



Coccygodynia - Causes, Local Symptoms and other Conditions within the Motor System - Concurrence and Correlation

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Abstract

Objectives: The objectives of this work were to define the causes of coccygodynia and to find its correlation and concurrence with other conditions within the motor system.

Method: The number of participants to be examined was established after the files of 13,793 patients with motor system conditions, who were treated in Center of Manual Therapy (CTM) in Sierosław (Poland), had been analysed. The participants were divided into the study group (A) and the control group (B) having 123 subjects each. The study was of a retrospective nature. The data was obtained from patients' files and collected in the study protocol, added to a spreadsheet, and finally submitted for statistical analysis in order to find cause and effect relationship between the coccyx pain and the factors examined. All patients underwent both examination and therapy according to the approach of the Manual Therapy by Rakowski.

Results: Out of 13,791 participants 621 (4.5%) was suffering from coccygodynia of various origin. Three people had coccygectomy (0.48%). In the study group (group A) the vast majority of participants (77.24%) were women ($p=0.0001$). There were no statistically significant differences in the median age of participants from group A and B ($p=0.0589$), the mean body weight of participants from group A was no different than the mean weight of participants from group B ($p=0.110570$). People from group A were shorter than people from group B ($p=0.0157$). The study on BMI in group A and group B didn't show any significant differences ($p=0.6559$). 24.39% of people from group A had coccyx injury. The aching period for these people wasn't longer than for people who didn't injure the coccyx, but reported the pain ($p=0.5927$). Not a single form of pelvic floor muscle tone disorders depends on a previously sustained coccyx injury: the excessive pelvic floor muscles resting tone ($p=0.1653$), the reduced pelvic floor muscles resting tone ($p=0.7222$), the pelvic floor muscles efficiency disorder ($p=0.4361$), the reverse pelvic floor muscles coordination ($p=1$). There isn't a statistically significant relationship in coccyx tenderness occurrence in the per rectum examination in group A people, who sustained coccyx injury and in people, who didn't have the injury: the dorsal mobilization of the coccyx ($p=0.1620$), the ventral mobilization of the coccyx ($p=0.5870$), the palpation tenderness of the coccyx tip ($p=0.0644$). The more frequent conditions in group A were: sacrum pain ($p<0.0001$), shoulder blade region pain ($p<0.0013$), mid-thoracic spine pain ($p<0.0011$). The more frequent conditions in group B were: difficulty to start and continue urination ($p<0.0067$), L and L/S spine pain ($p<0.0168$), hip region pain ($p<0.025$), knee pain ($p<0.0128$).

Conclusion: (1) The concurrence of coccygodynia and many other motor system conditions was shown. The following were named as clearly correlated with coccygodynia: sacrum, mid-thoracic spine and shoulder blade region pain. (2) Coccyx injury is just one of many possible causes of coccygodynia. (3) The idiopathic coccygodynia requires further studies in order to learn its pathogenesis in detail and to identify a cause-oriented therapy method.

Keywords: Causes of coccygodynia; Coccygodynia; Conditions which concur with coccygodynia; Manual therapy with regard to coccygodynia

Introduction

Coccygodynia-the pain of the coccyx and of the tissues around it [1-3] is a well-known problem, although there is still a lot to investigate and learn. The problem concerns around 1% of the population affected by spondylogenic conditions [4-6]. According to Woon, et al. [7] the problem affects around two thousand people annually in the United States and Great Britain. Patijn [8] writes that precise data on the incidence rates of both idiopathic and post-traumatic coccygodynia is not known, although he claims, according to Wray, that spontaneous coccygodynia accounts for less than 1% of non-traumatic spine conditions. Coccygodynia can be caused by both functional and structural issues. The experiences and observations of people dealing with the problem of coccygodynia show the relationship of the described problem with pain in the lumbar [5,9-11] and lumbosacral spine, of buttocks, hips, thighs [10,11] and with pain extended onto the back side of the lower limb [10] as well as pain in the sacrum [4,10], perineum and gluteal muscles [1,10] and upper regions of spine [4]. The literature on this subject lacks data indicating links between coccygodynia and conditions occurring in remote regions of the motor system. Only one case study shows that coccyx pain appeared secondary to cervical spine conditions [12]. However, there is information in the literature that the described problem may be the result of pain extended from other body regions [10,13,14].

