ACADEMY OF PHYSICAL EDUCATION IM.
BRONISŁAW CZECH
IN KRAKOW

Doctoral School Dissertation

DRAFT.

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DT-472

Effectiveness of Activity-Dependent Neuro-Orthopedic Plasticity and Traditional Therapy in Cervical Discopathic Pain Syndrome

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Krakow 2023

I dedicate the work to my
Mom, who has always
inspired me and supported my
ideas by blowing in my wings
And believing that I will succeed.

I would like to thank my husband Maximilian and my
sister Alexandra for their support every step of the way
writing this work, and in particular, in those most difficult moments.
It is fortunate to have you with us.

I sincerely thank my wonderful Promoters Prof.
Elzbieta Szczygiel and Dr. Grazy Guzy for their kindness,
substantive support and valuable comments given during
the writing of this dissertation.

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1. Introduction

Cervical spine pain (SCI) is one of the leading causes of disability worldwide, with an annual prevalence rate of more than 30%. Most acute episodes resolve on their own or with treatment, but nearly 50% of people continue to experience some discomfort in the neck. This type of condition tends to recur and exacerbate, especially when proper diagnosis and effective therapy have not been carried out (1). Ineffective treatment prolongs the healing process, and the time factor is particularly important in this case. Discomfort experienced for more than three months progresses to a chronic state (2). Studies show that a prolonged duration of BKS is associated with a poorer prognosis in the recovery of this disease (3; 4). Such a situation affects the individual's personal life and environment, and more broadly, the health care system and the country's economic structure (2).

The therapy of BKS appears to be a difficult process due to both the multiplicity of causes of this condition and the treatment methods used. The desire to address the role that Neuro-orthopedic Activity dependent Plasticity (N.A.P.) therapy plays in the treatment of cervical discopathic pain syndromes inspired the presented study.

1.2 Epidemiology

BKS is one of the primary musculoskeletal conditions among the adult population (5). It is the fourth leading cause of years of life lost due to disability (2). The prevalence of this disease worldwide ranges from 16.7% to 75.1% (5), on an annual basis from 10.4% to 21.3% (6), and on a monthly basis from 15.4% to 45.3% (7). Safirii et al (2) performed an extensive data analysis based on The Global Burden of Disease study (sponsored by the World Health Organization: WHO) conducted between 1990 and 2017, which looked at the prevalence of BKS and related disability in 195 countries. Based on the results, it was observed that in 2017

289 million people have experienced BKS, while the number of years lived with disability resulting from the condition was 28.6 million. The highest percentage of people suffering from the condition was observed in Norway, Finland and Denmark (2). In Poland, based on data from the Central Statistical Office, BKS was found to rank third among the most prevalent

diseases and chronic pain in 2019 (8). Chronic BKS also affects the country's socioeconomic situation (1). The economic burden of t h e condition is high, and includes medical costs, expenses spent on compensation and lost wages (9). BKS is also one of the most common causes of sickness absenteeism, GP visits, and in many cases results in loss of ability to work (10). The care of chronically ill people is prolonged over time and generates further financial costs (1). Estimates of the expenses incurred by the healthcare system vary from country to country. In the Netherlands, the costs allocated to the treatment of BKS already amounted to 485 million euros in 1996. It can be assumed that after more than twenty years, the amount is much higher (11). In the United States, spending on health care related to spinal problems increased by 7% between 1997 and 2006, and in 2005 their treatment accounted for 9% of its total cost (11). And in 2016, the amounts spent on treating cervical and lumbar pain syndromes were the highest in the country at $124.5 billion (12).

1.3 Factors risks

BKS is a complex condition. There are many different, often coexisting and interacting risk factors, among which are individual, physical and psychosocial (12; 13).

1.3.1 Factors individual

Individual factors include lifestyle, age, gender or comorbidities. The occurrence of a pain episode in the past particularly predisposes to the occurrence of another. Age and gender are strong determinants. The incidence of BKS is higher in women and peaks between the ages of 45-54 (1; 14; 13).

1.3.2 Factors physical

These risk factors are related to body stresses generated by physical labor, habitual posture, prolonged sitting, frequent neck flexion movements and vibration, among others (5; 13; 15). Studies show that manual laborers, office workers, health care workers and drivers are more predisposed to BKS (13; 14). However, an increase in the incidence of myofascial pain was observed during the COVID-19 pandemic

- skeletal, including the cervical spine, in other professional groups as well, such as among teachers and university lecturers (16; 17). It was mainly caused by reduced physical activity and increased working hours

remote performed in a seated position in front of a computer, in non-ergonomic home conditions (17). Among individuals with BKS, the most common postural disorder is Forward Head Posture (FHP) (Figure 1). This phenomenon involves the forward extension of the head relative to the shoulders (18). This position is associated not only with neck pain, but also with numerous consequences, such as decreased mobility of the cervical spine, increased neck muscle tension, impaired balance and respiratory function (18; 19).

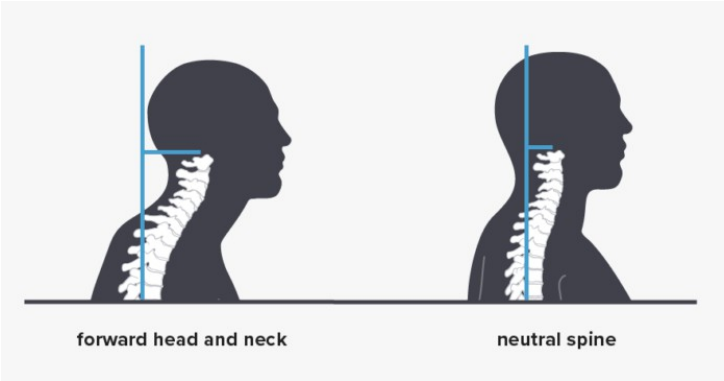


Figure 1: Left: anterior head position. Right: neutral head positioning. Source: https://www.medicalnewstoday.com/articles/forward-head-posture#what-is-it

1.3.3 Factors psychosocial

Psychosocial factors are strongly associated with chronic BKS and disability, and can alter central pain processing in the spine, brainstem or cortex. It leads to hyperalgesia, or sensitivity to pain (12). Among the most predominant psychological determinants of BKS are stress, anxiety, depression, generalized self-efficacy, job dissatisfaction and lack of social support (12; 14).

1.4 Characteristics of pain

Pain is a subjective sensation related to an individual's own experience. It is an unpleasant sensory and emotional experience caused by potential or actual tissue damage (20). Many patients report complaints of pain, despite the lack of a specific pathophysiological cause. It can be considered in the context of two important dimensions: physical and psychosocial (20).

1.4.1 Physical dimension of pain

The sensory dimension determines how pain is felt, its location, intensity and type (20). A basic classification distinguishes: neuropathic, nociceptive and secondary.

- Neuropathic pain results from injury or disease of the nervous system. It is divided into central (spinal cord pathology) and peripheral (mechanical or chemical irritation or damage to nerve roots) (1; 21). Patients describe it as a burning, freezing, numbness, tingling or prickling sensation (21).
- Nociceptive pain is caused by the activation of nociceptors. These are pain receptors that innervate somatic structures and inform about their damage or strain due to threatening mechanical, chemical or thermal stimuli (13; 22).
- Secondary pain arises from another disease process in the body, not necessarily related to the area in question. It can result from comorbidities or impaired function of internal organs. It is difficult to define due to the ambiguity of the symptoms, and therefore requires extensive diagnosis (1; 13).

Any of these mechanisms may play a role in chronic BKS. Their occurrence depends on the type of damaged structure. As our own study was conducted among patients with chronic pain, the nociceptive mechanism for acute and chronic pain is presented below (20).

Mechanism of nociception in acute and chronic pain

Any innervated structure in the neck area can be a source of somatic pain. It informs about the state of central excitability of nociceptive circuits triggered by a specific mechanical, chemical or thermal stimulus (Figure 2) (13; 22; 23). Pain that originates from damaged skin tissue is simple to identify and localize. In contrast, that which results from damage to deep somatic structures is more difficult to diagnose and can radiate, creating a sensation of deep pain spilling over a larger area. It is then more difficult to pinpoint its precise source.

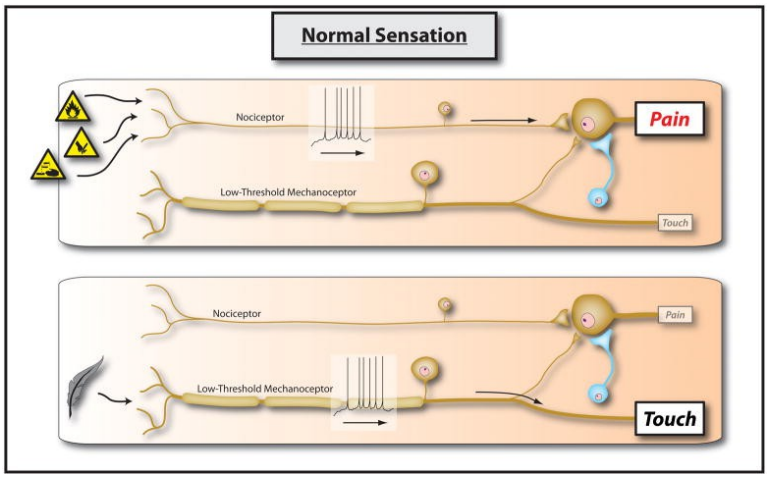


Figure 2: The normal central response to a nociceptive stimulus (23).

Mechanical forces, which can be induced by pressure or tissue tension, cause local tension or deformation of nociceptors. Once the mechanical stimulus is removed, the pain should subside. If the strain is excessive and there is actual damage or injury, then an inflammatory process begins, which should end once the causative factor is removed and the healing process is complete (13; 22). When the duration of pain and the time of its treatment are prolonged beyond 3 months, then it turns into a chronic state characterized by persistent nociceptive hypersensitivity (24). This mechanism is described as the phenomenon of central sensitization, involving an alteration in the sensory perception and interpretation of incoming stimuli from nociceptors (Figure 3).

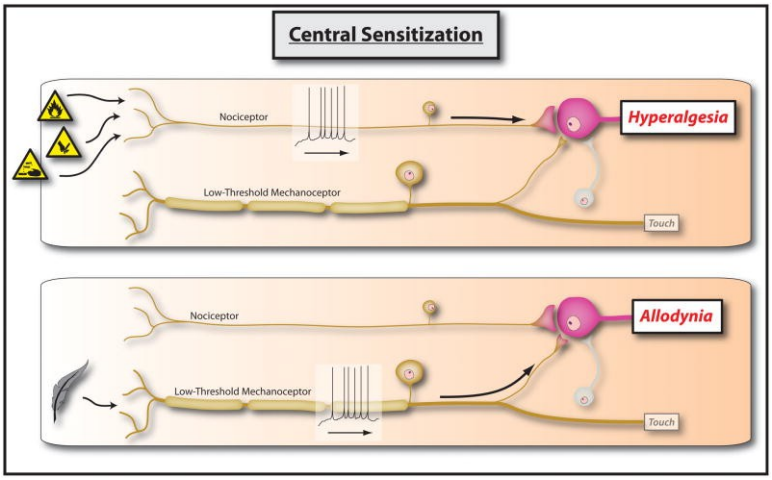


Figure 3: Abnormal central response to a nociceptive stimulus (23).

This condition manifests as hyperalgesia, otherwise known as pain hypersensitivity or tactile allodynia. When this happens, the patient interprets harmless stimuli as threatening, which can activate a pain response. In contrast, the response to actual

harmful stimulus is exaggerated, and its duration is prolonged over time. This significantly affects the patient's mood and daily functioning (23).

Discogenic pain

The intervertebral disc is often considered a common source of chronic BKS. In its structure, it is distinguished by a partially innervated fibrous ring, located at the front and back of the disc. In the front part, it resembles a crescent shape, which is thicker in front and narrows in lateral directions. On both sides, in the posterolateral part of the disc, there is a thin periosteal tissue.

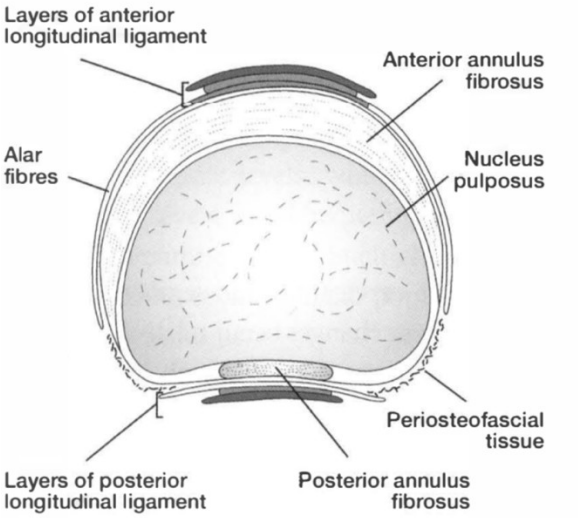


Figure 4: Intervertebral disc of an adult (13).

fascial. In the central area of the disc

The cervical nucleus pulposus is visible, which is composed of noninnervated fibrocartilage (Figure 4) (13; 14; 25). Only the outer part of the fibrous ring is innervated through, present within it, free nerve endings. The intervertebral disc of the upper spine is susceptible to mechanical stimulation, which can result in inflammation or cause pain. The cervical disc can be a source of somatic discogenic pain. It arises when free nerve endings within the annulus, become irritated, most often due to mechanical overload in daily functioning. As a result of this disorder, neck pain, headache, unilateral or bilateral pain in the shoulder, arm, eyes and chest can be induced. The patient may also experience neck stiffness, as well as muscle spasms and tension (13; 25). Lack of appropriate treatment in such cases can cause a chronic pain problem (25).

