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Regarding the assessment of the influence of thoracic spine manual therapy on the women 's cardiovascular system in the course of sanatorium treatment

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Abstract

Purpose: The purpose of this study was to evaluate the reaction of the cardiovascular system of women to manual therapy procedures on the chest during the course of sanatorium-resort treatment of osteochondrosis of the spine.

Material and methods

Under supervision were 29 women aged 37.8 (31.3; 45.8) years who underwent a course of sanatorium-resort treatment for osteochondrosis of the thoracic spine in the clinical sanatorium named after V.P. Chkalov (Odesa, Ukraine) in 2010-2011. The treatment complex included of 4 thoracic spine manual therapy (TSMT) procedures, which were performed every 5-7 days of sanatorium-resort treatment. The indicators of the cardiovascular system were recorded using the Omron M1 Classic device (Japan) in a supine position before and after every procedure TSMT.

Results

In general, the same type of significant changes is noted for most of the hemodynamic indicators under the influence of TSMT procedures. This applies to parameters DBP (mmHg), which increase, HR (min^{-1}), which decrease, and integral indicators – Double product (cu.) and Index Kerdo (cu.), which also decrease. Changes in MBP (mmHg) and PBP (mmHg) are not always significant.

Taking into account distribution of types Δ Double product and Δ Kerdo`s Index, it can be stated that the optimal reaction to the TSMT procedure was observed most often after the 2nd procedure - in 62.1% of patients for heart`s contractile function and in 65.5% for autonomic regulation of hemodynamics. It is also informative that from procedure to procedure the number of

cases falling into the extreme limits of the distribution and being assigned to excessively pronounced and inadequate types of response significantly decreases. According to the indicator Δ Double product their number from the first to the fourth procedure decreases from 17.2% to 3.4%, and according to the indicator Δ Kerdo`s Index from 17.2% to 6.8%.

Conclusions.

Determination of changes in indicators of the cardiovascular system activity under the influence of the thoracic spine manual therapy procedure made it possible to characterize the types of reactions of the cardiovascular system.

Keywords: thoracic spine manual therapy; cardiovascular system; Double product; Kerdo`s Index; types of reactions

Introduction.

Incorrect posture, changes in the biomechanics of movements, hypodynamia are the reasons for the appearance of structural changes in the spine and pain (Briggs et al., 2009; Kalmykova, 2024). The influence of physical and psychosocial factors at work and at home, emotional problems, uncomfortable working posture, use of smartphones, tablets and poor working conditions can be the causes of pain and incorrect position of the spine (Cagnie et al., 2007). It can also lead to various dysfunctions in the musculoskeletal system, the activity of the cardiovascular and respiratory systems, which affect the functional state of the patient and his quality of life (Araujo et al., 2019; Romanchuk & Hanitkevych, 2022c). A significant number of publications have appeared that testify to the negative impact of spinal disorders on the human endocrine and immune system (Haas et al., 2024; Chow et al., 2021; Kalmykova et al., 2024).

According to a number of authors, the lumbar and cervical regions of the spine are most often affected, the manifestations of which damage significantly limit people's ability to work, and pain and limitation of mobility in them are the most frequent complaints when seeking help (Audette et al., 2010; Bialosky et al., 2009). The largest number of scientific publications on the treatment and rehabilitation of spinal injuries is devoted to these problems (Beyer et al., 2022; Núñez-Cortés et al., 2021). This also applies to the provision of help in the form of various types of manual therapy, which is one of the main methods of treatment and rehabilitation of this category of patients (Locher et al., 2022; Heneghan & Rushton, 2016).

On the other hand, epidemiological data on pain in the thoracic spine among the population is extremely limited. Thus, a study of the Norwegian population showed a one-year prevalence of thoracic spine pain of 13% compared with 43% and 44%

for low back pain and neck pain, respectively (Leboeuf-Yde et al., 2009). Another study showed that the lifetime prevalence of thoracic spine pain ranges from 3.7 to 77% (Briggs et al., 2009), while most often in teenagers and elderly women. Scientists also investigated the combination of cases of thoracic spine pain with neck and/or low back pain, reporting an association of 40.7% in men and 36% in women. This is comparable to isolated thoracic spine pain, which was 18.7% in men and 16% in women (Roquelaure et al., 2014).