Materials and methods

The number of participants to be examined was established after the files of 13,793 patients with motor system conditions, who were treated in Center of Manual Therapy (CTM) in Sierosław (Poland) in the period 1990 – 2017, had been analysed. The participants were divided into the study group (A) and the control group (B) having 123 subjects each (Figure 1). All patients underwent both examination and therapy according to the approach of the Manual Therapy by Rakowski [10].

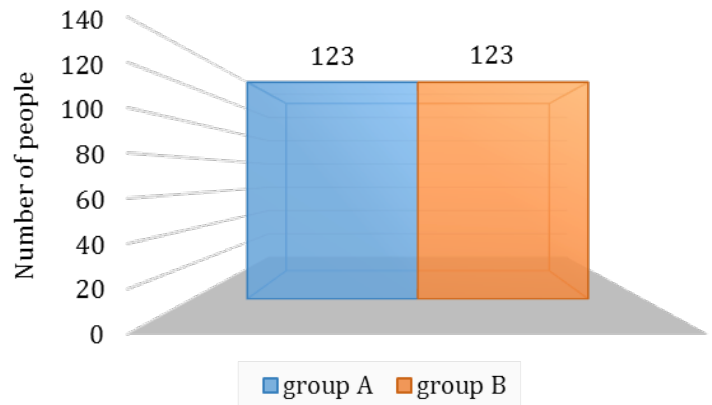


Figure 1: The study (A) and the control (B) group size.

The study group, hereinafter described as group A, is a group of people reporting to CTM because of coccyx pain. This was the dominant symptom, the main one of the complaints reported by patients. A control group was selected for the comparison purposes. The control group, hereinafter referred to as group B, is a group of people reporting to CTM due to various motor system conditions, excluding coccyx pain. They were: pain of the L/S and L spine, pain in the lower limbs region, pain in the pelvis region or functional conditions of internal organs. The control group are people who, due to the specific characteristics of the conditions experienced, required both examination and manual treatment with access per rectum. These are people who have never complained of coccyx pain, but who have had coccyx tip tenderness or tenderness in the sacrococcygeal joint when subjected to the dorsal or ventral mobilization of the coccyx during the manual examination with access per rectum.

The study covered women and men from 10 to 80 years of age (minimum age 10 years, maximum age 74). The criteria for inclusion in the study are as follows: people suffering from functional coccyx pain (without structural causes) and patients in whom no less than 3 manual therapy procedures have been performed in order to obtain as much data as possible. The criteria for exemption from the study are as follows: people suffering from

coccyx pain as a result of structural diseases and patients in whom less than 3 manual therapy procedures have been performed. The study was of a retrospective nature. The data was obtained from patients' files and collected in the study protocol, added to a spreadsheet, and finally submitted for statistical analysis in order to find cause and effect relationship between the coccyx pain and the factors examined.

The obtained results were submitted for statistical analysis in which the arithmetic mean and standard deviation were calculated for measurable traits, and their quantitative-percentage distribution was calculated for quality traits. Characteristics of particular groups are presented with the number and percentage of participants. Due to lack of normal distribution for continuous traits, medians are given in addition to arithmetic means to describe the variables tested. The normality of distribution was measured with the Shapiro-Wilk test. However, the homogeneity of variance was measured with the Fisher-Snedecor test. For the statistical analyses carried out, a significance level of $p=0.05$ was assumed, and in the case of multiple comparisons this level was changed in accordance with the Bonferroni amendment. The t-Student test or Mann-Whitney's test (when the assumptions of the t-Student test were not met) were used to compare quantitative variables. The Spearman test was used to study monotonic relationships for continuous variables. On the other hand, the relation between dichotomous variables was analysed by means of the chi-quadrant test or its corrections (when the expected or observed counts of particular subgroups were too small). If the table of observed values was below 10, the Yates correction was applied. Where Cochran's conditions for expected values were not met, the exact Fisher test was used for analysis.