1.4.2 Psychosocial dimension of pain

The psychosocial dimension of pain includes a social, emotional, cognitive and behavioral component. Emotions are the patient's feelings that arise when experiencing it. Over-experienced and misinterpreted anxiety along with experiencing stress or depression are strongly associated with chronic BKS and disability (20). The cognitive component is related to an individual's beliefs about pain sensations and their interpretation from past experiences. Self-efficacy and pain catastrophizing are also important. The emotional dimension

and cognitive are also of great importance in this case. In brain imaging studies, it has been observed that the activity of ascending and descending pain pathways changes depending on the state of attention or the type of emotion experienced (12; 20). Among patients struggling with chronic pain, there are changes in brain areas involved in its emotional and cognitive modulation. This complex relationship may explain the emergence of anxiety disorders and depression. Cognitive disorders and chronic stress also predispose to the perpetuation and amplification of pain. Pain symptoms are exacerbated when the patient is convinced that he is suffering from a serious illness that is likely to get worse. He describes his condition as catastrophic, leading to disability. The patient's involvement in litigation and the process of obtaining compensation is also a situation that worsens his health. Abnormal ways of perceiving and responding to sensory information are associated with chronic pain (20). The behavioral component includes the patient's associated behaviors, coping and activity patterns. Often chronic pain is accompanied by disease behaviors. Taking actions that promote healing may depend on the ability to self-regulate, that is, to consciously choose health-promoting behaviors. However, this ability is limited and may be depleted by long and persistent experience of pain (12; 20). In this regard, social support can be very important for the patient. This includes interpersonal relationships, functioning in society, access to and quality of medical care. It seems that this social aspect is often overlooked in treatment. However, it can prove to be very helpful and important to the patient, especially since environmental experiences or triggers can be a direct cause of chronic pain. Teaching the patient and his family can also be helpful during this period (12; 20).

In educating patients about their pain sensations, effective and common methods use the biopsychosocial model. It provides an understanding of the complex pain process and the patient's experience, and shows the interplay of physiological, psychological and social factors and their impact on pain sensation (Figure 5).

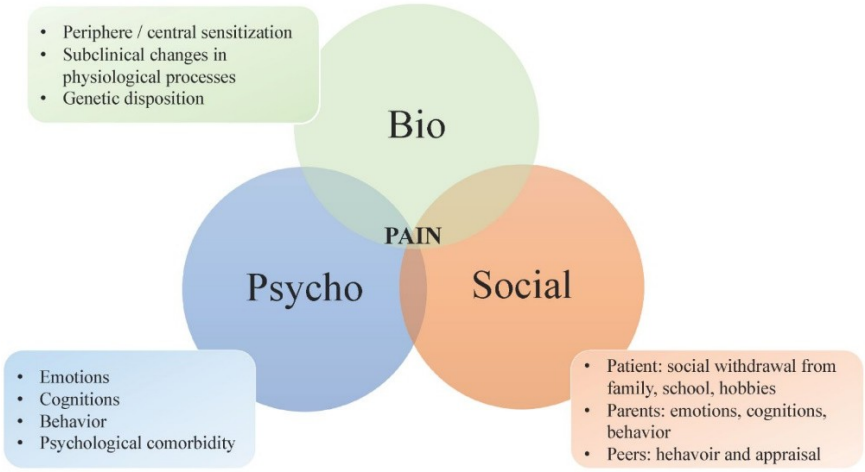


Figure 5: The biopsychosocial model of pain (26).

According to the above model, physiological factors include genetic predisposition, biological and somatic processes (including central sensitization). Psychological factors include emotions, behaviors, beliefs, and psychological comorbidities. These two large areas interact and are influenced by significant social factors, such as work environment, interpersonal relationships, support and social expectations, isolation or previous therapeutic experiences (26). Greater knowledge in this area is very important, as it can lead to reconceptualization of pain. This is a process in which the patient understands that pain complaints are not proportional to tissue damage. This is especially important in the chronic period, when the link between longer-lasting pain sensation and health is weaker. The patient also learns about the importance of psychological and social factors, as well as the physiology of pain and what it means for the body. Successful reconceptualization in the chronic period can be effective in normalizing beliefs and attitudes about pain complaints and reducing pain and disability as a result of treatment (26).

1.5 Treatment of chronic pain neck

Treating chronic pain is difficult, given the psychosocial component. Treatment patterns for chronic pain proposed in studies include an approach that combines specialists from different disciplines, including physiotherapists, psychologists, orthopedists or neurologists (24). A distinction is made between surgical and conservative treatment. For the latter modality, four areas of action are proposed in the available references, which include pharmacology, alternative medicine, psychology and physiotherapy (1; 27).

1.5.1 Pharmacology

From the field of pharmacotherapy, analgesics are offered, which can be divided into non-opioid analgesics and opioids. The WHO has defined a scheme for their use, which has been called the analgesic ladder (Figure 6).

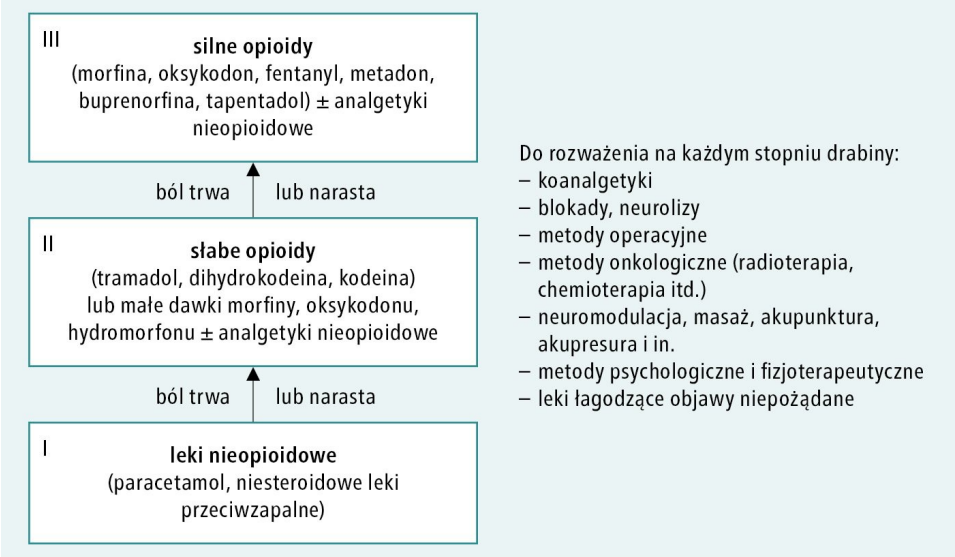


Figure 6: Analgesic ladder. Source: https://www.mp.pl/interna/image/B16.016_8349.

The first step of the ladder involves the use of non-opioid drugs, namely paracetamol or Non-steroidal Anti-Inflammatory Drugs (NSAIDs) (28). The latter are often used for general back pain. In contrast, topical NSAIDs, i.e. ointments, gels or patches, have proven efficacy among patients with mechanical pain (1). Its second tier consists of weak opioids, i.e. tramadol, codeine or small doses of morphine. The third tier includes strong opioids and these include morphine, oxycodone or methadone. While the effectiveness of opioid drugs is high, they require appropriate use and dosage selection by a doctor, especially since they have a strong addictive potential. At each step of the analgesic ladder, coanalgesics, or complementary drugs, can be used (28). In acute BKS, there is sometimes severe muscle spasm. Then muscle relaxant injections may be needed to relieve pain and improve sleep quality. The use of pharmacology in the treatment of BKS is very helpful to the patient, especially in the acute and subacute phases. However, in the chronic period, non-pharmacological methods are recommended (1; 20).

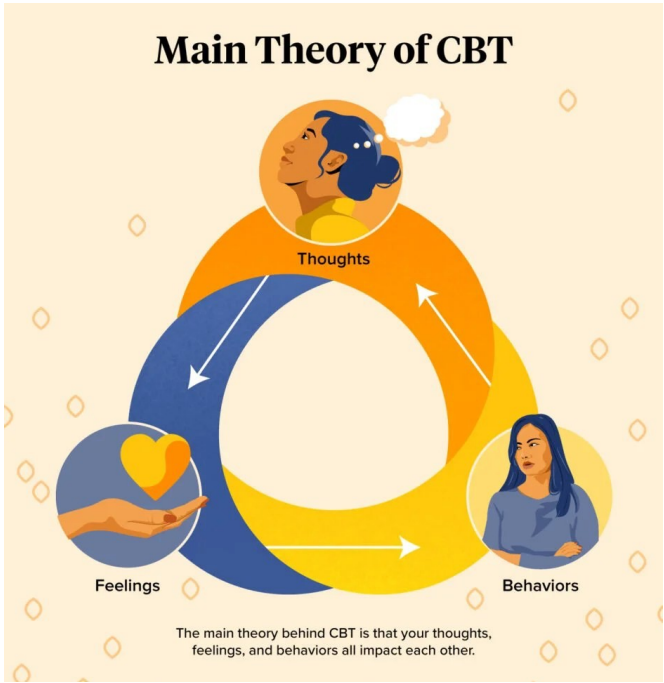
1.5.2 Medicine alternative medicine

Recently, the impact of alternative medicine has been widely studied. This includes acupuncture treatments, yoga, meditation, Qigonq or Tai Chi exercises (14). Several

reviews of the scientific literature (1; 14; 29) present weak evidence supporting the efficacy of these methods in the treatment of chronic BKS. Reductions in pain were observed immediately after the acupuncture treatment, but these effects were not sustained in the long term, i.e. after three months. The method also does not improve function in daily life. Additionally, it should be noted that the quality of studies evaluating the effectiveness of acupuncture is quite low (29). Yoga may reduce BKS and disability to a small extent, but it is no more effective than exercising at home (14). Tai Chi, on the other hand, has little benefit for BKS (29).

1.5.3 Psychology

Given the psychosocial aspect of chronic pain sensations, the impact of psychological therapies on these problems began to be studied. Treatment of musculoskeletal problems has focused on therapies that affect the body-mind connection, such as Mindfulness-Based Stress Reduction (MBSR) and Cognitive-Behavioral Therapy (CBT) (30). These two methods are worth looking into. Available references show that they have beneficial long-term effects on the physical and mental health of patients with chronic pain. They improve back pain and functional limitations (29; 30). CBT is a type of psychotherapy that is currently the best researched and scientifically validated method used to treat depression (Figure 7). It is based on the premise that human thoughts, feelings and behaviors influence each other. Therapy involves identifying harmful cognitive patterns that come from distorted thinking that trigger specific emotions in the body. Psychotherapist Works together with the patient to change unfavorable patterns



thoughts into ones that are supportive to him. In the course of this treatment, the patient learns self-help skills that he or she can apply after psychotherapy is completed (31). For patients with chronic pain, therapy focuses on eliminating harmful and reinforcing beneficial behaviors (29).

Another therapy proposal that targets the body-mind connection is the Mindfulness-Based Stress Reduction method, also called Mindfulness Meditation (Figure 8). It focuses on Being in the moment, increasing self-awareness and acceptance of momentary experiences, including physical discomfort or difficult emotions (30). The therapy session is generally conducted in a comfortable sitting position and begins with a focus on breathing. Adopting a curious attitude is recommended, friendly attitude and openness to experience flowing z body.

Figure 8: Basic components of Mindfulness Meditation. Source: https://www.builtlean.com/posture-problems/.

When destructors appear in the form of thoughts that distract from breathing, then it is important for the patient to notice and accept them. Sometimes it is also helpful to remind oneself that thoughts are just mental events that a person experiences. It is then recommended to refocus attention on breathing. The goal of Mindfulness Meditation is not to suppress thoughts, but to treat them as mental events and to distance oneself from them (32). It is a way of d e a l i n g with debilitating stress in outpatients, who often suffer from chronic pain. The above therapy seems to have neural and behavioral effects on its processing. After a short training session, a reduction in perceived pain intensity is associated with activation of so-called assessment circuits, including the orbitofrontal cortex and anterior insula. Awareness of the present moment can also contribute to inhibition of aversive cognitive anticipation, thereby reducing activity in areas of the amygdala. Changes in sensory processing, pain appraisal and cognition may help alleviate distress (32).

1.5.4 Physiotherapy

Physiotherapy has many ways to treat BKS. These can be broadly divided into traditional therapy (physical therapy treatments, massage and exercise) and special methods (e.g. Orthopedic Manual Therapy: OMT, Mechanical Diagnosis and Therapy: MDT, Proprioceptive Neuromuscular Stimulation: PNF and N.A.P.). Those whose effectiveness has been demonstrated in systematic reviews are described below (1; 33; 34; 35; 36; 37; 38).

Physical therapy

Physical therapy is a term covering treatments using various physical stimuli, which can be broadly divided into heat therapy and cold therapy. Both heat and cold have beneficial effects on many physiological processes in the human body, which have been thoroughly studied and confirmed (Table 1) (39).

Table 1 The effects of cold and heat on the body (39).

	Cold	Heat
Pain	↓	↓
Spasm	↓	↓
Metabolism	↓	↑
Blood Flow	↓	↑
Inflammation	↓	↑
Edema	↓	↑
Extensibility	↓	↑

According to the available literature on the subject, it is known that blood flow in the skin is controlled by two branches of the sympathetic nervous system. The noradrenergic system constricts blood vessels, while the cholinergic system dilates them (Figure 9). These two sympathetic nervous control mechanisms affect major aspects of the thermoregulatory responses of most of the human body surface (33).

