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# Deep tissue massage and mobility and pain in the thoracic spine

**Authors' Contribution:**
**A** Study Design
**B** Data Collection
**C** Statistical Analysis
**D** Data Interpretation
**E** Manuscript Preparation
**F** Literature Search
**G** Funds Collection

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## abstract

**Background:** The aim of the work is to determine the effectiveness of deep tissue massage therapy on mobility and pain of the thoracic spine.

**Material and methods:** The study involved 18 women and men aged 46–63 years doing office work. Functional diagnostics was performed prior to the therapy (study I), after the procedure (study II) and after 30 days (study III). The Otta test for flexion and extension of the spine, pectoralis major muscles length test, chest circumference measurement, and NRS were used. In the statistical analysis mean and standard deviations were determined and the following tests were used: Mann-Whitney U, Spearman's Rank Correlation, Pearson's Chi$^2$, Shapiro-Wilk, Friedman, and ANOVA. Statistical significance of the differences was estimated at $p < 0.05$.

**Results:** The results of the diagnostic tests obtained in men and women did not differ statistically, which allowed for further consideration as one group of patients. The results of mean differences in the spine extension between study I and II (D = 1.06, p = 0.001) and I and III (D = 0.83, p = 0.001) indicate improved spine mobility. The D = -0.22, p=0.041 result between the II and III test indicates a deterioration in the spinal extension. A similar tendency was observed in the results of the pectoralis major muscles length study. The results of mean differences in the chest circumference between study I and II (D = -1.61, p = 0.001) and I and III (D = -1.33, p = 0.001) indicate an increase in the chest circumference. The mobility of the chest after 30 days did not change (D = 0.28). The mean differences in the NRS between the study I and II (D = 5.22, p = 0.001) and I and III (D = 4.22, p = 0.001) show a reduction in pain. The D=-1.0, p = 0.001 score between tests II and III means that the improvement was not at the same level as immediately after the therapy.

**Conclusions:** Deep tissue massage is an effective method in the treatment of pain located in the thoracic spine. It improves the mobility of the spine and the chest, and the length of pectoralis major muscles in people doing work in a sitting position.

**Key words:** deep tissue massage, mobility, pain, thoracic spine.

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## INTRODUCTION

Almost 50% of the European Union residents work in a sitting position. Despite having a lot of knowledge in the subject related to work ergonomics, a lot of workers do not always keep a correct position [1]. Incorrect body positioning on the seat and a lack of adequate physical activity in free time causes an increase in the frequency of long-lasting back pains [2]. This pain is most often located in the lumbosacral segment; however, the number of patients reporting pains located within the thoracic spine has recently increased pain between the shoulder blades. A protracted head position and inwardly rotated shoulders can be observed in these patients. Vladimir Janda referred to such a pattern of posture as "the upper crossover syndrome" [3], whereas John Smith "the head set forward" [4].

The following work focuses on explaining the possible causes of pain between the shoulder blades, looking at the prism of myofascial tapes, and determining whether using deep tissue massage can reduce or eliminate pain in the thoracic spine and increase its mobility. The physiotherapy strategy was based on the knowledge about fascia, the concept of anatomical lines, the concept of tensegration and the properties of the deep tissue massage.

The fascia is the connective tissue that surrounds every single cell of the human body, shapes it, and also supports it. For many years this tissue has often been neglected in research, and it was only regarded for the creation of organs' packaging. Only the 21st century has brought about many publications on this fascinating topic [5–7]. The most important property of the fasciae is the ability to transmit tensions. Due to the knowledge of fascia features, dysfunctions occurring within the musculoskeletal system have been more globally analyzed [8–10].

One of the ways of global body analysis is the attempt to explain the continuity of structures included in the anatomical lines. This view assumes that the muscle, in addition to the bone attachment, is also connected to the muscle or ligament in its immediate environment via the fascia. These two connected structures continue to bind to another tissue which creates a myofascial line. According to the author of this concept, Tom Myers, this is why every muscle, in addition to an independent action, has a functional effect on the whole body in the region of the myofascial line to which it belongs [2]. In order to understand why this is the case, the creator of the anatomical lines model relies on the concept of tensegration, in which the skeletal system is a rigid element undergoing continuous compression and constitutes a point of attachment for the myofascial system. The myofascial system is an elastic element undergoing constant tensions and causing bone system compression. A well-functioning myofascial system keeps the bone system components in a proper position relative to each other. At the moment, when one muscle is undergoing excessive tension so that the balance in the skeletal system is maintained, there must be an increase in tension in other muscles, belonging to the same group or a line cooperating with it. Long-lasting elevated muscular tonus causes pain that occurs in places distant from the cause of their occurrence [11–13]. Knowing which line the painful structure belongs to, it is much easier to determine where the source of the symptoms is [2].