Results

The analysis of the collected data for 13,793 people made it possible to distinguish detailed information concerning the surveyed population. Based on that, eliminating specific cases, a study and control group were selected. In the group of 13,793 patients there were 159 people suffering from coccygodynia, with whom they reported to CTM. Out of this group, 123 people were included in the study group (group A) and the remaining 36 people were excluded from group A due to less than three manual therapy procedures. In the study population of 13,793 patients there were 132 people who underwent coccyx injury but currently do not feel pain in that region. These people were excluded from the study and control group. In the study group there were also 47 people who suffered a coccyx injury and periodically suffered from conditions of this region, but did not complain about coccyx pain when tested. These people are excluded from groups A and B. In addition to the above described people who suffered a coccyx injury, in group A, out of 123 participants, 30 people suffered an injury. Thus, in the whole study population, the injury of the sacrococcygeal

region affected 209 people. In the group of 13,793 people, 259 people were distinguished who named coccyx pain as a symptom occurring periodically or existing in the past, which makes out 1.89% of the studied population. This is the group of people who didn't have a coccyx injury and didn't feel any pain when tested. These people were not included in groups A or B.

Out of the described population - 7 people suffered a coccyx fracture in the past and 4 women suffered from coccyx pain that appeared during childbirth - there are those who did not feel pain during the test and were excluded from groups A and B. Out of 13,793 patients, 12 (1.93%) who underwent surgery were selected due to structural causes of coccygodynia - in 3 patients a cyst located on the coccyx was removed, in 1 person ganglion was removed, in 1 person an ulcer was dressed, 1 person was treated for coccyx cancer, 1 person had an abscess, 2 people underwent other procedures (impossible to determine due to lack of medical records), 3 people underwent coccygectomy (0.48% of the population). The above group of 12 people did neither complain about conditions in the coccyx region when tested.

In total, in the whole study population, 621 people complained about any form of coccygodynia, be it functional or structural, post-traumatic or idiopathic, being a symptom from the patient's history, appearing periodically, or about coccygodynia occurring currently, which is about 4.5% of people from the analysed group, as shown in (Figure 2).

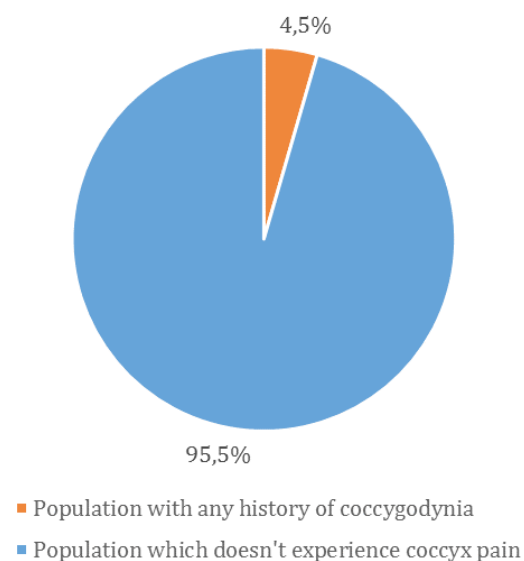


Figure 2: Presentation of the studied population and symptoms associated with coccyx pain.

In the study group (A) the vast majority of participants (95 people, 77.24%) were women ($p=0.0001$). On the other hand, in group B the number of women and men was similar, women

constituted 53.66% of the participants (66 people) and men 46.34% (57 people), as shown in (Figure 3).