As a rule, indications for the use of manual therapy of the thoracic spine (TSMT) are the appearance of thoracoalgia (Pecos-Martín et al., 2017; Briggs et al., 2009), neck pain (Fernandez et al., 2020; Joshi et al., 2019; Kim et al., 2021; Cagney et al., 2007; Cleland et al., 2007), shoulders pain (Walser et al., 2009; Muth et al., 2012; Huisman et al., 2013; Casanova-Mendez et al., 2014; Salom-Moreno et al., 2014), adhesive capsulitis (Edmondston et al., 2012; Page et al., 2014) and persistent subclinical dysfunctions or chronic pain in other areas of the upper (Berglund et al., 2008; Walser et al., 2009; Funabashi et al., 2021) limbs.

The interest of clinicians in TSMT has increased significantly in recent years, especially with the emergence of evidence demonstrating significant effects on the function of the cardiovascular, respiratory, autonomic nervous, endocrine, and immune systems (Amatuzzi et al., 2021; Araujo et al., 2019; Gera et al., 2020; Hinkeldey et al., 2020; Haas et al., 2024; Chow et al., 2021; Kovanur Sampath et al., 2021; 2024a; 2024b; Stępnik et al., 2024). The results of using TSMT in diseases of the respiratory system are convincing (Engel et al., 2013; Leonés-Macías et al., 2018; Simonelli et al., 2019), disorders of the respiratory system`s functional state (Fernández-López et al., 2021; Romanchuk & Hanitkevych, 2022c). The results of the meta-analysis (Gera et al., 2020;) showed that mobilization and manipulation techniques significantly reduce systolic and diastolic blood pressure, but the decrease in heart rate is not significant. However, these effects are not unambiguous and depend on the localization of the techniques, their intensity and the existing changes in the thoracic spine (Goertz et al., 2016; Sillevis et al., 2010). From this point of view, the results obtained during the study of practically healthy persons and persons with hypertension, which indicated significant differences in reactions to the manual therapy procedure (Ward et al., 2013; 2015). The results of the study of the effects of TSMT on heart rate variability are not entirely clear-cut (Liem et al., 2024; Roura et al., 2021; Rechberger et al.,

2019). In our opinion, this may be related to the not always clear localization of the influence aimed at a specific segment, and individual features of the distribution of sympathetic fibers during the formation of the sympathetic trunk (Haas et al., 2024; Minarini et al., 2018; Henderson et al., 2010).

In general, the problem of assessing the impact of TSMT on the cardiovascular system`s functional state is still insufficiently studied.

The purpose of this study was to evaluate the reaction of the cardiovascular system of women to manual therapy procedures on the chest during the course of sanatorium-resort treatment of osteochondrosis of the spine.

Research materials and methods.

Participants

Under supervision were 29 women aged 37.8 (31.3; 45.8) years who underwent a course of sanatorium-resort treatment for osteochondrosis of the thoracic spine in the clinical sanatorium named after V.P. Chkalov (Odesa, Ukraine) in 2010-2011.

Methods the research was conducted in a manual therapy office of the clinical sanatorium named after V.P. Chkalov (Odesa, Ukraine). In the course of sanatorium-resort treatment, which lasted 21-24 days, treatment was carried out, which included the use of a number of physiotherapeutic and balneological procedures, as prescribed by a medical rehabilitation doctor on the basis of clinical history and examination. The treatment complex included 4 TSMT procedures, which were performed every 5-7 days of sanatorium-resort treatment.

Procedure:

The TSMT procedure included the following:

- ✓ mobilization of the thoracic spine
- ✓ manipulation techniques on the thoracic spine in the position of lying on the back and on the stomach (at the level of T_{1-6}; T_{8-10})

The duration of the procedure was 15-20 minutes

After the preliminary medical examination, the patients were in the supine position for at least 5 minutes. Then, in the supine position, the indicators of the cardiovascular system were recorded using the Omron M1 Classic device (Japan). The TSMT procedure was carried out, after which the patient was in a supine position for 5 minutes, at the end of which repeated registration of indicators of the cardiovascular system was carried out.