In the pattern of the head forward, there is a disturbance of the balance between the lines: superficial front and back, deep front, superficial and deep front arms. Work in a sitting position, with bent upper arms, forces the employee to set the shoulders in internal rotation, round them and set the shoulders in the front inclination in relation to the ribs. As a result, the pectoralis major and minor muscles, components of the upper arms, can be shortened. Prolonged maintenance of the body position, where the pelvis is set in tautness causes contractures and excessive tension of the superficial front line. The abdominal shortened muscle reduces the ribs, pulling down the chest, which results in restricting its mobility and leads to breathing difficulties. In this situation, the diaphragm, which is the main respiratory muscle, does not have enough room to work, gets shortened, which further aggravates the limitation of the mobility of the chest. The described silhouette causes excessive tension of sternocleidomastoid muscles, which set the lower part of the cervical spine in flexion, and the upper one in extension, leading to many dysfunctions. The head is set in protraction and, as a result, the intervertebral discs, joints and ligaments are heavily pressurized, which can be manifested by pain in the head, neck, shoulder or pain in the area of the shoulder blade. Moving the head forward may also result in the elimination of cervical lordosis, the creation of trigger points or overloading of the scalene muscles. The shoulder plexus, which supplies the entire upper arm, passes between the anterior and middle scalene muscles. Excessively tense muscles can compress the shoulder plexus causing the upper thorax hole syndrome. All these symptoms are caused by the head syndrome protruding forward. The task of the superficial back line is to keep the head in the right position over the spine. It is supported by a deep front line. The headless setting of the head imposes an additional load on these lines. It is estimated that the protrusion of the head by 2.5 cm doubles the work of the spinae erector in the thoracic region. The result is an increased tension in the tissue within the thoracic spine, which generates myofascial pain between the shoulder blades [2, 11, 12, 14, 15].

There are various ways to restore the balance between the described anatomical lines. One of them is working with the use of deep tissue massage. It is a therapeutic tool that combines techniques from different methods of working with soft tissues (rolling, trigger point therapy, myofascial release, etc.). The purpose of this massage is to loosen and increase the mobility of tissues against each other, eliminate trigger points, extend shortened muscles, increase muscle blood flow, improve the quality of the fascia, regain muscular balance, which eliminates defective movement patterns [16–19].

The main objective of this work is to determine the effect of deep tissue massage on pain and mobility within the thoracic spine and to show that the place of pain is not always the place causing these symptoms, as well as to determine the impact of deep tissue massage on the mobility of the chest and the pectoralis major muscles length and the evaluation of the prolonged effects of the obtained results of the therapy.

The following research hypotheses were formulated to consider the research problem:

1. Deep tissue massage reduces or eliminates pain within the thoracic spine and increases its mobility.
2. Deep tissue massage increases the mobility of the chest and affects the lengthening of the pectoralis major muscles.
3. The effects of deep tissue massage appear immediately after the treatment and last for 30 days.
4. Pain can be alleviated without working in the place where it occurs.

## MATERIAL AND METHOD

The study involved a group of 9 women and 9 men aged 46–63 who had been working in a sitting position for a dozen or so years. The inclusion criterion was pain reported in the thoracic spine, as well as the results of functional tests. There were no contraindications to the therapy in any of the persons and everyone expressed their consent to participate in the research.

A basic interview was conducted, which included questions about age, work experience, the place of pain and possible contraindications to the therapy. Diagnostic tests were carried using: the Otta test for slope, the Otta test for extension, the chest circumference measurement, measurement of the distance of the right and left elbow joint from the table. The subjects determined their pain complaints in an 11-point numerical scale (NRS – Numerical Rating Scale), where 0 means complete absence of pain, and 10 is the most intense pain.

At the beginning of the procedure, gentle superficial techniques were made in order to make the patient familiar with the touch of the therapist. The diaphragm was the first to be treated. This was to facilitate breathing, as well as to free the chest from pulling down. Then the massage was extended to the pectoralis major muscles and the pectoralis minor muscles lying beneath them. Another very important structure in this work is the sternocleidomastoid muscle, which, due to its excessive tension, brings the head forward. It is a superficial muscle. The therapy consisted in setting the described tissue in extension, i.e. in the extension and rotation in the opposite direction with the use of gentle touch, stretching and relaxing the muscle in turns. Without this stage, therapy on the subsequent tissues would be ineffective, because without restoring the normal length of the sternocleidomastoid muscles, one cannot stretch the scalene muscles. Next, stretching techniques, stimulating muscle lengthening and blocking techniques were applied. Immediately after the massage and after 30 days, diagnostic tests were carried out.