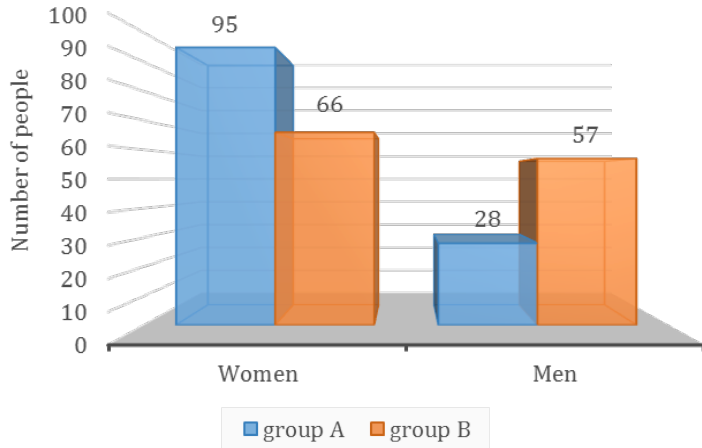


Figure 3: Sex in groups A and B.

The study of both groups showed that there are no statistically significant differences in the median age of participants from group A and B ($p=0.0589$), as shown in (Figure 4).

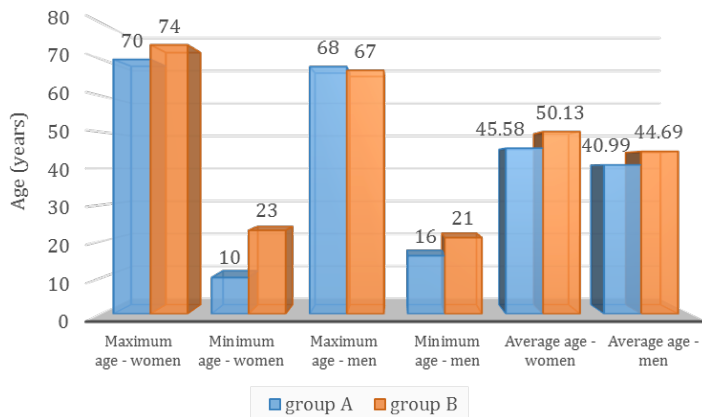


Figure 4: Age of women and men in groups A and B.

Also the mean body weight of group A did not differ significantly from the mean body weight of group B ($p=0.110570$), as shown in (Figure 5).

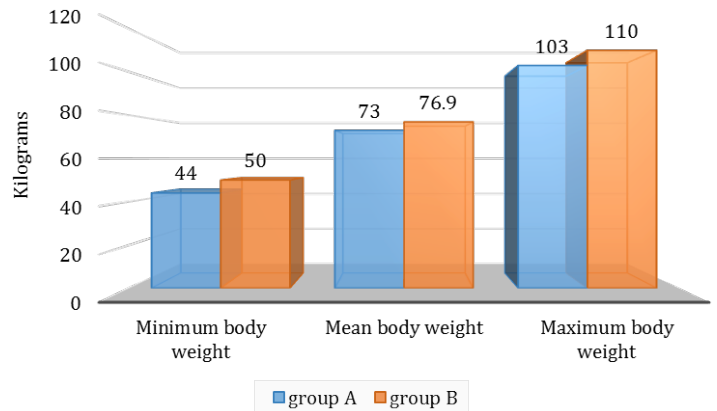


Figure 5: Body weight in kg.

However, there were statistically significant differences in the median height of A and B subjects. In group A, the median height was 167cm, and in group B - 173cm. Thus, people in group A were shorter than people in group B ($p=0.0157$), as shown in (Figure 6).

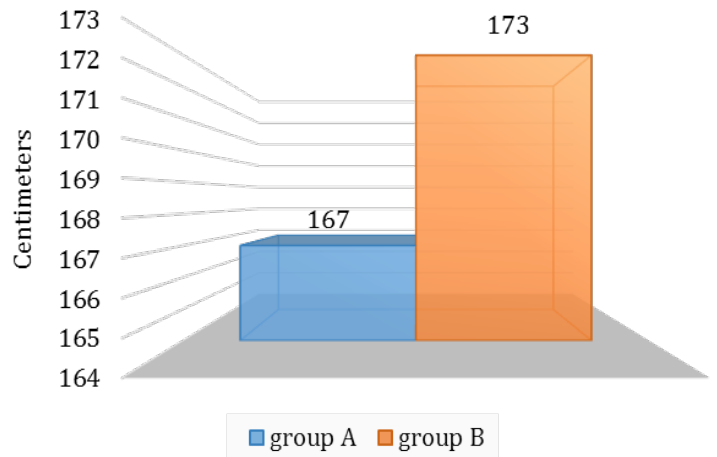


Figure 6: Mean height in groups A and B.