Inclusion/exclusion criteria

Inclusion criteria:

- ➢ the presence of signs of osteochondrosis of the thoracic spine on radiographs;
- ➢ of subluxations on radiographs intervertebral joints in the thoracic spine;

- periodic localized pain in the thoracic spine at rest or during movements;
- the presence of periodic disturbances of sensitivity in the upper limbs;
- periodic pain in the cervical spine.
- absence of contraindications to TSMT (unstable fractures, severe osteoporosis, multiple myeloma, osteomyelitis, ankylosing spondylitis in the inflammatory phase, spinal cord tumor, Paget's disease and similar conditions);
- availability of informed written consent.

Exclusion criteria:

- operations on the spine in the last year;
- fractures of the spine or ribs in the past year;
- pregnancy;
- rheumatoid arthritis;
- blood pressure is more than 140/90 mm Hg at the time of the start of the procedure;
- untreated hypertensive disease II degree;
- hypertensive disease of the III degree;
- angina pectoris II-IV FC;
- unstable angina pectoris;
- persistent heart rhythm disturbances;
- syncopal conditions in the anamnesis.

This study was approved by the Ethics Committee of the Odesa National Medical University (No. 101-24). All patients were informed about the study and signed an informed consent form before the trial.

Statistical analysis. The processing of the received results was carried out with the help of STATISTICA program for Windows (version 10.0), Microsoft Excel 2012. The data obtained are presented as a median with 25-75% (Q_1; Q_3) percentiles. Differences between initial and subsequent measurements were taken via the Wilcoxon matched-pairs test. The percentile method was used to develop the assessment criteria, which allows characterizing individual changes in physiological parameters within the defined ranges of the percentile distribution.

Results.

In the table 1 presents the morphometric parameters of the studied group of women.

According to the average data (Table 1), it can be stated that the majority of women had weight-height parameters within the normative values. However, a certain number of women had a tendency to be overweight.

Table 1. Morphometric parameters of the studied group of women

Parameters	Value
Body length , cm	167.0 (163.0; 170.0)
Body weight, kg	64.1 (55.0; 69.1)
BMI, kg×m $^{-2}$	21.1 (20.2; 26.6)
Body square , m ^{2}	1.73 (1.59; 1.80)

The table 2 shows the average changes in the cardiovascular performance of women before and after each of the four TSMT procedures. In general, the same type of significant changes are noted for most of the hemodynamic indicators under the influence of TSMT procedures. This applies to parameters DBP (mmHg), which increase, HR (min^{-1}), which decrease, and integral indicators – Double product (cu.) and Index Kerdo (cu.), which also decrease. Changes in MBP (mmHg) and PBP (mmHg), which in a certain number of cases only tend to decrease, are not always significant. It is noteworthy that in patients with normal initial SBP values (mmHg), no significant changes in this parameter were observed under the influence of the TSMT procedure.

That is, conducting TSMT has a significant effect on indicators of the cardiovascular system, but to a lesser extent it affects the value of SBP (mmHg).

At the same time, the analysis of the individual dynamics of the cardiovascular system`s indicators showed that they have characteristic features in each of the patients, which can be due to the variability of structural and functional differences of this group of patients, as well as the characteristics of damage to segmental somatic and autonomic structures peripheral nervous system at the level of the thoracic spine.

In previous studies, the a priori ranges of statistically significant and expected changes in indicators of the cardiovascular system and hemodynamics were determined, which showed the most frequent (within the 25-75% percentile distribution), less expected (within the 5-25% and 75-95% percentile distribution) and rarely expected (within 0-5% and 95-100% percentile distribution) variants of changes (Romanchuk & Hanitkevych, 2022a; 2022b). From the standpoint of normality, they can be characterized as normal, moderately decreased and moderately increased, as well as markedly decreased and markedly increased (Panenko et al., 2004). Such a characterization of changes in the indicators of the cardiovascular system allows to characterize them from the standpoint of the adequacy of the reaction to the TSMT procedure (Panenko & Romanchuk, 2006).

