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ELECTROMYOGRAPHIC FEATURES OF THE PERINEUM AND PELVIC FLOOR IN PATIENTS WITH AN ARTIFICIAL BLADDER

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Ключевые слова: *артифициальный мочевой пузырь, электромиография, промежность, тазовое дно, рак мочевого пузыря*

Abstract. Electromyographic features of the perineum and pelvic floor in patients with an artificial bladder. Savchuk R.V., Kostyev F.I., Golovko S.V., Dekhtiar Y.M., Zalyva K.A. *Aim – to assess the electromyographic features of the pelvic floor muscles and the sphincter apparatus in patients who underwent radical cystprostatectomy with the formation of an artificial bladder.The main study group consisted of 57 patients with muscle invasive bladder cancer who underwent a standard radical cystprostatectomy with ileocystoplasty. The study of the pelvic floor muscular bioelectric activity with computed electromyography (EMG) of the sphincter apparatus of the pelvic organs was carried out on a 2-channel computer electromyograph "NeuroTrac ™ MyoPlus4". The obtained results of the study of the bioelectric activity of the pelvic floor muscles showed a decrease in the amplitude of contractions in the Work Average mode by 42.1% ($p \leq 0.001$) for the perineal electrode, and by 35.7% ($p \leq 0.05$) for the rectal electrode, compared with the control group, which indicates a low contractility of the muscular diaphragm of the pelvis and may cause incontinence in patients with an artificial bladder. The average deviation over the entire duration of the session in Work mode in the group of patients with neobladder in channels A and B was 2.3 ($p \leq 0.05$) and 1.9 ($p \leq 0.05$) times higher, respectively, compared with control group. These data indicate an imbalance in the muscle tone of the pelvic floor in patients after extensive reconstructive intervention on the pelvic organs and can potentiate urodynamic disorders in the study group of patients. The average amplitude (Rest Average) of the activity of biopotentials in the resting state of the pelvic floor muscles along channels A and B is higher by 42.4% and 47.6% ($p \leq 0.05$), in comparison with the control group, which indicates insufficient relaxation and rest of striated muscles and sphincter. Despite the change in bioelectric potentials from the rectal electrode in the study group of patients, there were no signs of functional insufficiency of the anal sphincter, in contrast to the severity of urinary incontinence, which correlated and corresponded to the results of bioelectrical changes obtained through channels A and B, up to oscillations and loss of complete control. The EMG analysis of the pelvic floor muscles revealed characteristic changes in the biopotentials of the pelvic sphincters and indicated their relationship with the clinical features of the rehabilitation of this group of patients and the prospect of including the biofeedback method. It is a derivative form of the electromyographic signal in the treatment of incontinence in patients with neobladder.*

Реферат. Електроміографічні особливості промежини й тазового дна в пацієнтів з артифіційним сечовим міхуром. Савчук Р.В., Костєв Ф.І., Головко С.В., Дехтяр Ю.М., Залива К.А. *Метою роботи було провести аналіз електроміографічних особливостей м'язів тазового дна і сфінктерного апарату в пацієнтів, які перенесли радикальну цистпростатектомію з формуванням артифіційного сечового міхура. Основну групу дослідження склали 57 пацієнтів з інвазивним раком сечового міхура, яким була проведена стандартна радикальна цистпростатектомія з формуванням артифіційного сечового міхура. Вивчення біоелектричної активності м'язової системи тазового дна шляхом комп'ютерної електроміографії (ЕМГ) сфінктерного апарату тазових органів було виконано на двоканальному комп'ютерному електроміографі "NeuroTrac™ MyoPlus4". Отримані результати дослідження біоелектричної активності м'язів тазового дна*