The study on Body Mass Index (BMI) in group A and group B showed no significant statistical differences ($p=0.6559$), as shown in (Figure 7).

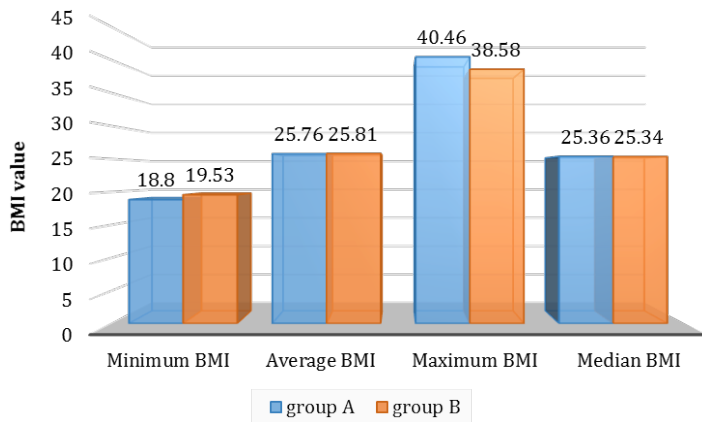


Figure 7: BMI in groups A and B.

In both groups, BMI minimum values showed similar results. The maximum BMI value in group A was slightly higher than in group B, but in both groups the median BMI was within the range slightly exceeding the norm. It was already overweight, although to a small extent, as it only slightly exceeded 25. Studies on the body mass index in group A and group B showed that the BMI value also had no impact on the short-term and long-term effect of treatment, as well as on the number of visits or the duration of treatment.

According to the studies conducted for the present work in group A, out of 123 participants, 30 people suffered a coccyx injury before the occurrence of clinical symptoms, which constituted 24.39% of people in group A. The injury was usually a fall or a blow to the coccyx. In group B there were no people who experienced an injury in the area described (Figure 8).

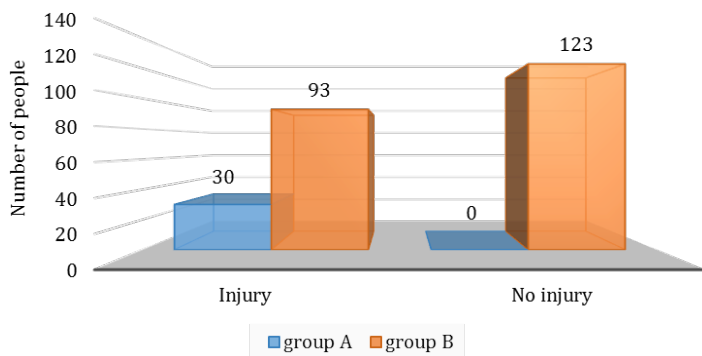


Figure 8: Injury and coccyx pain.

Statistical studies have shown that for all people with coccyx pain complaints the duration of the condition for people who suffered the injury was no longer than for those who didn't injure coccyx, but reported pain ($p=0.5927$). It also turned out that no form of pelvic floor muscle tone disorder (the test conducted according to the algorithm described by Rakowski [10] depends

on the previously sustained coccyx injury. The strength of the relationship for the studied disorders respectively amounted to: $p=0.1653$ for the excessive pelvic floor muscles resting tone, $p=0.7222$ for the reduced pelvic floor muscles resting tone, $p=0.4361$ for the pelvic floor muscles efficiency disorder, $p=1$ for the reverse pelvic floor muscles coordination.

It was also shown that there isn't a statistically significant relationship in coccyx tenderness occurrence in the per rectum examination in group A people, who sustained coccyx injury and in people, who didn't have the injury. The strength of the relationship for the studied factors respectively amounted to: $p=0.1620$ for the dorsal mobilization of the coccyx, $p=0.5870$ for the ventral mobilization of the coccyx, $p=0.0644$ for the palpation tenderness of the coccyx tip (the test conducted according to the algorithm described by Rakowski [10]).