Table 2. Changes in the indicators of the cardiovascular system`s performance of women under the influence of manual therapy procedures in the course of sanatorium-resort treatment (n=29), (Q_1; Q_3)

Parameters			Valid - N	T	Z	p-value
1 procedure	Before	After				
SBP, mmHg	115.0 (109.0; 127.0)	116.0 (106.0; 122.0)	25	138.5	0.65	0.518
DBP, mmHg	76.0 (72.0; 82.0)	80.0 (77.0; 84.0)	29	71.5	3.16	**0.002**
PBP, mmHg	41.0 (37.0; 46.0)	36.0 (29.0; 41.0)	28	54.0	3.39	**0.001**
HR, min $^{-1}$	73.0 (66.0; 79.0)	62.0 (58.0; 71.0)	28	13.5	4.3 2	**0.000**
MBP, mmHg	90.3 (83.7; 95.3)	90.3 (86.7; 97.7)	28	112.0	2.07	**0.038**
Double product, cu.	82.2 (73.7; 98.4)	72.3 (65.9; 80.1)	29	36.0	3.92	**0.000**
Index Kerdo, cu.	-0.10 (-0.18; 0.04)	-0.25 (-0.38; -0.15)	29	10.0	4.4 9	**0.000**
2 procedure	Before	After				
SBP, mmHg	112.0 (108.0; 124.0)	109.0 (106.0; 128.0)	29	142.5	1.62	0.105
DBP, mmHg	76.0 (69.0; 80.0)	77.0 (72.0; 84.0)	27	84.5	2.51	**0.012**
PBP, mmHg	41.0 (33.0; 48.0)	36.0 (32.0; 44.0)	28	55.0	3.37	**0.001**
HR, min $^{-1}$	70.0 (67.0; 77.0)	62.0 (56.0; 66.0)	28	5.0	4.5 1	**0.000**
MBP, mmHg	88.0 (83.0; 94.7)	86.7 (83.0; 99.0)	29	167.5	1.08	0.280
Double product, cu.	79.5 (70.4; 98.0)	68.3 (62.5; 76.7)	29	38.0	3.88	**0.000**
Index Kerdo, cu.	-0.06 (-0.16; 0.04)	-0.25 (-0.36; -0.13)	29	6.0	4.57	**0.000**
3 procedures	Before	After				
SBP, mmHg	111.0 (105.0; 126.0)	109.0 (105.0; 126.0)	24	131.0	0.54	0.587
DBP, mmHg	73.0 (69.0; 81.0)	76.0 (74.0; 84.0)	26	44.0	3.3 4	**0.001**
PBP, mmHg	38.0 (34.0; 47.0)	36.0 (31.0; 42.0)	27	85.5	2.4 9	**0.013**
HR, min $^{-1}$	73.0 (60.0; 79.0)	61.0 (56.0; 70.0)	29	15.5	4.3 7	**0.000**
MBP, mmHg	86.3 (80.7; 96.0)	88.3 (84.7; 100.0)	27	82.0	2.57	**0.010**
Double product, cu.	79.4 (67.7; 96.0)	71.0 (59.9; 79.4)	29	36.0	3.92	**0.000**
Index Kerdo, cu.	-0.08 (-0.18; 0.05)	-0.30 (-0.46; -0.13)	29	2.0	4.6 6	**0.000**
4 procedure	Before	After				
SBP, mmHg	112.0 (107.0; 123.0)	109.0 (105.0; 125.0)	26	143.5	0.81	0.416
DBP, mmHg	74.0 (70.0; 78.0)	76.0 (71.0; 82.0)	29	108.0	2.3 7	**0.018**
PBP, mmHg	40.0 (35.0; 45.0)	36.0 (33.0; 42.0)	28	135.5	1.5 4	0.124
HR, min $^{-1}$	70.0 (63.0; 76.0)	61.0 (58.0; 68.0)	29	6.0	4.57	**0.000**
MBP, mmHg	88.0 (82.0; 94.7)	87.0 (82.7; 96.3)	29	125.0	2.00	**0.045**
Double product, cu.	82.8 (68.0; 94.4)	68.1 (63.4; 77.5)	29	10.0	4.4 9	**0.000**
Index Kerdo, cu.	-0.03 (-0.16; 0.04)	-0.26 (-0.40; -0.13)	29	5.0	4.59	**0.000**