продемонстрували зниження амплітуди скорочень у режимі Work Average по промежинному електроду на 42,1% (p≤0,001), а по ректальному електроду – на 35,7% (p≤0,05) порівняно з групою контролю, що свідчить про низьку скорочувальну здатність м'язової діафрагми таза і може спричиняти інконтиненцію в пацієнтів з артифіційним сечовим міхуром. Середнє відхилення за всю тривалість сесії в режимі Work у групі пацієнтів з необладером по каналах А і В було вище в 2,3 (p≤0,05) і 1,9 (p≤0,05) раза відповідно порівняно з групою контролю. Ці дані свідчать про незбалансованість м'язового тонусу тазового дна в пацієнтів після значного реконструктивного втручання на органах малого таза, що може потенціювати уродинамічні порушення в досліджуваної групи пацієнтів. Середня амплітуда (Rest Average) активності біопотенціалів у стані спокою м'язів тазового дна по каналах А і В вище на 42,4 і 47,6% (p≤0,05) порівняно з групою контролю, що свідчить про недостатнє розслаблення і спокій поперечносмугастих м'язів і сфінктера. Незважаючи на зміну біоелектричних потенціалів з ректального електрода, у досліджуваній групі пацієнтів ознак функціональної недостатності анального сфінктера виявлено не було, на відміну від ступеня вираженості нетримання сечі, що корелювалося і відповідало результатам біоелектричних змін, отриманих по каналах А і В, аж до осциляцій і втрати повного контролю. Аналіз ЕМГ м'язів тазового дна дозволив виявити характерні зміни в показниках біопотенціалів тазових сфінктерів і вказав на їхній взаємозв'язок з клінічними особливостями реабілітації цієї групи пацієнтів і перспективність включення до комплексу лікування інконтиненції в пацієнтів з неоцистом методу біологічного зворотного зв'язку, що є похідною формою електроміографічного сигналу.

Bladder cancer is an unsolved clinical, social and economic problem [5]. The two main forms that differ in the volume of required surgical intervention are non-muscle invasive and muscle invasive bladder cancer. The main method of treatment of muscle-invasive forms of bladder cancer is radical cystectomy with various types of urine diversion [10]. Patients prefer orthotopic urine derivation with formation of artificial bladder (AB) compared to other types of urine derivation due to better quality of life [2]. The formation of an artificial bladder from the terminal ileum allows patients to maintain physiological urination. However, the large volume of surgical intervention on the pelvic organs, often leadsing to frequent complications in the form of daytime and nighttime urinary incontinence and erectile dysfunction [9]. Urinary incontinence after orthotopic ileocystoplasty is one of the main complications. Loss of urination control may be a physical, emotional, psychosocial and economic burden for men [6]. The main mechanism responsible for urinary retention after radical surgery on the bladder and prostate gland are striated sphincter of the bladder and pelvic floor muscles [3].

Changes in the integrity, innervation, blood supply of the rhabdosphincter and the pelvic diaphragm are one of the main causes of urinary incontinence in patients who underwent removal of the bladder with the prostate gland during postoperative period [7].

The bioelectrical activity of muscles can be assessed as a representation of muscle function [8]. The study of the bioelectrical activity of the pelvic floor muscles and sphincters will expand the understanding of neurogenic disorders of innervation and possible ways to correct them, which prompted our interest.

Aim – to assess the electromyographic features of the pelvic floor muscles and the sphincter apparatus in patients who underwent radical cystprostatectomy with the formation of an artificial bladder.

MATERIALS AND METHODS OF RESEARCH

The main study group consisted of 57 patients with muscle invasive bladder cancer who underwent a standard radical cystprostatectomy with ileocystoplasty in several specialized centers. Surgical intervention was performed according to the standard technique with mobilization and extirpation of the bladder and prostate gland, lymph node dissection, mobilization and disconnection of the ileal area, formation of an ileoconduitis and several anastomoses [10].

The patients' age ranged from 38 to 75 years on average – (69.5±8.5). All patients were males. The study was performed in postoperative period from 6 to 12 months after surgery. The control group were healthy men comparable in age.