The studies presented in this work clearly show the links between coccyx pain and other, also distant, motor system conditions. The concurring symptoms have been analysed, 3 of which are statistically significant in relation to coccygodynia. These are: sacrum, shoulder blade region and mid-thoracic spine pain. The data refer to a comparison with control group data. The study showed that sacrum pain in group A occurred 3.5 times more often in people with coccyx pain than in the control group ($p<0.0001$). Pain in the shoulder blade region occurred about 3.1 times more often in patients with coccyx pain ($p<0.0013$). Pain in the mid-thoracic spine was twice as common in group A ($p<0.0011$). This is illustrated in (Figure 9).

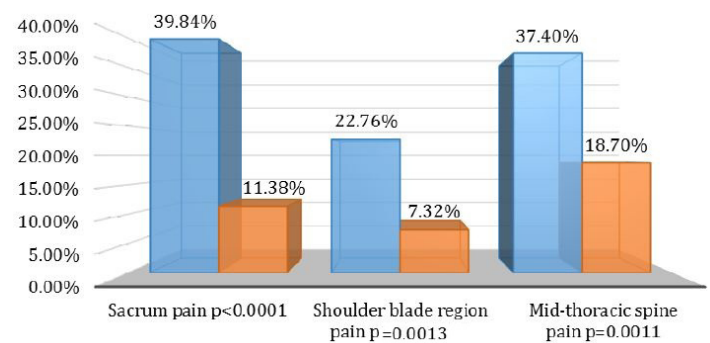


Figure 9: The relations between the occurrence of coccygodynia in group A people and other motor system conditions. Coccyx pain (group A) versus sacrum, shoulder blade region and mid-thoracic spine pain.

Other common concurring conditions in people with coccygodynia are: Lumbar spine pain occurring in 79 people from group A, which is 64.22% of the participants (96 people from group B), pain extending to lower limbs in 76 people from group A - 61.78% (19 people from group B), buttocks pain in 62 group A people - 50.4% (50 in group B), headaches in 53 group A people -

43.08% (49 in group B), pain in upper limbs in 52 group A people - 42.27% (52 in group B), knee pain in 38 group A people - 30.89% (57 in group B), C-spine pain in 39 group A people - 31.7% (27 in group B), hip region pain in 28 group A people - 22.76% (44 in group B), rectal pain in 27 group A people - 21.95% (19 in group B), vulva pain in 14 group A women - 14.73% (6 in group B), painful menstruation in 37 group A women - 38.94% (19 in group B).

In the control group - B (people without coccyx pain) the more frequent conditions were: difficulty to start and continue urination occurring about 2.2 times more often than in people with coccygodynia ($p < 0.0067$). L and L/S spine pain was about 1.2 times more frequent in people without coccyx pain ($p < 0.0168$). Hip region pain occurred about 1.6 times more often in people without coccyx pain ($p < 0.025$), and knee pain occurred about 1.5 times more often in people without coccyx pain ($p < 0.0128$). This is illustrated in (Figure 10).

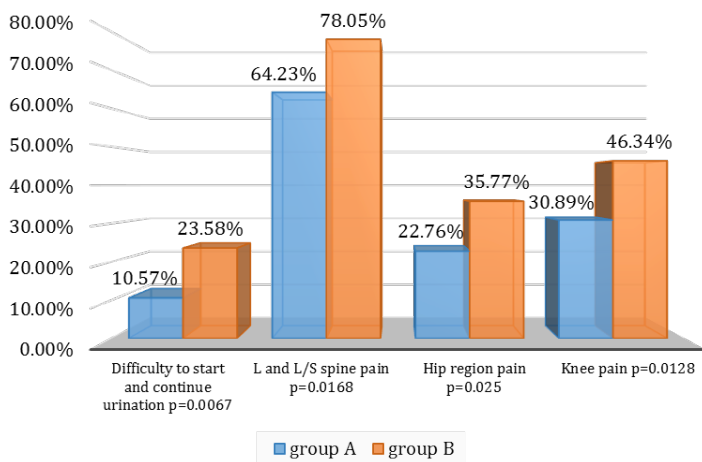


Figure 10: The relations in the occurrence of various motor system conditions in people from group B. The relationship between the occurrence of urination difficulties, L and L/S spine pain, hip region pain and knee pain in people without coccyx pain (group B).