Abbreviations: SBP – systolic blood pressure; DBP - diastolic blood pressure; PBP - pulse blood pressure; MBP - middle blood pressure; HR - heart rate.

In this message, in order to demonstrate the informativeness of this approach for assessing the impact of TSMT, we analyzed changes in integral indicators of the cardiovascular system, which reflect the degree of stress on the heart`s contractile function – the double product indicator, and autonomic

support of hemodynamics – the Kerdo`s index. The ranked changes of these indicators in response to the TSMT procedure are presented in the table. 3. Given the range of ranks of the percentile distribution of these indicators, it is possible to characterize their type on the basis of physiological ideas about the processes that occur in the autonomic nervous system and the heart`s contractile function.

Table 3. A priori characteristics of reactions in the main indicators of cardiovascular activity in women under the influence of the manual therapy procedure

Parameters	Types of reactions				
	And type	II type	III type	And V type	V type
Δ Double product	< -34.8	-34.8 – -18.3	-18.2 – -3.1	-3.0 – 4.0	> 4.0
Δ Index Kerdo	< -0.45	-0.45 – -0.29	-0.28 – -0.12	-0.11 – 0.01	> 0.01

Taking into account the known approaches, the most optimal can be considered the values of changes that fall into the range of 25-75%. That is, this type of reaction of the autonomic nervous system and the contractile function of the heart can be characterized as the optimal type of reaction (Type III).

Characterizing the ranges of changes in Kerdo's index, which determines the ratio of activity of the sympathetic and parasympathetic parts of the autonomic nervous system, as well as taking into account the activation of the parasympathetic part during the TSMT procedure in the vast majority of cases, falling into the ranges of 5-25% and 0-5% can be characterized as a pronounced type of reaction (Type II) and an excessively pronounced type of reaction (Type I). On the other hand, falling into the range of 75-95% will be characterized as an acceptable type of reaction (IV type), which is determined by a slight activation of the parasympathetic link of the nervous system, and falling into the range of 95-100% can be characterized as an inadequate type (V type), which is determined by minor changes with a tendency to increase sympathotonic influences.

On the other hand, characterizing changes Double product, as an indicator of the heart`s contractile function, it should be noted that during the TSMT procedure it has a pronounced focus on economization, primarily due to a decrease in heart rate (Table 2). In view of this, falling into the ranges of 0 - 5% and 5 - 25% can be characterized as excessively pronounced economization and pronounced economization of the heart`s contractile function, respectively. The variant of falling into the range of 75-95% can be defined as

an acceptable type, but the variant of falling into the range of 95-100% can be defined as inadequate.

In general, 5 types of response can be distinguished

And type is excessively pronounced;

II type – pronounced;

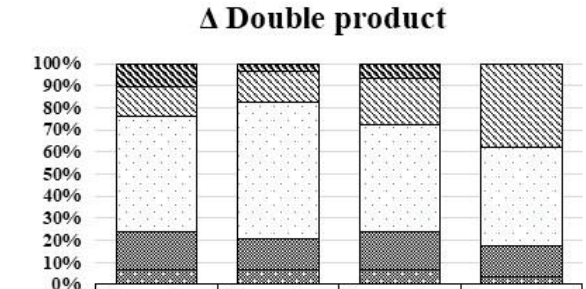
III type – optimal;

IV type – acceptable;

V type is inadequate.