The examination of all patients was in accordance with the ethical principles of conducting scientific medical research with human participation, which are defined in the declaration of the Helsinki World Medical Association (1964-2000). Voluntary written informed consent to participate in the study was required for all patients.

The electromyography method is based on the registration and analysis of biopotential difference oscillation of the neuromuscular structures, which characterizes the function of the organ and gives a clear idea of muscle tone, their contractile activity, as well as the integral state of reflex regulation. The study of the pelvic floor muscular bioelectric activity with computed electromyography (EMG) of the sphincter apparatus of the pelvic organs was carried out on a 2-channel computer electromyograph "NeuroTrac ™ MyoPlus4".

Surface electromyography is considered an acceptable tool for assessing the pelvic floor muscles contractions in real time, and functional assessment by identifying the action potential of the motor unit of myocytes [8].

The EMG in the Work/Rest Assessment mode performed in patients with an artificial bladder, will reveal the characteristic changes in the biopotentials of the pelvic sphincters and show their relationship with the clinical features of urinary incontinence in this group of patients. The principle of device operation is in a disposable cutaneous electrode using, fixed on the skin of the perineum (A – channel) and one rectal electrode (B – channel) for electromyography. The electrical activity of the pelvic floor muscles and the sphincter apparatus was measured for 5 minutes. Sessions were performed in the mode of 5 seconds contraction of the pelvic muscles (Work Assessment) and 5 seconds of relaxation (Rest Assessment) laying in the supine position with rectal and cutaneous sensors.

Data processing was carried out according to the following indicators: Work Average – the total average achieved during all periods of work for the entire duration of the session (in microvolts, μV); Rest Average is the total average rest during the entire session (in microvolts, μV); Onset Average is average time (in seconds) required to reach 75% of the work average value of all segments of the session; Release Average is the average time (in seconds) of relaxation below 37.5% of the work average value for all segments of the session; Work Average deviation is the average deviation (in microvolts or percent) of the work period for the entire duration of the session, except for the first second of each part of the work; Rest Average deviation is average deviation (in microvolts or percent) for rest periods of the entire session, excluding the first second of each rest part; Average peak/minimum value is the maximum/minimum value of muscle activity per session (in microvolts, μV).

Statistical analysis of the results was carried out using additional methods of descriptive and variable statistics based on the student's test criteria. The calculation of the results was received on a personal computer with licensed programs Statistica for Windows and Microsoft Excel 7.0. The start of the test was significant at $p<0.05$ [1].

RESULTS AND DISCUSSION

Registration and analysis of oscillations in the biopotential difference of the neuromuscular structure, characterizing the function of the pelvic floor and giving a clear idea of muscle tone, their contractile activity, as well as the integral state of reflex regulation in the Work mode is presented in table. The average amplitude for the entire duration of the session (Work Average) for each electrode was 33.8±2.4 μV, ($p\leq0.001$), which is statistically significant and lower by 42.1%, the amplitude in the control group of patients was 58.4±5, 2 μV. The average deviation over the entire duration of the session in the Work mode (Average deviation) in the group of patients with neobladder in channel A was 13.4±0.3% ($p\leq0.05$). This is 2.3 times more than in the control group 6.2±0.4%. The maximum value of the Peak value in the study group for channel A was 61.7±5.9 μV ($p\leq0.001$), which is statistically significant and 41.8% lower than the control group 106±9.7 μV. The average time (Onset Average) required to reach 75% of the Work Average value of all segments of the session in the group of patients with an artificial bladder according to the results of the perineal electrode was 0.8±0.1 sec., ($P\geq0.05$). It is statistically unreliable in the control group 0.8±0.1 sec.