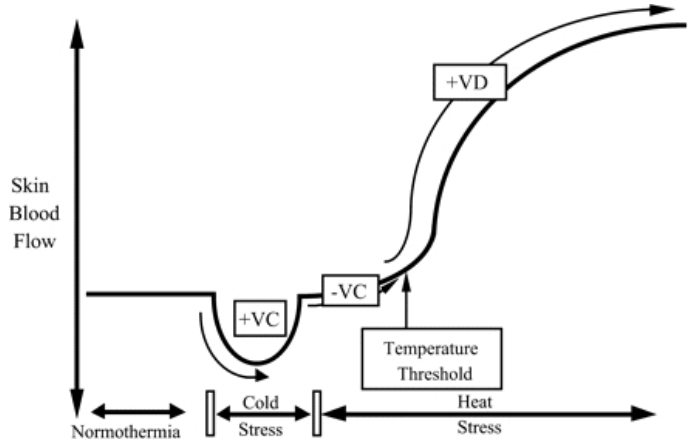


Figure 9: Skin blood flow responses to heat and cold stimulus stress.
VC = vasoconstriction, VD = vasodilation (33).

During periods of heat stress (that is, when the body receives more heat from the environment than it can give away), the temperature of the tissues increases, the vessels

Blood vessels dilate and blood flow in the skin is increased, and this consequently improves circulation and metabolism. Tissues are better oxygenated**,** which promotes faster recovery. There is an increase in the secretion of endogenous opioids, the natural analgesic substances that fight pain. The analgesic effect is also achieved by reducing the sensitivity of nerve conduction through the use of deep heat (33; 34). Heat lowers the sensitivity of muscle spindles to stretching, and this increases their elasticity. It also has a relaxing effect and reduces joint stiffness. Heat therapy treatments can be divided into systemic (hot packs, spa baths, steam baths, saunas) and local (electrotherapy, ultrasound, shock wave, Sollux lamp, laser therapy, electromagnetic field). Among patients with BKS, selected treatments from topical heat therapy are the most commonly used and studied. The literature on the subject reports that the evidence for the efficacy of laser therapy in the treatment of chronic cervical pain is moderate, and that the improvement achieved after therapy is short-lived (29). However, the studies described are of low scientific quality. Electrotherapy has been widely used for many years, but results supporting its effectiveness are limited or contradictory. In the case of BKS, studies evaluating electrotherapy treatments are of very low scientific quality, so no conclusions can be made about the effectiveness of these treatments. Current data on Transcutaneous Electrical Nerve Stimulation (TENS) currents and magnetotherapy show that they may be more effective than placebo, but this has not been observed in comparison with other therapeutic interventions. Extensive randomized controlled trials are needed to accurately assess the impact of these treatments in BKS. These should include more precise standardization and description of treatment characteristics (1; 34).

When tissues are cooled, blood vessels are constricted, so blood flow is reduced. This prevents cooling of the body and produces a strong analgesic effect by slowing the speed of nerve conduction and excitability of sensory nerves. This analgesic effect persists for up to several hours after treatment (33; 40; 41). At temperatures of 30°C or lower, the activity of enzymes that degrade articular cartilage, including collagenase, elastase, hyaluronidase and protease, is inhibited. The metabolic rate decreases, so further damage to the tissue is limited, which is especially important after injury. In addition, cold reduces

both swelling, causing an improvement in range of motion and a feeling of delayed muscle soreness, and activates the parasympathetic nervous system responsible for regeneration and relaxation of the body. The vasodilation of blood vessels, occurring in the next stage, prevents and nourishes potential damage caused by tissue hypoxia. Ultimately, muscle tension is reduced. Cold therapy can be divided into systemic treatments (ice baths) and local treatments (ice packs and cooling gel, cryotherapy with liquid gases, cold air and areosols). In the available literature, cryotherapy is presented as an effective, analgesic method of treating soft tissue injuries. It is widely used in physiotherapy (34; 40; 41). **Massage**

Massage has a rich history that dates back to antiquity. It has been used in many cultures as a relaxing or healing treatment. It involves manipulating the soft tissues of the body for a specific purpose and direction. The exact methodology of the treatment depends on its type and involves specific manual techniques (35). Massage can bring a number of physiological and psychological benefits to the body. It increases blood flow in tissues, reduces muscle tension and improves range of motion. It also reduces muscle soreness after exercise without leading to loss of muscle function. Depending on the massage technique used, mechanical pressure on a muscle can increase or decrease nerve excitability. It can also prevent the processing of painful stimuli, since pressure fibers are longer and transmit signals to the brain faster than painful ones. Low-intensity stimulation, such as light stroking or soft touch, releases oxytocin in the body. Most studies on the psychological effects of massage have shown that it has a relaxing effect, reduces feelings of anxiety and improves mood, which has a positive effect on recovery (35; 42). Based on available source items, this therapy has been shown to be effective in the treatment of various disease entities. The benefits of massage for patients with acute, subacute and chronic nonspecific back pain have been found mainly in the short-term follow-up period (36). An enhancement of the therapeutic effect is seen among patients who additionally performed self-massage between sessions with a therapist (43). Given the multifaceted effects of massage on the body and psyche, it can complement treatment in the course of chronic BKS (12).

Exercises

The WHO defines physical activity as any body movement that is produced by skeletal muscles and requires energy expenditure. It provides people with a range of health benefits, including improved functional capacity, reduced risk of chronic diseases or weight loss. It also affects psychological aspects, reducing anxiety and depression, improving mood, quality of life and life satisfaction (37; 44). Physical activity also includes physical activities performed during work, household chores, games, travel and recreation. Exercise is a subcategory of it and is a planned activity with a specific structure and purpose. They play an important role in the proper functioning of the cardiovascular, respiratory and musculoskeletal systems. Performed in full ranges of mobility, they favorably affect the metabolism of intervertebral discs. They effectively and safely reduce the intensity of BKS and disability. Patient involvement in the treatment of this condition enhances their ability to manage pain, and this serves self-esteem (37; 44).

Proper motor control, balance and posture are required to function in life and perform daily tasks in an energetically optimal manner. Responsible for these functions is the proprioceptive system, which is tasked with collecting sensorimotor information from proprioreceptors, the vestibular system and the visual system. Proprioreceptors are deep sensory receptors located in muscles, tendons, joint capsules and skin. The vestibular system collects information about the position of the head in relation to gravity, while the visual system uses a visual stimulus to identify the position of the head in relation to the surrounding environment. All this information is sent to the central nervous system, which processes the signals and sends motor commands to the muscles to perform movement (45; 46) (Figure 10).

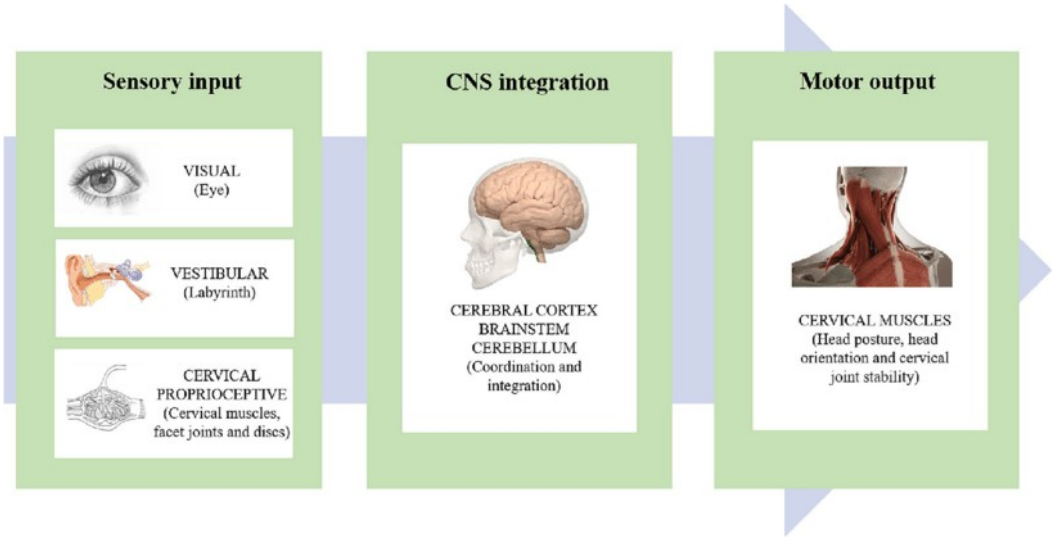


Figure 10: Diagram of sensomotor control of the neck (45).

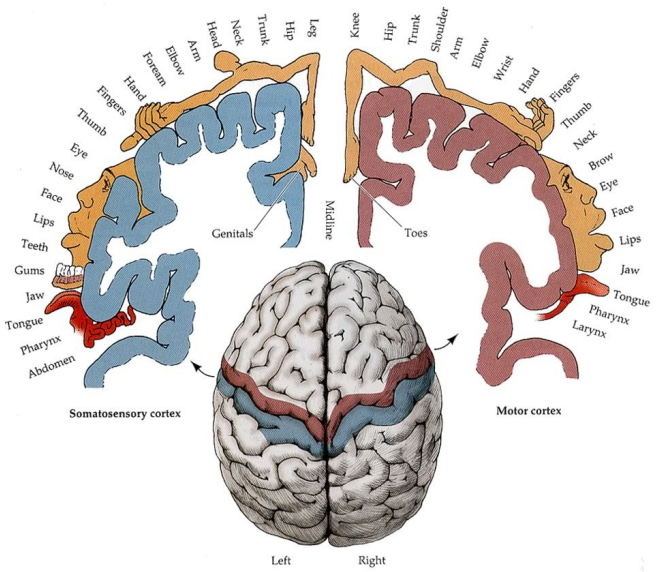


Figure 11: Somatotopic organization of the cerebral cortex
Source: https://szkolaanatomii.pl/2018/12/05/homunkulus-i-organizacja-somatotopowa/.

Disruption of sensorimotor control in the cervical region is considered a defensive response to pain. In the long term, this can lead to its exacerbation, tissue damage, sensitization of the peripheral and central nervous systems, and perpetuation of dysfunctional movement patterns (45; 46). Available studies confirm the effectiveness of exercises aimed at improving sensorimotor function, particularly motor learning, muscle coordination and deep sensation (45; 47; 48). They positively affect the sense of position and movement by repeatedly provoking proprioceptors, further reducing BKS and functional disability. Sensomotor exercises affect reorganization within the sensorimotor cortex (Figure 11). They can bring

pain-induced cortical changes to normal levels based on the plasticity of the nervous system, which partly explains the relief of symptoms and return of function in BKS patients (46).

Selected special methods of physiotherapy

OMT is a common method of treating musculoskeletal dysfunction in physiotherapy. The therapist performs a thorough diagnosis to determine the disturbed structure as well as function. He then selects the appropriate therapeutic action, which is usually performed with the therapist's hands. The basic technique in manual therapy is mobilization, which involves rhythmic oscillatory movements performed by the therapist on a joint or soft tissue. The amplitude of the movement and the strength depend on the degree of mobilization and the purpose of the treatment. The above mobilization procedures have positive effects on BKS, functional disability and selected psychological variables, such as anxiety, depressive symptoms and catastrophizing (49). The results of studies on the effectiveness of manipulation for spinal pain are mixed and may have an aspect of bias. In treating this condition, manipulation is moderately effective in the short-term, while it has shown little improvement in chronic BKS (29; 38). Manipulation and mobilization have also been shown to produce similar results. Therefore, further high-quality studies on the efficacy of these therapeutic procedures are needed (38). Another form of soft tissue manipulation in OMT is muscle energy techniques (MET). These include post-isometric muscle relaxation (PIR), trigger point massage and myofascial release therapy. PIR involves performing an isometric contraction against the therapist's resistance. The submaximal contraction is followed by muscle stretching and relaxation. This technique is used in the treatment of various musculoskeletal conditions, which work on the principles of restoring biomechanics and reducing pain and restriction of movement (50). Trigger points in skeletal muscles are characterized by a number of physical features, including a palpable painful nodule within a tense muscle band, its pinpoint tenderness, characteristic patterns of projected pain, and the presence of a local diastolic response after stimulation. Their therapy involves palpation of painful nodules and manual compression of them within the tense muscle band. This technique reduces local pain and the intensity and extent of projected pain, but often this immediate effect is short-term (51). Myofascial release therapy involves massaging the muscles through slow movements and appropriate pressure while

Using low-impact and long-term stretching of the fascia. It reduces pain, increases blood and lymph flow, and relaxes muscles. Studies suggest that MET manipulation has a good clinical effect in reducing BKS and improving cervical range of motion. However, this effect is better when combined with strengthening exercises (50).

Another physiotherapeutic method is MDT, also known as the McKenzie method. In this approach, the diagnostic part plays an important role. The therapist first conducts an extensive interview with the patient, followed by a physical examination. He determines the substrate of the patient's pain complaints (chemical or mechanical). If they are mechanical in nature, then the next step is to assess from which part of the musculoskeletal system they originate, and then classify them into one of three syndromes, i.e.: postural, dysfunctional or structural disorders. Each of these has a specific treatment algorithm. An important element in this method is regularity in the patient's home exercises and correction of harmful postural habits (13). The effectiveness of this therapy in short-term reduction of back pain and long-term improvement of disability has been confirmed (52; 53).

The PNF concept focuses on stimulating the nervous and muscular systems to achieve the highest possible functional level for the patient. In treatment, it applies the principles of postural control and motor teaching, which involves therapeutic action at different levels: body structure, activity and participation. The therapy uses specific movement patterns in specific planes. An important element is the positive approach, that is, using in rehabilitation those activities that the patient can already perform. Functional therapy is the most effective way to stimulate the patient and achieve the best therapeutic results. The PNF method is most commonly used in neurological rehabilitation, but the effects of this therapy on cervical spine pain and disability have been scientifically proven (54; 55).