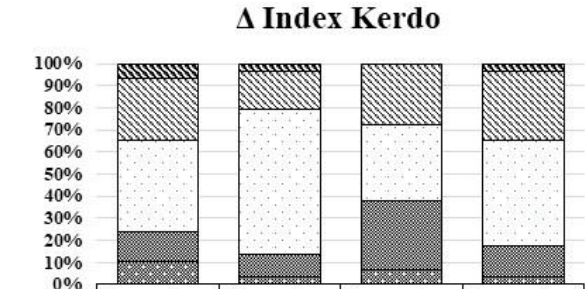
That is, this interpretation of changes in the heart`s contractile function and autonomic regulation of hemodynamics allows to provide an individualized assessment of their reaction in response to the TSMT procedure. In turn, this may be the basis for warnings regarding possible inadequate reactions in specific patients.

In fig. a and b present distributions of types of changes in indicators Δ Double product and Δ Index Kerdo in the dynamics of the TSMT procedures course.



	1 procedure	2 procedure	3 procedure	4 procedure
V type	10,3	3,4	6,9	0,0
IV type	13,8	13,8	20,7	37,9
III type	51,7	62,1	48,3	44,8
II type	17,2	13,8	17,2	13,8
I type	6,9	6,9	6,9	3,4

A



	1 procedure	2 procedure	3 procedure	4 procedure
V type	6,9	3,4	0,0	3,4
IV type	27,6	17,2	27,6	31,0
III type	41,4	65,5	34,5	48,3
II type	13,8	10,3	31,0	13,8
I type	10,3	3,4	6,9	3,4

B

Fig. A, B. Changes in the distribution of response types of the heart`s contractile function (Δ Double product) and autonomic regulation of hemodynamics (Δ Kerdo`s Index) on the influence of the TSMT procedure in the dynamics of the sanatorium-resort treatment course

Taking into account their distribution, it can be stated that the optimal reaction to the TSMT procedure was observed most often after the 2nd procedure - in 62.1% of patients with heart`s contractile function and in 65.5% of patients with autonomic regulation of hemodynamics. It is also informative that from procedure to procedure the

number of cases falling into the extreme limits of the distribution and being assigned to excessively pronounced and inadequate types of response significantly decreases. According to the indicator Δ Double product their number from the first to the fourth procedure decreases from 17.2% to 3.4%, and according to the indicator Δ Index Kerdo from 17.2% to 6.8%. Such a variant of changes can confirm the improvement of reactions of the cardiovascular and autonomic nervous systems in the dynamics of the TSMT procedures course.

Discussion.

The problem of assessing changes in the activity of the cardiovascular system under the influence of TSMT mobilization and manipulation techniques lies in the plane of approaches to the registration of indicators, the position of the patient's body during registration, the duration of the manual therapy procedure, the time intervals between the application of the techniques and the beginning of the measurement, the stability of the changes, as well as the place the use of localized methods, which are often associated with certain manual therapy practices - classical practices, chiropractic, osteopathic, etc. (Mintken et al., 2008). Each of them has its own characteristics with the direction of techniques, body position, range of corrective influence (Guyatt et al., 2011). Therefore, even describing certain results often indicate a certain range of application of manual therapy. Only a small number of works emphasize a clear influence on one or another vertebral -motor segment of the thoracic spine. This is reflected in the research results, which in many cases makes their comparison impossible. First of all, the studies conducted by Ward et al. (2013; 2015) deserve attention in which supine varied anterior chest manipulation was shown to have minimal effect on any of the cardiovascular physiological variables tested, although statistically significant changes in PQ interval and QRS duration were noted. Based on these results, the author concludes about the safety of manipulations on the upper thoracic spine in people with normal or elevated blood pressure. On the other hand, the study of the state of the autonomic nervous system during directed manipulations at the level of T_2; T_5; T_{11} vertebrae, by the authors (Minarini et al., 2018) showed a significant increase in the activity of parasympathetic activity according to the RMSSD indicator. In other studies, which analyzed the general effect of the procedure in healthy people, an ambiguous effect on HRV indicators, which testify to the activity of the autonomic nervous system, was shown. Among TSMT techniques, mobilization and manipulation of the upper thoracic spine at T_{1-4} levels are more often used (Cleland et al., 2007), T_4 (Casanova-