The obtained results were entered into the STATISTICA 10 database and analyzed statistically. Due to the orderly nature of the results, the tests of choice were the Mann Whitney U test for comparing the results of two independent groups, and the Spearman rank correlation test for analyzing the relationships between the variables of the studied characteristics. The test used for the analysis of the variables on the nominal scale was the Chi2 Pearson test. In order to determine whether the variable has a normal distribution, the Shapiro-Wilk test was used. In the case of a normal distribution, further analysis was carried out with the ANOVA test – one-way for dependent variables. In case of a lack of a near-normal distribution, the Friedman test was applied (a non-parametric test for comparisons of three dependent variables) [20]. During the verification of all analyses, a significance coefficient of $\alpha = 0.05$ was used, which allowed considering statistically significant variables at $p < 0.05$.

## RESULTS

The results of the diagnostic tests obtained in men and women did not statistically differ, which allowed for further consideration as one group of patients; p took values from 0.067 to 1.000. The mean age in the studied group was 52.3 ±5.2 years, while the average working time was 24.4 ±7.5 years.

Table 1 presents the results of the Otta test for spine extension in the thoracic segment in a team of office workers.

Table 1. Comparative characteristics of the Otta test results for extension

| Study | Mean ±SD | | D | t | p |
|---|---|---|---|---|---|
| I – II | 29.0 ±0.5 | 27.9 ±0.4 | 1.06 | 12.49 | 0.001* |
| I – III | 29.0 ±0.5 | 28.2 ±0.6 | 0.83 | 9.861 | 0.001* |
| II – III | 27.9 ±0.4 | 28.2 ±0.6 | -0.22 | 2.630 | 0.041* |

* statistically significant difference for $p < 0.05$

The smallest standard deviation indicating the smallest dispersion of individual results was obtained in the Otta test for straightening immediately after the therapy (SD = 0.4). The Otta test results for the extension were analyzed to determine their similarity to the normal distribution by the Shapiro-Wilk test. Due to the lack of a parametric distribution (obtained values were below the assumed alpha coefficient), for parameters in the Otta test for extension, it was necessary to use a nonparametric test for comparisons of three dependent variables – the Friedman test. The results of the mean differences in the spine extension between tests I and II (D = 1.06) and I and III (D = 0.83) show an increase in the mobility of the spine. The result D = -0.22 between study II and III indicates a decrease in the spinal extension. The differences illustrating the changes were statistically significant.

Table 2 presents the results of the Otta test for the slope in the thoracic spine in the study group.

Table 2. Comparative characteristics of the Otta test results for the slope

| Study | Mean ±SD | | D | z | p |
|---|---|---|---|---|---|
| I – II | 31.6 ±1.1 | 31.6 ±1.1 | 0.00 | 0 | 1 |
| I – III | 31.6 ±1.1 | 31.6 ±1.0 | 0.00 | 0 | 1 |
| II – III | 31.6 ±1.1 | 31.6 ±1.0 | 0.00 | 0 | 1 |

For a variable in the Otta test – slope – the obtained results indicated similarity to the normal distribution. It allowed using the test for dependent variables – ANOVA (one-way test) for dependent variables. The obtained results of the Otta test for the slope did not show differences between tests I and II, I and III and II and III.

Tables 3 and 4 show the results of the length of the pectoralis major muscles examined by measuring the distance of the elbow joint from the table.

Table 3. Comparative characteristics of the results of distance measurement of the elbow joint from the table for the right upper limb

| Study | Mean ±SD | | D | t | p |
|---|---|---|---|---|---|
| I – II | 3.8 ±2.6 | 0.9 ±1.5 | 2.83 | 3.51 | 0.001* |
| I – III | 3.8 ±2.6 | 1.6 ±1.8 | 2.22 | 3.41 | 0.001* |
| II – III | 0.9 ±1.5 | 1.6 ±1.8 | -0.61 | 2.52 | 0.011* |

* statistically significant difference for $p < 0.05$

Table 4. Comparative characteristics of the results of distance measurement of the elbow joint from the table for the right upper limb

| Study | Mean ±SD | | D | t | p |
|---|---|---|---|---|---|
| I – II | 3.9 ±2.7 | 1.0 ±1.7 | 2.89 | 3.51 | 0.001* |
| I – III | 3.9 ±2.7 | 1.6 ±2.4 | 2.28 | 3.51 | 0.001* |
| II – III | 1.0 ±1.7 | 1.6 ±2.4 | -0.61 | 2.36 | 0.017* |