N.A.P. therapy was developed by German physiotherapist Renata Horst, who specializes in OMT, neurological rehabilitation and motor learning. In addition to working with patients in her private practice, she also conducts training of trainees and instructors around the world. She is also the author of numerous scientific articles and specialized books (56). N.A.P. is an integrative, neuro-orthopedic therapy that aims to improve daily activities of daily living

patient, for example, such as moving, speaking, swallowing or looking. It is used in neurological, orthopedic and sports rehabilitation, as well as in traumatology. The concept of this method is based on the assumption that motor activity influences brain plasticity, that is, stimulates a positive change in its cortical representation. On the contrary, chronic pain, through increased hyperactivity of the nervous system, reduces the volume of the gray matter of the brain area corresponding to the painful part of the body. In order to rebuild it, the patient must experience pain-free, normal movement again. An important element in the N.A.P. concept is motor control, which controls movement mechanisms through the interaction of the musculoskeletal and nervous systems. Based on these, it plans to carry out the movement in the most economical way. The determinants of adequate motor control are mobility, stability and dexterity. Mobility is the ability to initiate movement, or to have functional mobility leading to the adoption of a chosen position. In the case of stability, both dynamic and static activities are distinguished. Dynamic stability is the ability to control posture when the body or its parts are in motion. Static stability is the ability to properly maintain a selected body position (57; 58). Agility is the ability to perform goal-oriented motor actions with distal areas of the body, with simultaneous postural control responsible for proximal stability of the body. In the case of an unstable position, there is an emergence of protective tension in the muscles surrounding the joint. In N.A.P. therapy, controlled mobility is used while performing closed chain exercises. The distal parts of the body then form a stable point so that the proximal parts can move. Motor control also makes use of such information transfer systems as anticipatory feedback (movement planning) and feedback (information about the action performed). Since passive movement can stimulate protective tension and cause pain, learning a new activity only occurs through the patient's active participation in performing it. If the patient cannot perform it in this way, he should at least visualize it. Then the processes of planning the movement are stimulated, and the therapist, by performing it, stimulates feedback. Thus, the intended activity is confronted with the performed one. This approach is very important, because only the active participation of the patient can lead to functional change, and passivity on the part of the patient, while holding a position or performing a movement, has no practical benefit. The process of teaching new skills involves many

areas of the brain. Therefore, in order to achieve its full spectrum of stimulation, multiple stimuli are used during therapy, including sight, hearing, speech, touch and taste. Another important element is the patient's interest in the activity being performed, so that he becomes involved in the treatment and his motivation is naturally aroused. The therapist combines manual knowledge with neurophysiological principles. He uses motor learning techniques, postural control exercises and respiratory function improvement. The therapist's hands help achieve the best possible biomechanical situation for the patient by stabilizing positions or mobilizing a particular body part for movement. There are three elements of motor learning, such as cognitive function (recognition), association (action) and automatization (repeated repetition of a new movement). Sensory information from the environment is important in planning and organizing movement. Motor learning is oriented toward feedback, but occurs only in connection with purposeful motor action. Frequent repetition leads to changes at the level of synapses, and this is a feature of the nervous system called plasticity. The therapist assesses the patient's functional limitations when performing daily activities, including social and cultural aspects. In the case of BKS, the N.A.P. concept proposes activities such as diaphragmatic stimulation with vowel phonation, elongation of suboccipital muscles in the activity of looking, eccentric stimulation of the sternocleidomastoid (MOS) muscles during the activity of turning onto one's back, inclined muscles in the activity of pulling down a blanket and subglottic muscles during the utterance of vowels, among others (57).

2. Purpose of work

The purpose of this study was to evaluate the effectiveness of the N.A.P. concept and traditional therapy in the course of disc-like BKS. The effectiveness of both treatment modalities was considered in the short term, i.e. immediately after its completion, and in the long term, i.e. after a period of three more months.

2.1 Questions research

The following research questions were formulated:

1. Is the N.A.P. concept more effective in reducing pain intensity than traditional therapy for BKS?
2. In the study group, do the therapies used for BKS patients reduce their level of disability, and to what extent?
3. Does one of the selected therapies more effectively correct FHP among subjects?
4. Does the use of the N.A.P. method reduce depression more effectively than traditional therapy in patients with BKS?
5. In the study group, do the therapies used for BKS patients affect the level of anxiety experienced, and to what extent?
6. Do the level of anxiety-trait and the level of overall self-efficacy moderate the achieved effects of the two therapies?

2.2 Hypotheses research

The following research hypotheses were formulated:

1. The N.A.P. concept is more effective in reducing pain intensity compared to traditional therapy in patients with BKS.
2. The N.A.P. method reduces the level of BKS-related disability more effectively than traditional therapy.
3. N.A.P. therapy effectively corrects FHP compared to traditional therapy among subjects.
4. N.A.P. therapy is more effective in reducing the level of depression among people with BKS of discopathic origin compared to traditional therapy.
5. The N.A.P. concept more effectively reduces state anxiety in BKS patients compared to traditional therapy.
6. The level of anxiety-trait and the level of overall self-efficacy affect the achieved effects of both therapies among the patients studied.

3. Material and method

3.1 Material

The study was carried out in one of the rehabilitation clinics in Cracow in 2020-2022. The consent of the Bioethics Committee (consent number: 40/KBL/OIL/2020) and the head of the clinic was obtained. Seventy-four patients in the age range of 30-50 years complaining of cervical disc pain syndromes were qualified for the study. The following inclusion criteria were defined: non-traumatic, disc-like, chronic (symptoms lasting more than 3 months) cervical pain of mechanical origin, localized in the cervical region with the possibility of radiation to the upper edge of the scapula and head (without root symptoms and neurological disorders), classified as syndrome No. 1 according to the Quebec Task Force (QTF) Classification, and a condition not requiring surgery (59). Exclusion criteria for the study included: comorbid advanced neurological, rheumatic, urological, psychiatric diseases and unsystematic participation in therapy. Patients were qualified prior to treatment on the basis of a medical examination (history, physical examination, analysis of imaging studies, including X-ray, MRI, CT scan). Respondents were randomly divided into two groups. The study group used the N.A.P concept (group N), while the control group used traditional therapy (group T). The subjects were predominantly female. There were 27 women in the N group (77.14%), and 34 in the T group (87.18%). The gender frequency distribution was not statistically significantly different between the groups. The mean age value in group N was 42.09±6.62 years, while in group T: 45.28±5.38 years. The mean value of the duration of a pain episode in group N was 12.17±6.70 months, while in group T it was 9.23±3.57 months.

Treatment in both groups included 10 therapy sessions held daily from Monday to Friday over a two-week period. The following treatment programs were used:

I. N.A.P. therapy treatment program.

Six exercises were used, each of which was performed 10 times. Their progression was introduced through changes in position, individually adapted to the patient's capabilities. Therapy for patients with BKS included the following exercises (57):

1. **Eccentric subglottic muscle work during breathing activity.** The patient lies backwards on a therapy table with his knees bent, and the therapist sits on the side of his head. To stabilize the positions, the patient has a roller placed under his head, and the person conducting the exercises with his right hand additionally supports his head at occipital level. The therapist's left hand is at the level of the sternum. The patient is instructed to place the tip of the tongue behind the upper teeth, then takes a deep breath in and pronounces the "l" voice with exhalation. At this time, the therapist assists the exhalation by pushing the chest slightly in a caudal direction. The head is a stable point and the chest is mobile (Figure 12, Figure 13).

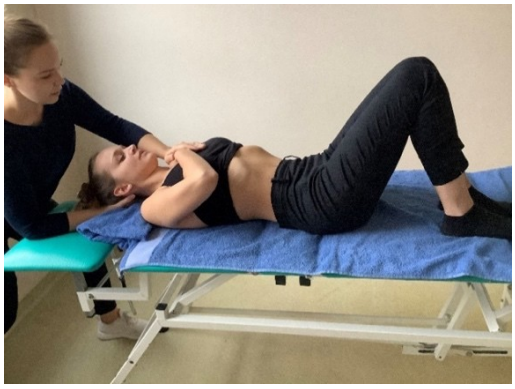


Figure 12. Eccentric work of the subscapular muscles during breathing activity: the beginning of the exercise. Source: own collections.

Fig. 13. Eccentric work of the subscapular muscles during breathing activity: the end of the exercise. Source: own collections.

2. **Elongation of suboccipital muscles in gaze activity.**

The patient lies backwards on the therapy table with his knees bent. The therapist sits on the side of his head. The therapist's fingers rest at the level of the suboccipital muscles. The therapist asks the patient to look at him and then move his gaze to a point on the extreme opposite side. The head is a stable point and the gaze is mobile (Figure 14, Figure 15).

Figure 14 Stimulation of suboccipital muscles through vision: beginning of the exercise. Source: own collections.

Figure 15: Stimulation of suboccipital muscles through gaze: end of exercise. Source: own collections.

3. **Stimulation of the diaphragm with a scarf in breathing activity.**

The patient lies backwards on the therapy table with his knees bent and the roller under his head. The patient wraps the scarf around his chest at the level of his ribs, crossing it in the middle of his torso, and holds the opposite ends in his hands. The patient is instructed to take an inhalation, and then on exhalation, slightly tightening the scarf, rotates the forearms outward pronouncing the "sh" voice. The head is a stable point and the chest is mobile (Figure 16).

Figure 16: Stimulation of the diaphragm through a scarf. Source: own collections.

4. **Repeated eccentric activity of MOS muscles during rotation.**

The patient lies on his right side (later switching sides) with his legs bent at the knees. The therapist stands to the side of his head and uses his left hand to stabilize his head at occipital level, while placing his right hand on his chest at the level of the terminal attachment of the MOS muscle on the left side. The therapist asks the patient to look at him, then take an inhalation, and with an exhalation

uttered the "sh" voice and turned his torso on the blanket behind his back. The head is a stable point and the chest is mobile (Figure 17, Figure 18).

Figure 17. Repeated eccentric activity of the MOS muscles during rotation on the blanket: the beginning of the exercise. Source: own collections.

Figure 18. Repeated eccentric activity of MOS muscles during rotation on a blanket: end of exercise. Source: own collections.

5. **Repeated eccentric activity of inclined muscles in a blanket pulling motion.** The patient lies on his right side with his legs bent at the knees. The therapist stands behind the patient from the side of his head and uses his left hand to stabilize the head at the level of the occiput, while placing his right hand on the chest at the level of the terminal attachment of the inclined muscles on the left side. He then asks the patient to look at him, take an inhalation and with an exhalation, saying the "sh" voice, pull the blanket down towards his legs. The head is the stable point and the chest is the mobile point (Figure 19).

Fig. 19. Repeated eccentric activity of inclined muscles in the movement of pulling a blanket. Source: own collections.

6. **Elongation of suboccipital muscles in the activity of reaching for a snack.**
   The patient sits in a chair at a therapy table with his elbows propped up on a recliner. He holds a snack such as dried fruit at face level. The therapist instructs the patient to grasp the food he is holding with his teeth and make a backward head movement. The patient holds the snack with his teeth the whole time. He then returns to the starting position. The treating person can assist the head retreating movement. The shoulder rim is the stable point and the head is the mobile point (Figure 20, Figure 21).

Figure 20. Retracting the head after the activity of reaching for a snack: the beginning of the exercise. Source: own collections.

Figure 21 .Therapist support of head retraction movement: end of exercise. Source: own collections.

II. Traditional therapy treatment program

Traditional therapy was a comprehensive rehabilitation program that included physical therapy treatments and therapeutic exercises commonly used in BKS. The following exercises were selected (60; 61; 62; 63):

- Isometric neck muscles - consisted of inducing tension in the cervical muscles on each side of the neck without making a movement. The therapist applied resistance to the patient's head from the front, sides and back. Each direction was one series of exercises of 10 repetitions of contractions against external resistance. The contraction time was 5 seconds, and the relaxation period was about 10 seconds.

- Active self-assisted for the muscles of the shoulder girdle performed in the Universal therapeutic improvement room (UGUL) in the sagittal (flexion) and frontal (abduction) planes for 10 minutes.
- Active in relief for the shoulder girdle muscles performed in the UGUL in the transverse plane (horizontal flexion and extension) for 10 minutes.

From the field of physical therapy, (63; 64) were selected:

- TENS current treatment performed in the area of the cervical spine and shoulder girdle. Two electrodes were placed parallel to each other on the middle area of the quadriceps muscle, on both sides of the spine. In the above procedure, an apparatus from EIE (model MULTITRONIC MT-4) was used. The treatment lasted 15 minutes, its frequency was 100 Hz, while the pulse time was 200 μs.
- Topical cryotherapy treatment with carbon dioxide was performed with a CyroFlex apparatus, Cyro-T portable model (NR-2). During cryotherapy, the distance of the nozzle outlet from the treated area was about 20 cm, and the physiotherapist made circular movements with the blowing nozzle in the neck and shoulder rim. The session time was 3 minutes at a time.

3.2 Method

Prior to the start of the study, participants were briefed on the study, informed of its anonymity, signed a written consent form, as well as completed a form containing questions characterizing the study group (age, gender, episode duration). The therapies, as well as the evaluation of the variables, were performed by experienced physiotherapists in cooperation with a psychologist. Measurements were made using appropriate survey instruments, which were carried out on three occasions, i.e.: before the treatment, after the treatment, and after a further three months. The exceptions were trait anxiety and self-efficacy, which were examined only before the start of rehabilitation. The pattern of participation in the study is shown in Figure 22, which shows that several patients dropped out during the study.