Results of the perineum and pelvic floor EMG in patients in Work mode

EMG indicators in Work mode	Patients with neobladder (n=36)		Control group (n=18)	
	chanel A M±m	chanel B M±m	chanel A M±m	chanel B M±m
Average [μV]	33,8±2,4*	63,2±4,1*	58,4±5,2	98,4±8,03
Average deviation [%]	13,4±0,3*	15,9±0,7*	6,2±0,4	8,5±1,3
Peak value [μV]	61,7±5,9*	101,5±7,5*	106±9,7	183±16,5
Onset Average [sec]	0,8±0,1	0,7±0,2	0,8±0,1	1,1±0,2

Notes: * – the differences between the indicators are significant $p\leq0.05$; cutaneous perineal electrode – channel A; cavity rectal electrode – channel B.

The results obtained using the rectal electrode B in the Work mode in patients with orthotopic ileocystoplasty fixing the biopotentials of the sphincter and deep muscles of the pelvic diaphragm are presented in Table. The amplitude for the entire duration of the session (Work Average) according to

the rectal electrode was 63.2±4.1 μV (p≤0.001). It is statistically significant and 35.7% lower than the amplitude recorded in the control group of patients (98.4±8.03 μV). The average deviation in the study group according to electrode B was 15.9±0.7 μV (p≤0.001), which is 1.9 times higher than in the healthy group (8.5±1.3 μV).

The peak value of the amplitude in the group of patients with neobladder on channel B was 101.5±7.5 μV (p≤0.001), which is statistically significant and 44.5% lower than in the control group 183±16.5 μV. The average time (Onset Average) for channel B was 0.7±0.2 seconds, which is statistically insignificant in comparison with the control group (1.1±0.2 seconds).

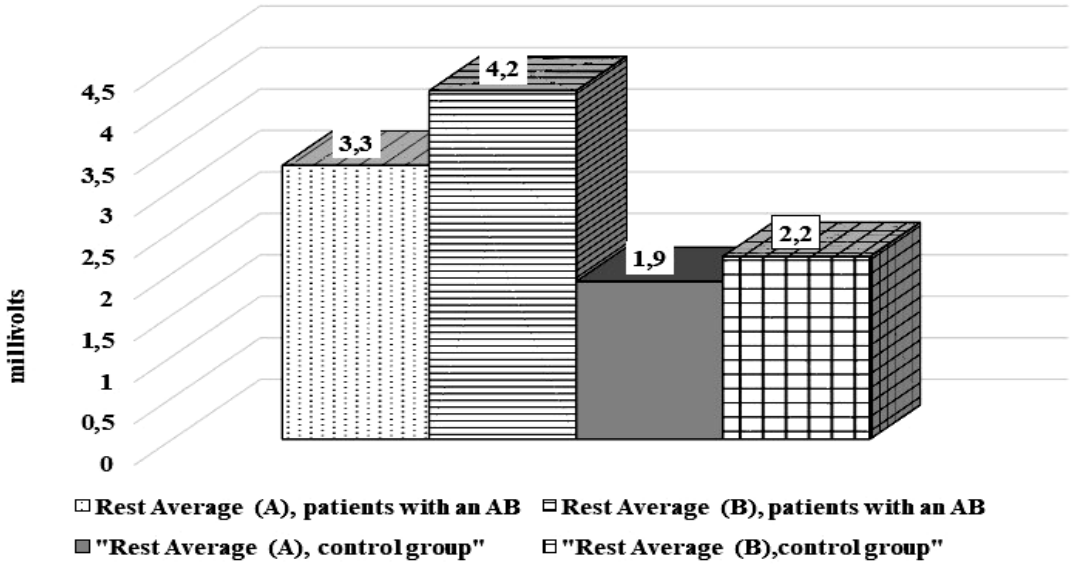

Fig. 1. Average amplitude for the entire duration of the session (Rest Average)

The results characterizing the average amplitude (Rest Average) of the activity of the biopotentials of the muscles of the perineum and pelvic floor at rest are shown in Fig. 1. The average amplitude at rest was 3.3±0.27 μV (p≤0.05), according to the data of channel A, in patients with an artificial bladder. It is significantly higher and 42.4% higher than in the control group (1.9±0.3 μV). The results of channel B showed the level of the average amplitude (Rest Average) at the level of 4.2±0.32 μV, which is 47.6% higher than in the healthy group (2.2±0.63 μV).