A comparison of the occurrence of conditions in groups A and B is shown in (Table 1).

Type of condition	Group A	Group B	Statistical significance
Rectal pain	27	19	
Testicular pain	9	18	
Penis pain	2	12	
Vulva pain	14	6	
Painful menstruation	37	19	

Menstruation disorder	12	9	
Sexuality disorders	9	17	
Stress urinary incontinence	12	18	
Polyuria	15	23	
Other urination disorders (difficulty to start and continue urination)	13	29	p=0.0067
Flatulence	21	30	
Constipation	31	28	
Diarrhoea	11	11	
L and L/S spine pain	79	96	p=0.0168
Hip region pain	28	44	p=0.025
Pain extending to lower limbs	76	90	
Headache	53	49	
Sacrum pain	49	14	p<0.0001
Buttocks pain	62	50	
Groin pain	28	32	
Abdominal pain	30	33	
Shoulder blade region pain	28	9	p=0.0013
Mid-thoracic spine pain	46	23	p=0.0011
Cervical spine pain	39	27	
Neck pain - cervicothoracic junction	33	27	
Upper limbs pain	52	52	
Dizziness	20	20	
Fainting	6	3	
Knee pain	38	57	p=0.0128
Tinnitus - ringing in the ears	10	7	

Table 1: The most common conditions in groups A and B. The relationships in the occurrence of various motor system conditions in both groups are given. The last column of the table shows statistically significant differences, and (Figures 9 and 10) illustrate detailed data analysis.

Discussion

The link between this problem and the injury seems obvious. According to the literature [15-17], coccygodynia is the entity to which traumatic causes are attributed as the main cause of pain. However, the studies presented in the above work show that past coccyx injury is not the only factor determining the occurrence of coccygodynia. It seems probable that the injury may only be a stimulus for the occurrence of coccygodynia, which is not caused by tissue damage, but by disturbance of their functional balance. It seems a logical concept that injury can contribute to the development of pathological stimulation in tissues originally prepared for a negative stimulus (functionally disturbed tissues). It also seems obvious that there is a relationship in which the injury - impact or force applied from the outside - influences the change of tissue function, and those not equipped with physiotherapeutic effect after the injury - which equalizes tension, stretches or leads to a functional norm - remain in chronic dysfunction, thus provoking pain. In the case of post-traumatic coccygodynia, the procedure should be conducted in close cooperation between the doctor and the physiotherapist.

Concurrence of other symptoms in the motor system with coccygodynia shows that anatomical structures associated with the conditions analysed in this study can be significantly associated with coccyx pain. They can affect its formation and maintenance. Therefore, they can be at the same time access to afferences [10] (the right place to induce therapeutic stimuli) in coccygodynia. Thus, when examining people complaining about conditions in coccyx region, a detailed anamnesis should be conducted to reveal the concurring conditions, including those from the patient's history. Structures lying remotely and having direct, although at the moment difficult to explain, connections may prove to be key in the treatment process.

The links between coccygodynia and distant conditions of the motor system and, consequently, dysfunctional structures that lie outside the location of the problem described can be explained, as stated by Rakowski, by several hypotheses: "reflex arch (dermatome, myotome, sclerotome, viscerotome, etc.), through tissue continuity (tendon-muscle-fascia-ligament tape), through tissue neighborhood and germ leaves [18,10]. Another way of information transfer in the body is the existence of the migraine-vegetative pathway [10], which indicates the connectivity of the sacroiliac joints, motion segments of the mid-thoracic spine as well as the head-neck junction. A detailed explanation for the above may be the existence of a connection of these structures through the anterior longitudinal ligament, which starts on the cranial base of the occipital bone and ends on the pelvic surface of sacrum. On the coccyx, the anterior sacrosclatiac ligaments correspond to it [19]. In the thoracic spine, it partially covers the radiate ligaments of the rib heads, directly affecting the motion