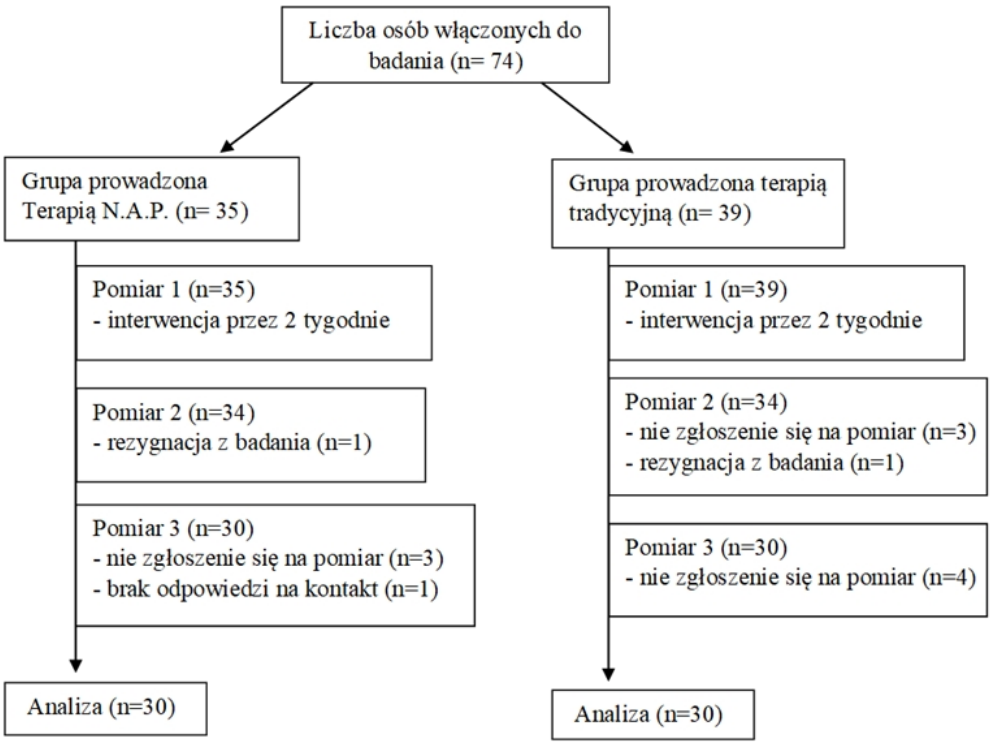


Figure 22 Diagram of participation in the study. Source: own collections.

3.2.1 Tools research

The following research tools were used in our own work:

- The Numerical Rating Scale (NRS), which contains 11 degrees of pain intensity. It represents a 10-centimeter section divided into 10 equal parts, each marked with a number in the order of 0 to 10 points, where 0 means no pain, while 10 means maximum pain. Studies on psychometric characteristics have proven its high sensitivity and reliability (65).

- The Neck Disability Index (NDI) questionnaire, which examines the level of disability from BKS. It includes 10 questions, regarding head and neck pain and limitations in daily functioning resulting from these pain conditions. Each question can be answered by the patient by selecting one of six answers scored from 0 to 5 points, so the final score from the entire questionnaire can range from 0 to 50. A score between 1-4 points indicates no disability, 5-14 points mild disability, 15-24 points moderate disability, 25-34

points severe disability, and above 35 points total disability. The Polish version of the NDI questionnaire has been psychometrically tested (66).

- Photographic method to evaluate FHP. Based on photographs of the shoulder and head region taken in the forward and lateral standing positions, two angles are measured using the computer program GIMP (version 2.10.34). The camera was placed on a tripod at a distance of 150 cm from the patient. In the sagittal plane, the Cranio Vertebral Angle (CVA), formed by the line connecting the C7 spinous process to the targus of the ear, was measured. CVA values below 48° indicate FHP. In the frontal plane, on the other hand, the Frontal Head Tilt Angle (FHT) formed by two lines is measured. One connects the lower edges of both ears, and the other runs horizontally from the lower edge of the right ear. The FHT provides information about the position of the head in lateral flexion. There are no specific norms for FHT, while it is advisable to be at or near zero. A higher score for CVA and a lower score for FHT indicate improvement in FHP. The reliability of the described procedure is rated as high (67; 68; 69). In the author's study, images were taken with a SONY DSC-W810B camera.

- The State-Trait Anxiety Inventory (STAI), which measures anxiety understood as a transient and situationally conditioned state of the individual, and anxiety as a relatively fixed personality trait. The STAI consists of two subscales, one of which (X-1) is used to measure anxiety-state and the other (X- 2) anxiety-trait. The questions that make up the two scales are placed on both sides of a single test sheet. Each subscale consists of 20 items, to which the respondent answers by choosing one of four categorized responses. The point values for each part can range between 20 and 80 points. High point values indicate higher levels of anxiety. As mentioned above, in the author's study, anxiety as a trait was only assessed prior to therapy and will be a moderating variable (70).

- The Center for Epidemiologic Studies Depression Scale-Revised (CESD-R). It is a self-report scale that examines levels of depression. It consists of 20 statements relating to mood and behavior occurring over the past two weeks. For each statement describing mood or behavior, subjects choose one of five possible responses regarding the frequency of occurrence. The lowest score is 0 points and the highest is 80 points. The authors of the scale suggest that a score of 16 points or more can be considered worrisome. It is then worth suggesting that the patient go for psychological or psychiatric consultation. The higher the score, the worse the depressive state (71).

- The Generalized Self-Efficacy Scale (GSES), which measures the strength of an individual's overall belief in the effectiveness of coping with difficult situations and obstacles (72). The scale consists of 10 statements that can be answered with a range of 1 to 4 points. The sum of all the city's scores ranges from 10 to 40 points. The higher the score, the greater the sense of self-efficacy. Scores between 10 and 24 points indicate low self-efficacy, 25 to 29 points indicate medium self-efficacy, and 30 to 40 points indicate high self-efficacy. The GSES variable is a relatively constant character trait, so it was examined only once, at the beginning of therapy, and will be a moderating variable (73).

3.2.2 Analysis Statistical

Statistical analysis was performed to examine whether the results at each of the two and three measurement points differ, and whether the differences, if any, are different in the group treated with the N.A.P. concept and traditional therapy. For this purpose, mixed analyses of variance were used with one repeated-measure factor (for the two and three measurement points) and one between-group factor (T vs. N group). Analysis was performed on moderators in the form of STAI-X2 and GSES. In terms of statistical analysis, means, standard deviations, minimum and maximum values were used to describe numerical variables, and qualitative variables were used for counts and percentages. To assess the statistical significance of differences between groups, Student's t-tests were used for

numeric variables and chi-square tests for qualitative variables. A two-factor analysis of variance with one repeated-measure factor and one group factor was used to examine changes in scores across the three measurements with grouping. On the other hand, analysis of interactions between numerical variables was carried out using moderation analysis. In addition, an a posteriori (post-hoc) statistical power analysis was performed, which showed that the sample of 74 individuals provided sufficient power to detect the main effect of repeated measure and its interaction with the group factor for the medium and large effect size, but not for the weak strength effect. This means that the number of people included in the study is sufficient to produce significantly statistical results (Table 2).

Table 2 Power analysis

	Weak effect (f = 0.10)	Average effect (f =0.25)	Strong effect (f = 0.40)
Main effect	57,7%	95,6%	99,9%
Effect for interaction	44,7%	99,8%	99,9%

4. Results

4.1. Intensity of pain

In group N, the mean NRS values in measures 1, 2 and 3 were: 5.73±1.96 points, 0.87±1.53 points and 1.27±2.16 points, while in group T: 6.13±2.03 points, 3.67±2.29 points, 3.13±2.43 points (Table 3, Figure 23). It was also observed that statistically significant differences between groups were only in measure 2 and 3 (mean values in group N were lower than in group T) (Table 4).

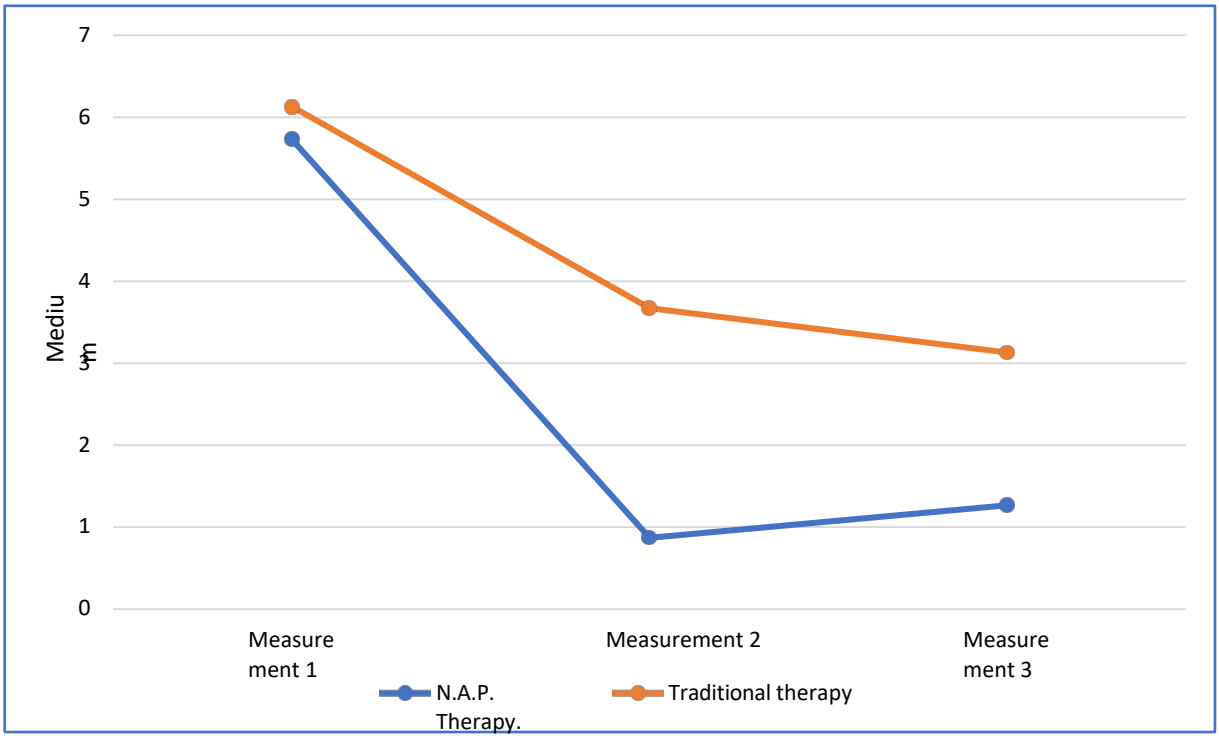


Figure 23: Average values of pain intensity in three measurements.

Table 3. Mean and Standard Deviation of pain intensity in individual measurements of both groups.

Group	Medium			OS			N
	Measurement 1	Measurement 2	Measurement 3	P1	P2	P3	
N	5,73	0,87	1,27	1,96	1,53	2,16	30
T	6,13	3,67	3,13	2,03	2,29	2,43	30

Table 4 Differences between groups in mean pain intensity measurements.

Measurement	Difference in averages	*p*
Measurement 1	-,40	,441
Measurement 2	-2,80	<,001*
Measurement 3	-1,87	,003

* - statistically significant result

After the therapy, statistically significant improvements in the NRS between measurements 1 and 2 and 1 and 3 were achieved in both groups of subjects. In group N, the pain intensity level decreased by 4.87 points between measurements 1 and 2, and by 4.47 points between measurements 1 and 3. In group T, the difference between measurement 1 and 2, as well as 1 and 3
amounted to respectively: 2.47 points and 3.00 points (Table 5).

Table 5 Differences between measurements separately in the groups.

		Difference in averages		*p*	
Group	Measurement	Measurement 1	Measurement 2	Measurement 1	Measurement 2
N	Measurement 2	-4,87		<,001*	
	Measurement 3	-4,47	,40	<,001*	,357
T	Measurement 2	-2,47		<,001*	
	Measurement 3	-3,00	-,53	<,001*	,221

* - statistically significant result

Analysis of variance for interaction (ANOVA) showed that the changes observed in the outcome of therapy both at the end of treatment ($p<0.001$) and after a further three months ($p = 0.001$) were statistically significantly different. Therapy N.A.P. proved to be more effective in this regard (Table 6).

Table 6 Analysis of variance of pain intensity measurements.

	After therapy		After three months	
Effect	*F*	*p*	*F*	*P*
Measurement	254,44	<,001*	103,03	<,001*
Measurement × Group	29,20	<,001*	8,26	,001*

* - statistically significant result

4.2. Level of disability

In the N group, the mean NDI values at the 1st, 2nd and 3rd measurement points were, respectively: 11.47±3.48 points, 3.97±3.27 points and 3.40±2.98 points, while the in the T group: 15.63±7.22 points, 9.53±5.73 points, 8.20±6.20 points (Table 7, Figure 24). Further statistical analysis showed that the differences between the groups in each of these measurements were statistically significant (mean values in group N were lower than in group T) (Table 8).