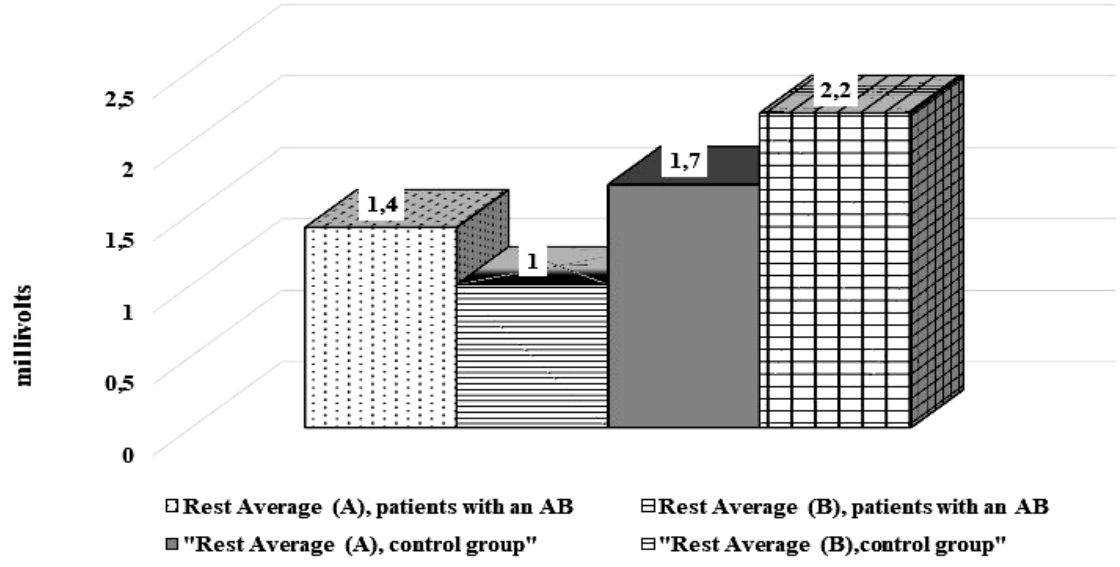

Fig. 2. Average deviation for the rest period of the entire session (Rest Average deviation)

The results of the average deviation for the rest period of the entire session (Rest Average deviation) along channel A are shown in Fig. 2. It was 1.4±0.82 μV (p≥0.05) in patients with a neobladder. It does not statistically differ from corresponding results of the control group (1.7±0.91 μV). Indicators (Rest Average deviation) for channel B were slightly higher, and amounted to 1.00±0.45 μV (p≤0.05) in the study group. It is significantly (by 54.6%) lower than in the control group (2.2±0.51 μV).