* statistically significant difference for $p < 0.05$

The data show that the lowest mean results occurred immediately after the therapy. The lowest standard deviation was observed during the second measurement of both the right and the left upper limb. In the test examining the length of chest muscles larger for the right upper limb, the results of the mean differences between tests I and II (D = 2.83) and I and III (D = 2.22) indicate an increase in the length of the pectoralis major muscle. The result between tests II and III (D = -0.61) means that the pectoralis major muscles in the right upper arms were shortened (Tab. 3.). The analysis of the results of mean differences in the length of the pectoralis major muscle for the left upper arm was between tests I and II (D = 2.89), I and III (D = 2.28) and II and III (D = -0.61). It proves that the muscle length immediately after the therapy increased; however, a month later, the muscles slightly decreased (Tab. 4.). Due to the lack of parametric distribution of results for statistical analysis, the Friedman test was used. All the examined differences were statistically significant.

Table 5 presents the results of changes in the chest circumference. The results of mean differences in the chest circumference between tests I and II (D = -1.61) and I and III (D = 1.33) indicate an increase in the chest circumference. These changes are statistically significant. The chest circumference after 30 days decreased when compared to study II, but this difference is not statistically significant. The analysis carried out with the Shapiro-Wilk test checking the occurrence of differences between the analyzed parameters in relation to the normal distribution did not show statistically significant differences. This indicates that as regards the chest circumferences in each of the analyzed studies, the results showed normal distribution. Due to the close-to-normal distribution, the ANOVA test was used for statistical analysis.

Table 5. Comparative characteristics of the chest circumference measurements

| Study | Mean ±SD | | D | z | p |
|---|---|---|---|---|---|
| I – II | 89.9 ±8.7 | 91.5 ±8.7 | -1.61 | 9.59 | 0.001* |
| I – III | 89.9 ±8.7 | 91.2 ±8.4 | -1.33 | 7.94 | 0.001* |
| II – III | 91.5 ±8.7 | 91.2 ±8.4 | 0.28 | 1.65 | 0.096 |

* statistically significant difference for p < 0.05

Pain results obtained from the questionnaire and the NRS scale were analyzed. The most frequently reported place of complaints in the subjects was the area between the shoulder blades. Pain in this place was felt by 39% of patients. Pain complaints occurring more strongly on the right side occurred in 28% of the subjects. The pain occurring between the shoulder blades and cervical-thoracic transition was reported by 17% of the respondents, while pain between the shoulder blades and in the cervical spine was reported by 11% of the subjects. One patient experienced pain between the shoulder blades combined with pain in the arms. Table 6 presents the results of the NRS scale.

Table 6. Comparative characteristics of the results of distance measurement of the elbow joint from the table for the right upper limb

| Study | Mean ±SD | | D | t | p |
|---|---|---|---|---|---|
| I – II | 5.6 ±1.0 | 0.3 ±0.5 | 5.22 | 3.72 | 0.001* |
| I – III | 5.6 ±1.0 | 1.3 ±1.1 | 4.22 | 3.72 | 0.001* |
| II – III | 0.3 ±0.5 | 1.3 ±1.1 | -1.00 | 3.17 | 0.001* |

* statistically significant difference for p < 0.05

The lowest average results were obtained immediately after the therapy. The second examination was also characterized by the smallest standard deviation. The analyzed results on the NRS scale, depending on the study, do not have a normal distribution and are represented on the ordinal scale, which allowed for the use of Friedman's test for comparison of results. The mean differences in the pain scale between tests I and II (D = 5.22) and I and III (D = 4.22) mean a reduction in pain. The result of D = -1.0 between study II and III means that the pain increased. The differences illustrating the changes were statistically significant.

## DISCUSSION

The results of this study indicate that there are no statistically significant differences in the response to the proposed therapy between women and men, which enabled us to consider them representative of the group of office workers of both sexes. In the literature, data dealing with the impact of massage on increasing the range of spinal mobility and reducing pain in its area, authors such as Majchrzycki, Preyde, Smolis-Bąk and Zheng also analyze the whole group of subjects without sex division [1, 14, 21, 22, 23].