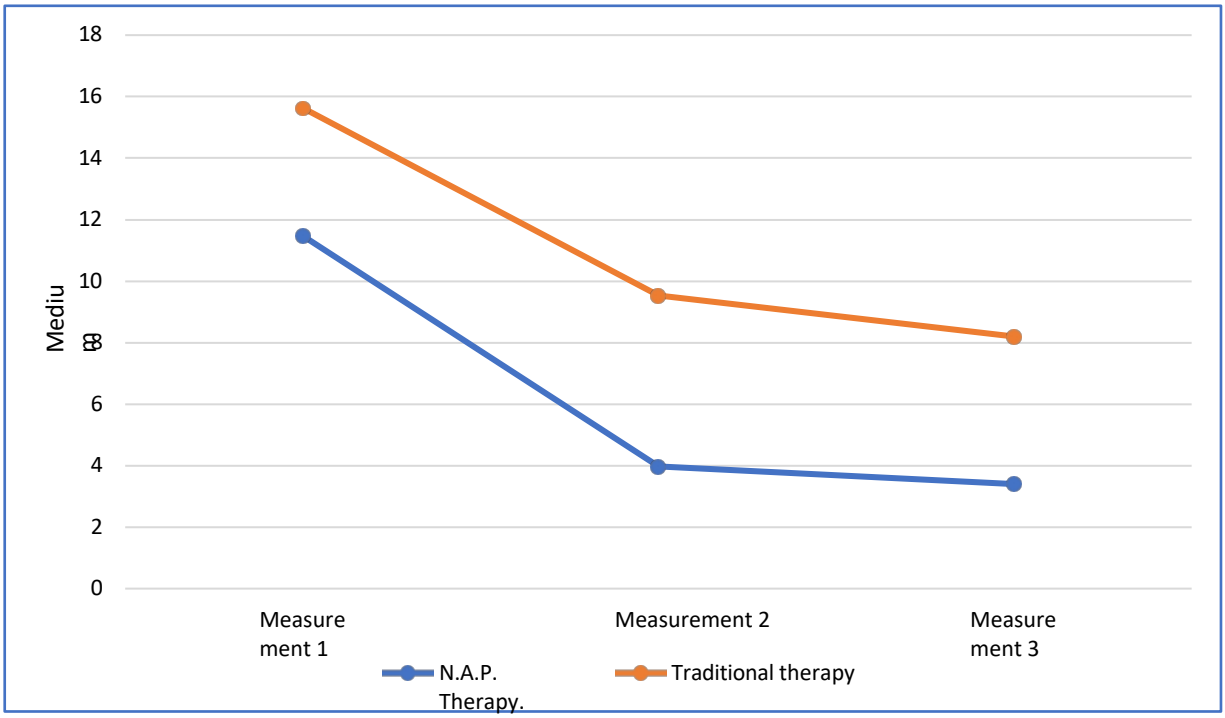


Figure 24: Average values of the level of disability in the three measurements.

Table 7. Mean and Standard Deviation in the level of disability in each measurement of the two groups.

Group	Medium			OS			N
	Measure ment 1	Measure ment 2	Measure ment 3	P1	P2	P3	
N	11,47	3,97	3,40	3,48	3,27	2,98	30
T	15,63	9,53	8,20	7,22	5,73	6,20	30

Table 8 Differences between groups in measures of mean NDI values.

Measure ment	Difference in averages	*p*
Measure ment 1	-4,17	,006*
Measure ment 2	-5,57	<,001*
Measure ment 3	-4,80	<,001*

* - statistically significant result

As a result of the treatment, both the N and T groups achieved statistically

significant improvements in NDI only between measurements 1 and 2 and 1 and 3**.** In the N group, the level of disability decreased by 7.50 points between measurements 1 and 2 and by 8.07 points

Between 1 and 3 measurements. In the T group, the difference between measurement 1 and 2, as well as 1 and 3

amounted to respectively: 6.10 points and 7.43 points (Table 9).

Table 9 Differences between measurements of mean NDI values separately in the groups.

		Difference in averages		*p*	
Group	Measurement	Measurement 1	Measurement 2	Measurement 1	Measurement 2
N	Measurement 2	-7,50		<,001*	
	Measurement 3	-8,07	-,57	<,001*	,412
T	Measurement 2	-6,10		<,001*	
	Measurement 3	-7,43	-1,33	<,001*	,057

* - statistically significant result

An analysis of variance for the interaction showed that the changes observed in treatment outcome both after the end of treatment (p=0.147) and after a further three months (p=0.440) were not significantly different (Table 10).

Table 10: Analysis of variance of disability level measures.

	After therapy		After three months	
Effect	*F*	*p*	*F*	*P*
Measurement	199,73	<,0018*	115,02	<,001*
Measurement × Group	2,16	,147	,79	,440

* - statistically significant result

4.3. Angle CVA

The mean CVA values in the N group were: 52.12±4.95 degrees (measurement 1), 56.59±4.31 degrees (measurement 2), and 56.46±4.62 degrees (measurement 3), and in the T group:

48.78±6.15 degrees (measurement 1), 50.30±6.50 degrees (measurement 2) and 50.25±6.61 degrees (measurement 3) (Table 11, Figure 25). It was also found that the mean values in the N group were statistically significantly higher than in the T group in all measurements (Table 12).

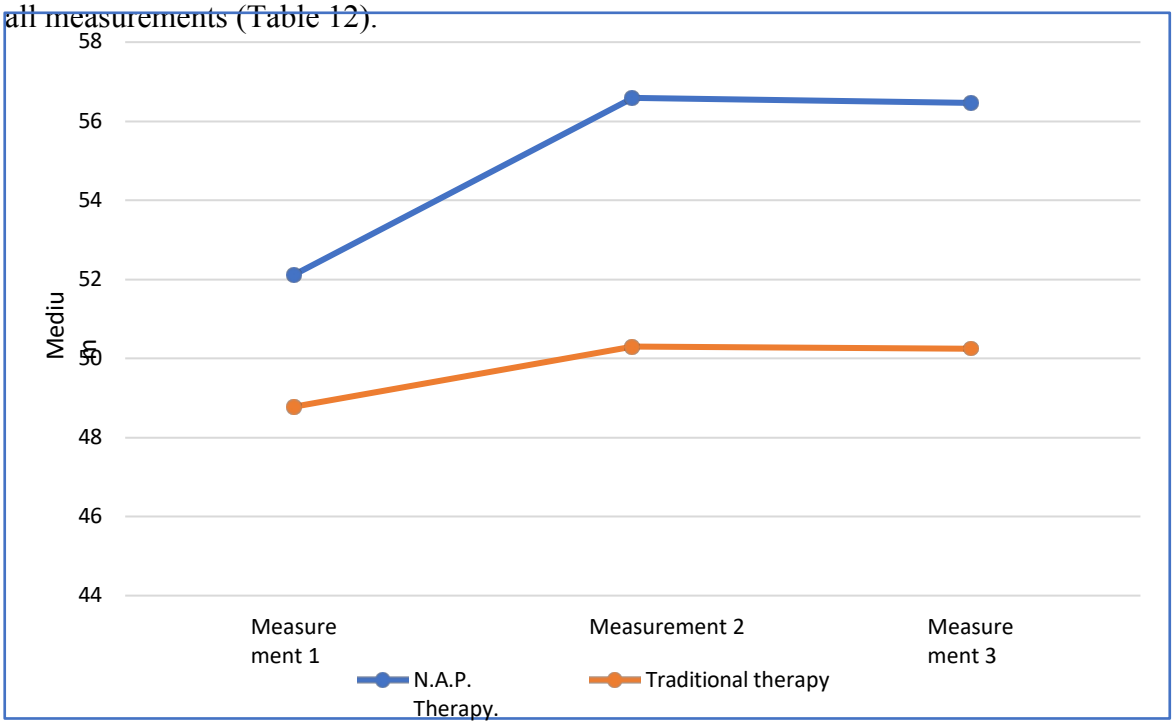


Figure 25: Average CVA angle values in three measurements.

Table 11. Mean and Standard Deviation for CVA in individual measurements of both groups.

Group	Medium			OS			N
	Measure ment 1	Measure ment 2	Measure ment 3	P1	P2	P3	
N	52,12	56,59	56,46	4,95	4,31	4,62	30
T	48,78	50,30	50,25	6,15	6,50	6,61	30

Table 12: Differences between groups in measurements of mean CVA values.

Measure ment	Difference in averages	*p*
Measure ment 1	3,34	,024*
Measure ment 2	6,29	<,001*
Measure ment 3	6,21	<,001*

* - statistically significant result

A statistically significant improvement in the CVA variable was observed in both groups of subjects after the therapy. In group N, head extension improved by 4.47 degrees between measurement 1 and 2 and by 4.33 degrees between measurement 1 and 3. In the T group, the difference was 1.52 degrees between measurement 1 and 2 and 1.46 degrees between measurement 1 and 3 (Table 13). Analyzing the period between the 2nd and 3rd

measurement, it was noted that there were no significant changes for the N (-0.13 degrees) and T (-0.05 degrees) groups.

Table 13 Differences between measurements of mean CVA values separately in the groups.

		Difference in averages		*p*	
Group	Measurement	Measurement 1	Measurement 2	Measurement 1	Measurement 2
N	Measurement 2	4,47		<,001*	
	Measurement 3	4,33	-,13	<,001*	,475
T	Measurement 2	1,52		<,001*	
	Measurement 3	1,46	-,05	<,001*	,785

* - statistically significant result

Analysis of variance showed that the changes observed as a result of therapy both after the end of treatment ($p<0.001$) and after a further three months ($p < 0.001$) were statistically significantly different. N.A.P. therapy appeared to be more effective in this regard (Table 14).

Table 14: Analysis of variance of CVA measurements.

	After therapy		After three months	
Effect	*F*	*p*	*F*	*P*
Measurement	337,40	<,001*	138,44	<,001*
Measurement × Group	88,15	<,001*	33,80	<,001*

* - statistically significant result

4.4. FHT angle

The mean FHT values in the N group were: 1.37±0.73 degrees for the 1st measurement, 0.61±0.41 degrees for the 2nd measurement and 0.68±0.46 degrees for the 3rd measurement, while in group T: 1.79±0.91 degrees for the 1st measurement, 1.54±0.93 degrees for the 2nd measurement and 1.52±0.92 degrees for the 3rd measurement (Table 15, Figure 26). Differences between the groups were statistically significant only in the 2nd and 3rd measurements (mean values in the N group were lower than in the T group) (Table 16).

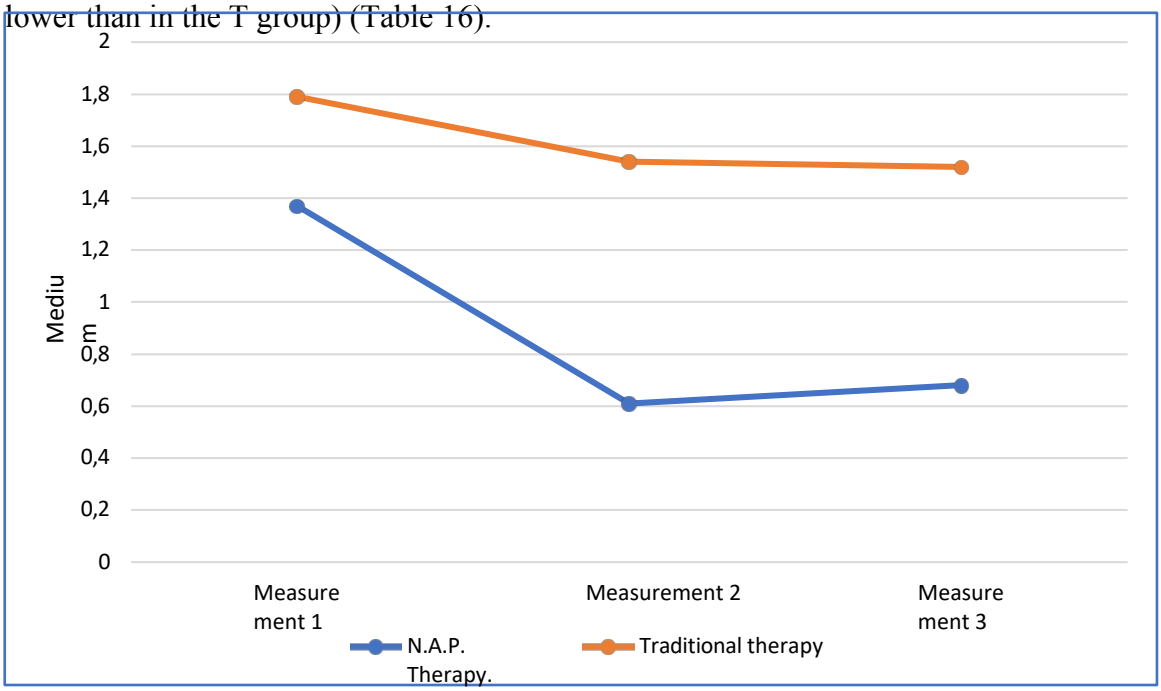


Figure 26: Average values of FHT angle in three measurements.

Table 15. Mean and Standard Deviation for FHT in individual measurements of both groups.

Group	Medium			OS			N
	Measurement 1	Measurement 2	Measurement 3	P1	P2	P3	
N	1,37	,61	,68	,73	,41	,46	30
T	1,79	1,54	1,52	,91	,93	,92	30
Total	1,58	1,07	1,10	,84	,85	,83	60

Table 16 Differences between groups in measurements of mean FHT values.

Measurement	Difference in averages	*p*
Measurement 1	-,41	,057
Measurement 2	-,93	<,001*
Measurement 3	-,84	<,001*

* - statistically significant result

After the therapy, a statistically significant improvement in the FHT variable was found for both groups of subjects. In the N group, the mean FHT value decreased by 0.77 degrees between 1 and 2 measurements, 0.69 degrees between 1 and 3, and 0.07 degrees between

2 versus 3. In the T group, the difference between the 1st and 2nd measurements was 0.25 degrees, while the

between the 1st and 3rd measurements of 0.27 degrees (Table 17). After a three-month follow-up period, a significant deterioration in FHT was noted in the N group (0.07 degrees), while no significant change was found in the T group.

Table 17 Differences between measurements of mean FHT values separately in the groups.

		Difference in averages		*p*	
Group	Measurement	Measurement 1	Measurement 2	Measurement 1	Measurement 2
N	Measurement 2	-,77		<,001*	
	Measurement 3	-,69	,07	<,001*	,006*
T	Measurement 2	-,25		,004*	
	Measurement 3	-,27	-,02	,001*	,442

* - statistically significant result

The results of the analysis of variance show that the changes observed after the end of treatment ($p<0.001$) and after a further three months ($p < 0.001$) were statistically significantly different. N.A.P. therapy appeared to be more effective (Table 18).