Mendez et al., 2014) and T_{3-6} (Salom-Moreno et al., 2014). The majority of works testify to a significant decrease or unchanged heart rate, a decrease or unchanged LF (sympathetic) component, a significant increase or unchanged HF component of HRV, an increase in SDNN and RMSSD (Gera et al., 2020). There are much fewer publications on the effect of TSMT in patients with pathologies of the cardiovascular, respiratory, endocrine, and immune systems. There are certain results of changes in autonomic regulation in pain syndromes (Salom-Moreno et al., 2014). Our research on groups of sanatorium patients using a complex method of studying the cardiorespiratory system made it possible to show not only the features of changes in HRV during TSMT, but also pattern breathing, variability of blood pressure and hemodynamics in osteochondrosis of the spine (Romanchuk, 2022 a ; 2022 b)

Earlier, on a significant number of registrations of cardiovascular system indicators in patients who underwent a course of manual therapy according to the Yumeiho method, the results of heart rate and blood pressure measurements, which were carried out in the supine position after 5 minutes of rest before the start and end of the procedure, were processed (Romanchuk & Hanitkevych, 2022a; 2022b). Of course, this approach does not allow us to clearly predict further changes, but it allows us to clearly determine the reactivity of the cardiovascular system in response to the use of manual therapy. The determination of reactivity, or the type of reaction, can be further used as a separate characteristic of the patient's condition, his adaptation capabilities and the expediency of using manual therapy in the complex treatment of certain diseases of the cardiovascular, respiratory, autonomic nervous systems, etc.

The same research algorithm was used earlier when examining patients who underwent sanatorium-resort treatment in the clinical sanatorium named after V.P. Chkalov (Odesa, Ukraine). The obtained results are slightly different from others published in different publications, but they are significant. In addition, they made it possible to calculate and analyze the integral indicators of the activity of the cardiovascular and autonomic nervous systems, which has a certain value from the standpoint of determining the general state of the body and its reaction to the TSMT procedure.

The results obtained by us of the absolute values of the measured indicators indicated sufficiently characteristic significant changes in HR ($min.^{-1}$), which decreases in the range of 8-12 ($min.^{-1}$), DBP (mmHg), which increases in the range of 1-4 (mmHg). The absence of significant changes in SBP (mmHg) was different from many

studies. However, as previously mentioned, SBP responses to the TSMT procedure differ between healthy patients and hypertensive patients, and in our studies, such patients were excluded from the observation group.

The evaluations by ranks of changes in indicators of the heart`s contractile function and autonomic support of hemodynamics, which showed a certain significance during the sanatorium-resort treatment of patients with osteochondrosis of the spine from the standpoint of the adequacy of reactions to the TSMT procedure during the course of treatment, turned out to be sufficiently informative.

In our opinion, the typing of changes in these parameters should allow one to objectify the individual reaction, qualitatively assess the reactivity and, accordingly, compare the effects of other methods of spine correction, taking into account the observance of the conditions of the procedure and measurements.

Conclusion.

Determination of changes in indicators of the cardiovascular system activity under the influence of the thoracic spine manual therapy procedure made it possible to characterize the reaction of the main parameters of the cardiovascular system, to develop ranked criteria for evaluating changes that formed the basis of typing and evaluating reactions of the heart`s contractile function according to the Δ indicator Double product and autonomic support of hemodynamics according to the Δ indicator Kerdo`s Index for the procedure of manual therapy of the thoracic spine. In the future, this will make it possible to unify the evaluation of the reaction of the cardiovascular system in order to prevent the occurrence of negative effects of the procedure in normotensive women.

Author's contribution

Conceptualization, AP and OR; methodology, OR; software, OR; check, AP, OR; formal analysis, AP; investigation, OR; resources, AP; data curation, OR; writing - rough preparation, AP and OR; writing - review and editing, AP; visualization, OR; supervision, AP; project administration, AP; receiving funding, AP. All authors have read and agreed with the published version of the manuscript.

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No

Conflict of Interest

The authors declare that it has no competing interests.

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