It was assumed in the paper that among office workers there are numerous cases of pain in the thoracic spine. There is a lot of research on how prevalent this phenomenon is in this profession. Milanow states in his work that 75 to 85% of the world's population has experienced low back pain at least once, and 71% of the population neck pain [22]. Smolis-Bąk, examining physical activity as prophylaxis of back pain in people working in front of a computer, found that more than half of the subjects suffered from muscular imbalance, manifested in increased shoulder and neck tone, and that spine pain occurred in 72.8% of the cases [1]. According to Tom Myers, acute pains are not so commonly encountered in the thoracic spine; the most prevailing ones turn out to be chronic complaints caused by overloads in the movement system [2].

The aim of this work was to check whether deep tissue massage reduces pain in the thoracic spine and increases its mobility. The conducted research shows that the applied therapy brought about positive results by reducing pain and increasing the range of motion. The average pain rating reported before the therapy was 5.3 in the eleven-grade NRS scale, while after the therapy it decreased to 0.3. The available literature does not yield any studies on the impact of deep tissue massage on pain and mobility of the thoracic spine, while there are numerous publications on the use of massage in the treatment of the lumbosacral spine. A randomized study conducted by Preyde on the effectiveness of massage in subacute low back pain showed that the whole group achieved a significant reduction in pain and improvement in the range of motion [14]. Another randomized study by Majchrzycki on a group of 59 participants divided into two groups focused on deep tissue massage treatments for the first 2 weeks, followed by the same massage supplemented with non-steroidal anti-inflammatory drugs, showed no statistically significant differences between the test group and the control group [21]. A group of Chinese scientists, led by Zheng, also proved positive effects of deep massage on lumbar pain. They compared results obtained in two groups, where in the first one the massage and traction of the spine was performed, while and in the second only traction was applied. It turned out that the first group achieved statistically significant differences indicating better treatment results [24]. In 2016, Webb performed a review of randomized studies on deep massage, showing that in nine of them (with a total of 534 people) there was an increase in the range of joint mobility and a significant reduction in pain [25]. The aforementioned research results, as well as numerous scientific works of Wytrążek, on deep tissue massage confirm the thesis put forward in this work [18, 19, 24].

This study has also tried to prove that deep tissue massage lengthens muscles. The results obtained immediately after the therapy indicate an improvement in the elasticity of the pectoralis major muscles, and thus an increase in their length. The increase in the range of joint mobility, which was a result of the therapy, also confirms a positive effect of deep massage on muscle elongation. The same effects were observed earlier by other researchers: Tozzi [9], Ciechomski [16], Webb [25], or Preyde [26].

Another important aspect of the research was to determine how long the obtained effects of the treatment last. The results of the conducted research indicate that after 30 days there was a slight deterioration of Otta test results for extension, distance of the elbow joint from the table and pain assessment, and no statistically significant differences were observed in chest circumference measurements. Also Preyde noticed in her research that the effects of therapy persisted for 30 days in 63% of people undergoing massages [26]. Slight deterioration in the results after a long time may be caused by the lack of self-therapy, which prolongs the noticeable effects of the therapy, and engages the patient in the recovery process.

In the available literature, one can find many works on the impact of classical massage on the mobility and spinal pain; however, the vast majority of tests cover a series of treatments and do not check whether the achieved results are long-term [27, 28]. The following study points out that using deep tissue massage, after just one treatment, a significant reduction in pain and improvement in the range of motion is achieved. The results obtained during the tests indicate that in all the subjects there was a significant improvement in this parameter. In the available literature, no publications have been found that exhaust the subject of muscular pain of the thoracic segment of the spine. It seems that this is due to the fact that the problems of this area of the body are connected with problems of the cervical segment, which probably results from the small mobility of the examined spine area. An increasingly common posture, in which the head is advanced, causes chronic pain located within the thoracic segment of the spine; therefore, it seems reasonable to continue research on this problem.

## CONCLUSION

1. Decreasing the subjective feeling of pain or complete elimination of it and increasing the movement of the prominent thoracic spine confirm the effectiveness of the therapy.
2. After the intervention with the use of deep tissue massage, an increase in the chest circumference and the length of the pectoralis major muscles was found, which indicates the effectiveness of the therapy.
3. A significant reduction in pain and an improvement in the mobility of the thoracic segment after just one treatment and work in an area far from the place of reported ailments indicate that the source of the problems is not always located in the place of pain sensation.
4. A slight deterioration of the results of therapy after 30 days indicates the legitimacy of using autotherapy to achieve the long-term effects.

In conclusion, it can be said that deep tissue massage is an effective method in the treatment of pain located in the thoracic spine; it improves spine and chest mobility and the length of pectoralis major muscles in people doing work in a sitting position.

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