Table 18: Analysis of variance of FHT measurements.

	After therapy		After three months	
Effect	*F*	*p*	*F*	*P*
Measurement	97,78	<,001*	77,30	<,001*
Measurement × Group	26,57	<,001*	18,31	<,001*

* - statistically significant result

4.5. Anxiety-state level (STAI- X1)

In group N, the mean values of anxiety-state in measures 1, 2 and 3 were, respectively: 31.03±6.90 points, 25.47±4.56 points and 25.30±3.65 points, while in the T group: 35.60±8.20 points, 29.73±7.01 points, 30.47±10.70 points (Table 19, Figure 27). Further statistical analysis showed that the differences between the groups in each of these measurements were statistically significant (mean values in Group N were lower than in Group T) (Table 20).

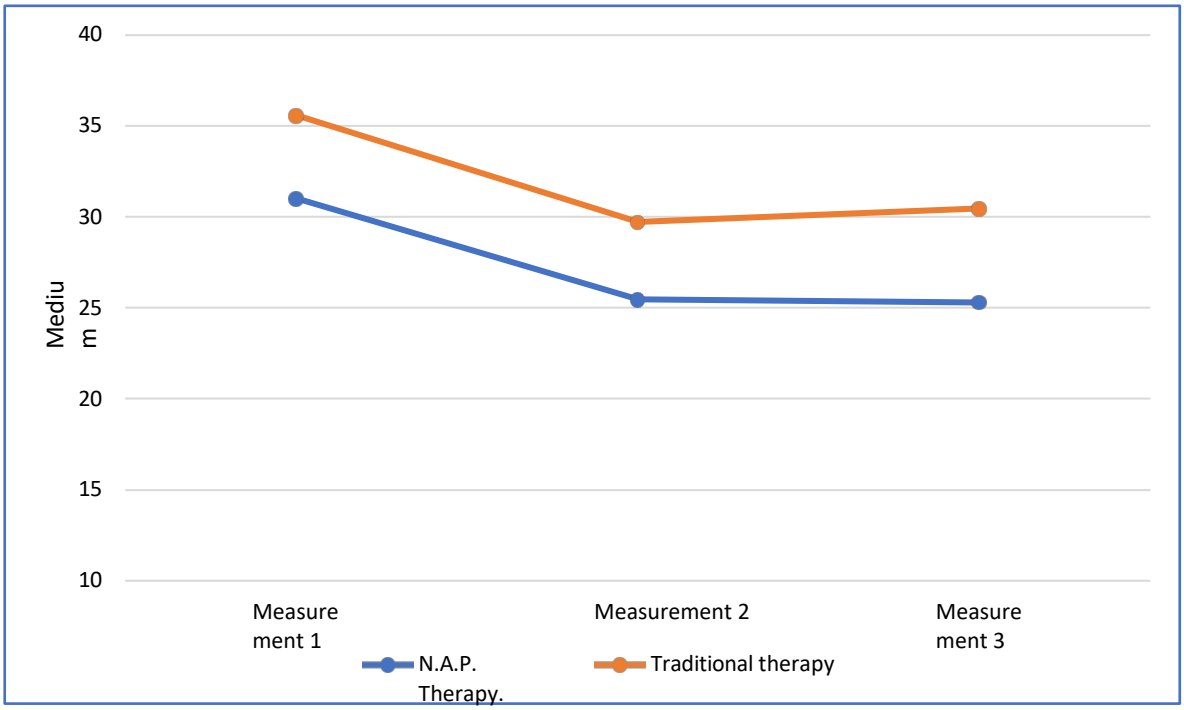


Figure 27: Average anxiety-state values in three measurements.

Table 19. Mean and Standard Deviation of the level of anxiety-state in each measurement of the two groups.

Group	Medium			OS			N
	Measure ment 1	Measure ment 2	Measure ment 3	P1	P2	P3	
N	31,03	25,47	25,30	6,90	4,56	3,65	30
T	35,60	29,73	30,47	8,20	7,01	10,70	30

Table 20: Differences between groups in measurements of mean anxiety-state values.

Measure ment	Difference in averages	*p*
Measure ment 1	-4,57	,023*
Measure ment 2	-4,27	,007*
Measure ment 3	-5,17	,015*

* - statistically significant result

As a result of the treatment, both the N and T groups showed statistically

significant improvements between measurements 1 and 2 and 1 and 3. In the N group, anxiety levels dropped by 5.57 points between measurements 1 and 2 and by 5.73 points between measurements 1 and 3.

In the T group, the difference between measurement 1 and 2 dropped by 5.87 points, while the difference between measurement 1 and 3 dropped by 5.13 points (Table 21).

Table 21. Differences between measures of mean anxiety-state values separately in groups.

		Difference in averages		*p*	
Group	Measurement	Measurement 1	Measurement 2	Measurement 1	Measurement 2
N	Measurement 2	-5,57		<,001*	
	Measurement 3	-5,73	-,17	,007*	,924
T	Measurement 2	-5,87		<,001*	
	Measurement 3	-5,13	,73	,015*	,674

* - statistically significant result

The results of the analysis of variance showed that the changes observed as a result of treatment (p=0.951) and after a further three months (p=0.917) were similar in both groups of subjects (Table 22).

Table 22: Analysis of variance of anxiety-state measures.

	After therapy		After three months	
Effect	*F*	*p*	*F*	*P*
Measurement	34,05	<,001	13,10	<,001
Measurement × Group	,01	,951	,07	,917

4.6. Level of depressiveness

In the N group, the mean values of depressive levels in measures 1, 2 and 3 were, respectively: 8.47±6.24 points, 4.27±3.54 points and 5.13±3.01 points, while in the T group: 11.87±11.21 points, 6.20±3.93 points, 8.33±10.48 points (Table 23, Figure 28). Another statistical analysis showed statistically significant differences between the groups only in measure 2 (the mean value in group N was lower than in group T) (Table 24).

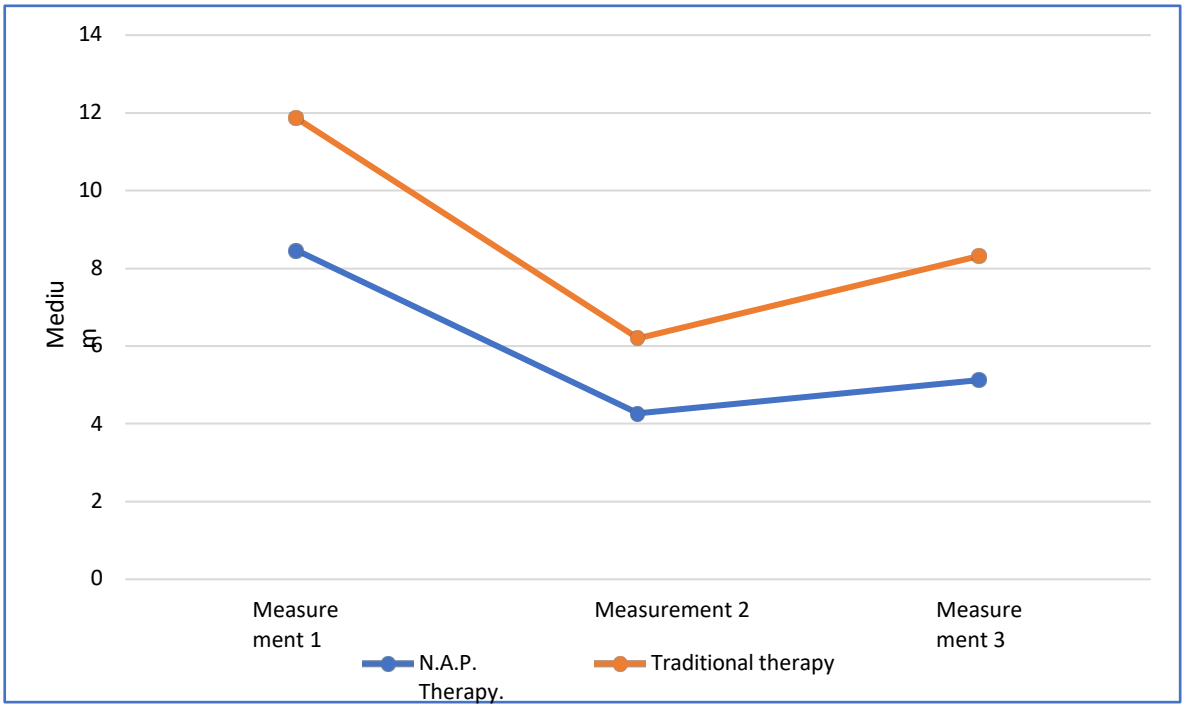


Figure 28: Average values of the level of depressiveness in the three measurements.

Table 23. Mean and Standard Deviation of the level of depressiveness in each measurement of the two groups.

Group	Medium			OS			N
	Measure ment 1	Measure ment 2	Measure ment 3	P1	P2	P3	
N	8,47	4,27	5,13	6,24	3,54	3,01	30
T	11,87	6,20	8,33	11,21	3,93	10,48	30

Table 24: Differences between groups in measures of mean depressive levels.

Measure ment	Difference in averages	*p*
Measure ment 1	-3,40	,152
Measure ment 2	-1,93	,050*
Measure ment 3	-3,20	,113

* - statistically significant result

In the N group, there was a statistically significant improvement in the level of depression between measurements 1 and 2 (a decrease of 4.20 points) and 1 and 3 (a decrease of 3.33 points) as a result of treatment. In the T group, there was a statistically significant improvement between measurements 1 and 2 (a decrease of 5.67 points), 1 and 3 (a decrease of 3.53 points) and 2 and 3 (a decrease of 2.13 points). After a follow-up period of three months, there was no significant change in the level of depression in the N group, while in the T group, the level of depression increased by 2.13 points and this change was statistically significant (p 0.46) (Table 25).

Table 25: Differences between measures of the mean values of depressive levels separately in the groups.

		Difference in averages		*p*	
Group	Measurement	Measurement 1	Measurement 2	Measurement 1	Measurement 2
N	Measurement 2	-4,20		,002*	
	Measurement 3	-3,33	,87	<,001*	,412
T	Measurement 2	-5,67		<,001*	
	Measurement 3	-3,53	2,13	<,001*	,046*

* - statistically significant result

Analysis of variance for the interaction showed that the changes observed in treatment outcome both after the end of treatment (p=0.257), as well as after a further three months (p=0.553), were similar in both study groups (Table 26).

Table 26: Analysis of variance of depression level measurements.

	After therapy		After three months	
Effect	*F*	*p*	*F*	*P*
Measurement	34,83	<,001	22,07	<,001
Measurement × Group	1,31	,257	,55	,553

4.7. Moderators: anxiety-trait (STAI-X2) and GSES

Before therapy, the mean value of the STAI:X2 variable in group N was 38.51±7.70 points, and in group T it was 43.97±8.67 points. Statistical analysis showed that the mean level of anxiety-trait in group T was significantly higher than group N (Table 27). As for the GSES, the mean values of this variable in the two groups were not significantly different, with 33.63±3.93 points in the N.A.P. treatment group and 31.82±5.82 points in the traditional therapy group (Table 27). There was no statistically significant moderating effect of the overall level of trait anxiety and generalized pain-related self-efficacy. The level of these variables before therapy did not significantly affect the scores obtained in the 2nd and 3rd measures for both groups of subjects (Table 28).

Table 27. Mean and standard deviation and significance of differences of STAI-X2 and GSES variables before therapy.

Variable	N		Medium		Deviation St.		*t*	*p*
	N	T	N	T	N	T		
STAI:X2 at P1	35	39	38,51	43,97	7,70	8,67	-2,85	,006*
GSES at para.	35	39	33,63	31,82	3,93	5,82	1,55	,126

* - statistically significant result

Table 28: Moderators in the form of STAI-X2 and GSES.

	STAI-X2		GSES	
Variable	*F*	*p*	*F*	*p*
NDI	0,09	,766	0,13	,715
NRS	0,06	,806	0,04	,847
CVA angle	0,15	,703	0,54	,465
HFT angle	,02	,885	0,01	,958
STAI:X1	0,90	,346	1,10	,298
CESD - R	0,10	,758	1,10	,299

5. Discussion

The results of the author's study primarily showed that the N.A.P. concept and traditional therapy had a positive effect on all variables studied, such as pain intensity, disability level, FHP, anxiety-trait and depressive levels immediately after the completion of treatment. Therapy N.A.P. proved proved more effective in reducing pain intensity and improving FHP (CVA and FHT angles). In addition, it was observed that in both groups, the obtained effects persisted without significant changes after a further three months for most of the analyzed variables. The above results partially confirmed the formulated research hypotheses. To the best of my knowledge, based on a review of available scientific reports, there are no studies evaluating the effectiveness of N.A.P. therapy in the course of BKS. However, the above issue has been addressed in the case of rehabilitation of patients with pulmonary disorders, voice disorders, and those diagnosed with frozen shoulder syndrome (58; 74; 75). In a pilot study, Mętel et al (75), among others, applied the N.A.P. method among adults with bronchial asthma treated at the Wieliczka Salt Mine Health Resort. It is known that these patients, as a result of their disease, struggle with problems such as shortness of breath, emotional stress associated with it and postural disorders. Therefore, the treatment included both the therapy offered by the spa, including group general fitness and breathing exercises. The N.A.P.-based activity program was conducted during group classes and used techniques such as c h e s t mobilization, breathing exercises, diaphragm support, postural control improvement exercises and nervous system relaxation. In addition, each patient received two individual sessions of N.A.P. The results showed improvements in dynamic balance and functional strength of the lower extremities after three weeks of the course, but the lack of a control group does not allow definitive confirmation of the effectiveness of this therapy. In another study, Mętel et al (74) observed a positive change in voice performance in patients with bronchial asthma after treatment including breathing and postural exercises using N.A.P. therapy techniques, conducted in an underground environment Mine Salt w Wieliczka. Horst i et al. (58), in a randomized controlled trial, proved that the N.A.P. concept oriented toward reducing pain and improving daily functioning was more effective than treatment involving the PNF method, manual therapy and strengthening exercises among the

patients with frozen shoulder syndrome. These effects were evident both after the therapy and after a period of three months after its termination. The studies presented above (58; 74; 75) suggest that the N.A.P. concept is effective in improving the condition of patients with various disorders. The beneficial effect of this method may be due to the fact that it targets specific problems seen in various disorders, and the therapy is individually tailored to the functional needs of the patient. Since structural damage to the musculoskeletal system affects body function, resulting in the production of a protective mechanism through tension at the painful area and a compensatory movement pattern, adapting properly selected exercises increases the chances of improving the patient's condition (57).

