving the quality of life of affected patients [25].

Another study by Moore et al. and published in January 2018 [6] reveals the application of interferential current in symptoms of constipation and fecal incontinence and shows us in the conclusions that "There is speculative evidence that interferential current therapy is a viable alternative in reducing symptoms of constipation and fecal - horse incontinence." The study finds that the preliminary data on children are encouraging, but that more studies are needed for adults, especially placebo-controlled studies. And in the end it states that, despite all this, interference stimulation is an attractive therapy for chronic gastrointestinal disorders because it seems effective, has a relatively low cost, is a non-invasive and non-pharmacological intervention.

Other non-invasive neuromodulatory techniques have been explored, such as stimulation of the pudendal nerve [26], stimulation of the posterior tibial nerve [27,28] and magnetic stimulation of the sacral nerves [29].

At the same time, we can also consider studies that address treatments with mineral waters in biliary dyskinesia: Munteanu et al. presents mineral water springs (Spring 1 and Spring 1 bis) located in the balneo-climatic resort Slanic Moldova in Romania, among the indications of which is mentioned "They can enhance digestive function and alleviate symptoms of biliary dyskinesia and chronic cholecystitis"[30,31]. Multidisciplinary therapeutic approaches in biliary dyskinesia are successful options, either through the application and simultaneous action of multiple procedures, or through alternating approaches, thus avoiding accommodation and laziness of the targeted organ.

Electropuncture could also be approached from the perspective of its action on the nerve path of the vagus nerve plexus (plexus hepaticus, truncus sympathicus, n. Vagi) responsible for innervating the gallbladder, choosing from the electropuncture device either to stimulate its motility (in the case of the gallbladder hypotone), or by sedating its activity (in the case of hypertonic cholecyst), thus acting either by increasing or decreasing the intensity and frequency of nerve/electrical impulse transmission to the cholecyst similar to electropuncture treatment on other internal organs [32].

The mentioned studies concluded that interference current therapy can be considered a safe and effective way of treatment in the management of digestive dysfunctions which are caused by the slow motility of internal organs with smooth muscles in the long term, having delayed effects, without any recorded effects secondaries worth considering.

5. Conclusions

Patients with biliary dyskinesia who are on the verge of undergoing a cholecystectomy surgical intervention can opt, prior to the surgical intervention, for the stimulation of the gallbladder motility in physiotherapy courses consisting of the application of a quadripolar interference current, thus obtaining a stimulation of the gallbladder motility which will thus fulfill its function of bile production. In this way, surgical intervention is removed or even avoided, thus obtaining an increase in the patient's quality of life from two perspectives: the resumption of cholecyst activity in conditions as close to physiological as possible and the avoidance of surgical intervention. The earliest possible presentation to the doctor, the adaptive modification of the diet and the performance of physiotherapy treatments with the objective of increasing the motility of the gallbladder through the application of interferential current represent the successful bridge to avoid the surgical intervention of cholecystectomy. The present study opens options for the application of simple but effective treatments as well as the opening of research and study paths for finding out new treatment options or improving the existing ones in order to increase the quality of life of patients affected by biliary dyskinesia but also to reduce the significance of the health system expenses recorded with the treatment of these types of pathologies that affect the quality of life of patients.

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