segments of the thoracic spine. This ligament, also attaching itself to the anterior surface of the vertebra body, takes part in inhibiting the extension movement of the entire spine [19]. By binding the entire column of the spine, it closely connects to the intervertebral discs and can transmit stimuli on the principle of tissue continuity and connectivity of individual motion segments of the spine. The posterior longitudinal ligament, also closely connected to the intervertebral discs, may work in a similar way. It can transmit information to the back of the body. This is because it covers the back surface of the vertebral bodies, inside the vertebral canal, starting on the clivus of the occipital bone and on the edge of the foramen magnum, ending in the upper part of the sacral canal [19]. The tissue cohesion of the dorsal surface of the body was described by Mayers [20], showing the musculo-fascial continuity from the plantar fascia, through the calf triceps, the hamstring muscles, the sacrotuberous ligament, the spinal erectors to the epicranial aponeurosis. The fascia researchers unambiguously describe that all structures of our body are "dressed" in connective "coats", permeating each other and interacting with each other [20]. In the fascial system there are countless kinetic chains - a disorder in one place of any chain will have an effect in another [21-23].

Another possible way of transmitting information seems to be the azygos of the sympathetic trunk located on the anterior surface of the coccyx, which connects the sympathetic trunks descending from both sides of the spine and running from the base of the skull [19].

Another explanation for these relationships are the transverse planes of the motor system described by Plato and Kopp [10,24], which include: the plantar plane of the feet, the pelvic floor, the diaphragm, the thoracic inlet and the occipital plane with the mandible, the jaw and the floor of mouth. There is a constant exchange of information between these planes, the authors claim.

Another way of explaining such distant connections is the so-called "tissue speech", i.e. communication between all structures of our body. It is described as "small talk" [25]. It plays a role in regulating and maintaining homeodynamics - "which means sustaining physiological changes and variability throughout the whole life of an individual" [26]. The regulation takes place thanks to the nervous, hormonal and immune system; however, it also takes place at the molecular level, within a single cell or organ - it is called internal regulation [26]. The main way of transmission of signals (effector proteins) emitted by almost every cell are tissue fluids. Therefore, any disturbance in their flow will prevent effective internal communication. A special role is attributed to exosomes - small vesicles, secreted by cells, which can transmit proteins, DNA, mRNAs and microRNAs (miRNAs) as charge and information to other tissues. These vesicles are secreted into the intercellular space and transferred to other tissues playing an important role in the regulation of body

functions. Any disorder affecting the condition of cells will affect the quality of the transmitted information, both those regulating the biological functions of the organism and those transmitting the state of pathology in the human body [above based on: 26]. Fry et al [following 25] emphasize the importance of communication through exosomes during muscle reconstruction.

Stecco states after Jaroszyk and Marzec that “both collagen and aqueous molecules have properties of electric conduction and polarization, similar to those of cellular matrix molecules. The polarization waves and protons formed may “jump” over the collagen fibres much faster than nerve-conducted electrical signals” [22]. This may explain the immediate reaction of the body to the given treatment stimuli and may be another way of explaining how information is transmitted in the body.

Conclusion

- The concurrence of coccygodynia and many other motor system conditions was demonstrated. The following were named as clearly correlated with coccygodynia: sacrum, mid-thoracic spine and shoulder blade region pain.
- Coccyx injury is only one of the possible causes of coccygodynia.
- The idiopathic coccygodynia requires further studies in order to learn its pathogenesis in detail and to identify a cause-oriented therapy method. All the studies referred to in this paper, known to the authors, illustrate uniform groups of patients with clinically symptomatic coccygodynia. There is a lack of research in the literature which would capture a larger population and observe this phenomenon in a wider context. This is probably the first study of its kind to show coccygodynia in a larger population. It can be assumed that it is a small percentage of the occurrence of this pain syndrome that makes it difficult to get to know the specificity of the problem and the possibilities of its treatment.

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