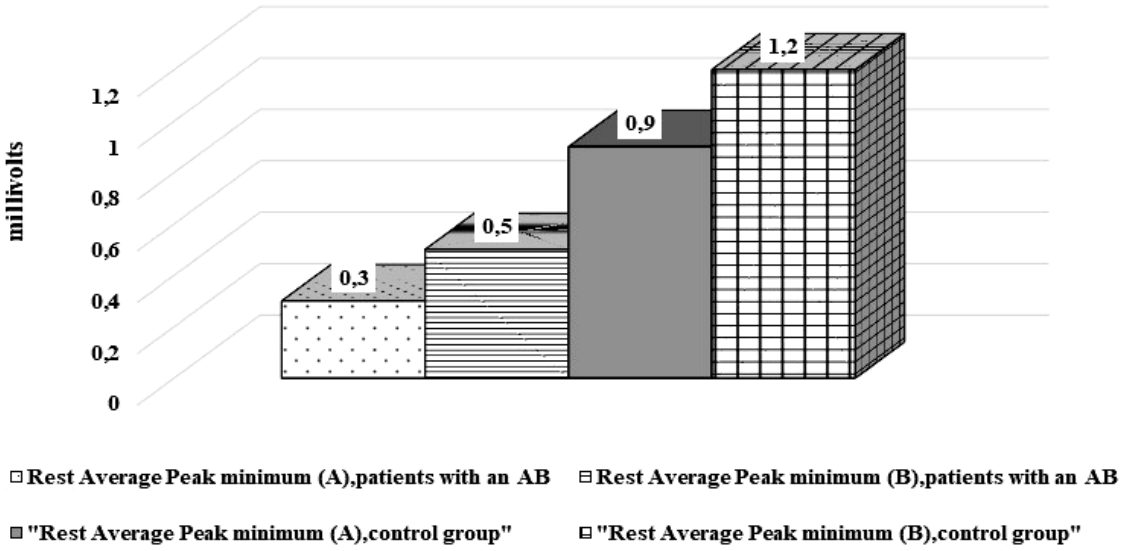

Fig. 3. Minimum muscle activity per session (Rest Average Peak minimum, μV)

The results of the minimum muscle activity (Peak minimum) for the session are shown in Fig. 3.

Thus, the Peak minimum for the skin electrode in patients with neobladder was 0.3±0.02 μV (p≤0.001). It is 3 times lower than in the control group, 1.2±0.09 μV. Channel B showed higher biopotential values, so in the group of patients with artificial bladder they were 0.5±0.04 μV (p≤0.001). It is 2.4 times lower than in the control group (1.2±0.09 μV).

Average release time for channel A in patients with neobladder was 0.41±0.02 sec. (p≥0.05). It is not statistically different from the volunteers (0.29±0.01 sec). The results from the rectal electrode also demonstrated the lack of statistical significance in the comparison groups and amounted to 1.0±0.06 sec in the group with neobladder. (p≥0.05), and in the control group – 1.3±0.01 sec.

CONCLUSIONS

1. The obtained results of the study of the bioelectric activity of the pelvic floor muscles showed a decrease in the amplitude of contractions in the Work Average mode by 42.1% (p≤0.001) for the perineal electrode, and by 35.7% (p≤0.05) for the rectal electrode, compared with the control group, which indicates a low contractility of the muscular diaphragm of the pelvis and may cause incontinence in patients with an artificial bladder.

2. The average deviation over the entire duration of the session in Work mode in the group of patients with neobladder in channels A and B was 2.3 (p≤0.05) and 1.9 (p≤0.05) times higher, respectively, compared with control group. These data indicate an imbalance in the muscle tone of the pelvic floor in patients after extensive reconstructive intervention on the pelvic organs and can potentiate urodynamic disorders in the study group of patients.

3. The average amplitude (Rest Average) of the activity of biopotentials in the resting state of the pelvic floor muscles along channels A and B is higher by 42.4% and 47.6% (p≤0.05), in comparison with the control group, which indicates insufficient relaxation and rest of striated muscles and sphincter.

4. Despite the change in bioelectric potentials from the rectal electrode in the study group of patients, there were no signs of functional insufficiency of the anal sphincter, in contrast to the severity of urinary incontinence, which correlated and corresponded to the results of bioelectrical changes obtained through channels A and B, up to oscillations and loss of complete control.

5. The EMG analysis of the pelvic floor muscles revealed characteristic changes in the biopotentials of the pelvic sphincters and indicated their relationship with the clinical features of the rehabilitation of

this group of patients and the prospect of including the biofeedback method. It is a derivative form of the electromyographic signal, in the treatment of incontinence in patients with neobladder.

6. It is advisable to create pelvic rehabilitation centers with the possibility of surgical correction of severe forms of incontinence to assess and improve the quality of life of patients with urinary incontinence after volumetric reconstructive interventions on the pelvic organs.

Conflict of interests. The authors declare no conflict of interest.

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