Typical disorders seen in patients with BKS include increased muscle tension and soreness in the cervical region and shoulder girdle, FHP causing subsequent postural abnormalities, abnormal breathing patterns, especially diaphragmatic breathing, or emotional stress related to the disease (76). In the author's study, traditional therapy used therapeutic activities that are commonly used in BKS rehabilitation recommended by the National Health Fund. Isometric exercises of the neck muscles, aimed at strengthening and stabilizing the cervical region, were used. In addition, patients performed weight-bearing and assisted exercises aimed at relaxing, flexing and strengthening the shoulder girdle muscles. From the field of physical therapy, TENS currents and local cryotherapy were chosen for their analgesic effect (77). Compared to traditional therapy, the N.A.P. method focuses more broadly on treating the functional disorders of the BKS patient. It proposes techniques such as muscle lengthening in static activity and eccentric muscle stimulation in repetitive activity, among others. This therapy also introduces stimulation of the subglenoid, MOS, incline and diaphragm muscles, as well as lengthening of the head extensor muscles (57). Selected techniques stimulate postural control by improving head positioning, reducing tension in painful tissues and oxygenating the body. Similar individualized approaches in the selection of procedures and therapies are also used in other international methods, such as PNF, MDT and OMT. Therefore, the following Discussion also presents the results of studies evaluating the effectiveness of these methods in BKS (61; 78; 79; 80;
81).

Our study analyzed the impact of the N.A.P. concept and traditional therapy on pain and disability levels, among other variables. These variables are used in many studies evaluating the effectiveness of various treatment programs for BKS (82; 76; 79; 61; 78; 83; 80; 81). Based on a review of the literature, it is known that pain and disability in BKS are significantly associated (82; 83). Restrictions in cervical spine mobility and reduced dexterity and comfort in daily functioning are also evident in these patients (76). In the author's study, significant reductions in pain intensity and disability levels were obtained in both groups of subjects after treatment. However, it turned out that the concept of

N.A.P was more effective than traditional therapy in reducing the intensity of pain. A review of the subject's literature confirms that the use of various exercise programs targeting the cervical and shoulder girdle muscles reduce pain and disability in BKS (61; 78; 84; 85; 62; 80; 81). Aydoğmuş et al (84) emphasized the important role that scapular stabilization exercises play in reducing pain intensity and improving quality of life. Kang et al (85) also believe that a program that includes scapular stabilization exercises and chest muscle stretching techniques is an effective way to reduce disability and pain intensity among office workers. Guzy and Frańczuk. (61) and Guzy et a1. (62) conducted a study among patients with cervical pain syndromes with a root distribution. In it, they compared the effectiveness of the MDT method also characterized by individualized, but different compared to N.A.P., treatment. The control group, on the other hand, was treated with traditional therapy including the same exercises as in the author's s t u d y (including isometric exercises for the neck muscles, as well as active exercises in weight-bearing and self-assisted for the shoulder girdle muscles), as well as massage and infrared radiation. They obtained results similar to those of their own study, which confirmed the superiority of the MDT method over traditional therapy in reducing pain intensity (62) and mcGill questionnaire indicators (61). Similarly, Abdel-Aziem et al (78) observed that the MDT method was more effective in reducing pain and disability levels compared to traditional physiotherapy among patients with BKS. Based on a systematic review of randomized controlled trials, Hidalgo et al (79) confirmed the positive therapeutic effect of OMT in BKS. They also showed that combining this method with exercise was more effective than doing it alone. Another systematic review by Sbardella et al (80)

demonstrates that MET techniques, which are a group of activities in OMT, are more effective in reducing pain in BKS than traditional rehabilitation. In addition, Maicki et al (81) showed that both OMT and PNF were effective in reducing pain and improving daily functioning among women with BKS. However, the PNF method proved more effective in both the short and long term. The authors recommend opting for a pain-free therapy based on engaged patient participation and motor teaching. It should be noted that a similar approach is taken precisely by the concept of
N.A.P. (57). In conclusion, obtaining better results in reducing pain intensity in the N.A.P. group in the author's study confirms the greater effectiveness of this therapy in the treatment of BKS. However, it should be noted that both therapies significantly reduced pain and disability levels, and no superiority of either therapy was found for NDI. Traditional therapy, in contrast to the N group, included physical treatments in the form of TENS currents and local cryotherapy, whose effectiveness in treating BKS has been documented (40; 86; 87; 88). Rehabilitation programs that combine exercise with physical therapy treatments are widely used (61; 78; 89; 90; 86). For example, Miao et al (87) confirmed the effectiveness of TENS current treatment in treating cervical degenerative changes. At the end of the twelve-week treatment and after a four-week follow-up period, they showed a statistically significant decrease in disability and pain levels in the TENS-treated group compared to the control, placebo-treated group. Yesil et al.
(89) conducted a study in three groups, in which therapy was based on the same stabilization exercises, but TENS current treatment was added in group two and interferential treatment in group three. At the end of the treatment, as well as after a three-month follow-up period, the authors showed that the exercises combined with the physical treatments were as effective as the exercises alone in treating pain and disability. Duscanceli et al (90) proved the superiority of a variety of cervical stabilization exercises in reducing disability and pain for BKS, compared to physical therapy treatments alone (TENS, ultrasound, sollux) and to general isometric and stretching exercises targeting different muscle groups in the body. Lizis et al (86) demonstrated the effectiveness of using cryotherapy in combination with cervical spine mobilization in reducing the intensity of pain and disability in BKS, while adding stretching home exercises to the above program in the other group did not provide additional benefit. In contrast, Hassan and Asaad (88) in a group of students

with headaches of tension origin, applied cold compresses to the neck. After six sessions spread over a month, they showed a significant reduction in headache intensity and mental tension, as well as greater relaxation. However, the lack of a control group prevents definitive verification of the effectiveness of this physical therapy treatment. The results of the above-cited studies (87; 89; 90; 86; 88) and the results of the author's work suggest that exercises that stimulate muscles in the cervical and shoulder girdle are effective, while the use of TENS currents and local cryotherapy do not always improve their effectiveness on pain and disability among patients with BKS.

In our study, the effectiveness of the N.A.P. concept and traditional therapy was also evaluated by analyzing FHP, using CVA and FHT angles. FHP is characterized by upper (in C1-C3 segments) and lower cervical spine flexion (in C4-C7 segments). The posture of a person with FHP is characterized by rounding of the shoulders and thoracic spine. Excessive tension of the quadriceps muscle is also evident (91). FHP interferes with normal respiratory function, including chest and diaphragm function, and limits mobility in the thoracolumbar spine. The location of the body's center of gravity is altered and shifted forward. This body positioning, due to muscle imbalance, also brings with it a number of musculoskeletal disorders, including upper crossed syndrome causing head, jaw, neck, back and shoulder pain (85). One component of therapy N.A.P. are breathing exercises that, by acting on the diaphragm, not only stabilize and strengthen the spinal muscles, but also increase lung volume and vital capacity (57). Therefore, in our own work, the N group (as opposed to traditional therapy) used not only exercises that act on the shoulder girdle and cervical spine, but also stimulated the respiratory muscles by strengthening exhalation and vocal phonation. Both therapies achieved significant improvements in FHP in both the frontal (FHT angle) and sagittal (CVA angle) planes. However, the N.A.P. concept proved more effective in this area. The above results may suggest that breathing exercises in the N group played a significant role in improving FHP. Interesting results are presented by Dareh-deh et al (92), who showed that the addition of a breathing exercise (exhaling air into a balloon while lying on the back) to traditional exercises (strengthening and relaxation)

with legs leaning against a wall), does not benefit the elimination of FHP, but improves the abnormal breathing pattern seen among those with the disorder. In contrast, many authors emphasize the importance and effectiveness of scapular stabilization exercises in the treatment of FHP (85; 85; 93; 94). According to Nitayaraka and Charntaraviroj (94), these exercises improve FHP because they increase the flexibility of the pectoralis minor muscle and strengthen the scapular muscles. Also Im et al.
(91) demonstrated the effectiveness of a similar treatment used in FHP, compared to relaxation exercises. It aimed to reduce the activity of the upper quadriceps muscle by strengthening the weakened muscles, namely the lower part of the
m. quadriceps and the anterior cingulate m. to increase postural control. The above reports (94; 91) are consistent with the results obtained by El-Azim et al (93), who proved that scapular stabilization exercises are more effective in improving FHP, increasing shoulder girdle muscle activity and reducing disability than postural correction exercises alone. The researchers suggest including evaluation of the anterior cervical and inferior quadriceps muscles in further studies because of their role in movement kinematics. Kang et al (85) also believe that a combination of scapular stabilization exercises along with chest muscle stretching is an effective way to reduce FHP. These interventions can also be used to prevent the occurrence of FHP (85). On the other hand, Shiviari et al (95) emphasized that adding abdominal control feedback to scapular stabilization exercises yields better results in improving shoulder joint proprioception and FHP. Stimulation of abdominal muscle contraction occurred through verbal and tactile information. The results obtained in the above-cited reports (85; 92; 93; 94; 95) and the results of our own study suggest that treatment in the N group including, among other things, diaphragm exercises (which also affect scapula stabilization and abdominal muscle activation) may have contributed to achieving greater improvement in FHP than traditional therapy. As mentioned earlier, there are other therapeutic methods characterized by a personalized approach in the treatment of BKS that have shown positive effects in correcting FHP (96). For example, Kim et al (96) showed that both MDT and OMT MET techniques were effective in improving FHP. Also, Guzy et al (60) showed that MDT is more effective than traditional therapy in correcting FHP in patients with cervical pain syndromes with root topography.

Chronic BKS restricts and impedes daily functioning, resulting in poorer mental state of patients (24). Experiencing negative emotions has been shown to be correlated with pain, disability, anxiety, depression, catastrophizing or kinesiophobia (97). Therefore, the author's study analyzed such psychological variables as anxiety as a state and depressiveness levels before, after treatment and after a three-month follow-up period. Anxiety as a trait and generalized self-efficacy only before treatment were also examined, treating them as moderating variables to assess their potential impact on treatment outcomes. A sense of anxiety is defined as the anticipation of a future threat and is different from fear, which is a reaction to an actual threat. Anxiety is a normal and important emotion that, from an evolutionary point of view, is adaptive in that it promotes survival by avoiding dangerous places and situations. Anxiety disorders and their pathological varieties place a heavy burden on the patient and, like worry, negatively affect his health. They occur with many types of chronic pain, including BKS. The available literature suggests that generalized anxiety syndromes and post-traumatic stress disorder are more common in spinal pain than phobias or panic attacks (98; 99; 100). In contrast, depression is more common than anxiety disorders in cases of BKS. It is also strongly associated with experiencing psychosomatic symptoms, as sufferers may experience pain with no apparent physical cause. Symptoms of depression can also affect central processing of pain, causing hypersensitivity to this stimulus (12; 31). Depression is a serious mood disorder and is one of the most prevalent mental illnesses. The condition is characterized by negative beliefs about oneself, one's immediate environment and the world. The spectrum of symptoms is extensive depending on the severity of the illness. The most common are prolonged sadness, loss of interest, inability to feel pleasure, permanent feelings of guilt and worthlessness, low appetite, fatigue and poor concentration. Untreated depression can last for years and worsen during difficult life situations. It significantly affects the ability to cope with daily challenges, both personal and professional. The cornerstone of depression treatment is pharmacotherapy combined with psychotherapy, especially CBT, whose effectiveness has been scientifically proven. Then the patient, working with the therapist, learns to identify and change distorted thinking patterns (31). Physiotherapy offers supportive treatment for depression through physical activity. Exercise has been proven to

significant impact on reducing the symptoms of this disease of both mild, moderate and severe severity, and play an important role in its prevention. They are an important and effective way to support treatment, especially since people suffering from this condition, are often less active. Group activities can be a good motivation for exercise, with a supportive social impact in addition to the benefits of movement. Exercise interventions using moderate- to high-intensity aerobic exercises, performed alone or under the supervision of specialists, are recommended (101; 102). In self-reported work, before therapy, patients in both groups had low levels of anxiety as a condition. Also, the level of depressiveness among all patients was not high (less than 16 points), meaning that these subjects did not experience depressive symptoms of an intensity suggestive of psychiatric consultation (71). Significant reductions in these two variables were observed after treatment, but none of the treatments proved to be better. It was also shown that the level of anxiety as a trait before therapy was low in the N group and medium in the T group, and the difference between these values was found to be statistically significant. However, as a moderating variable, it did not affect the results obtained as a result of the two therapy programs. The author's results on anxiety and depression are consistent with the results of available scientific reports on BKS therapy (103; 104). For example, Nazari et al (103) found that deep and superficial muscle training reduced anxiety and depression. Kaka et al (104) showed that stabilization exercises are more effective in reducing depression and anxiety than dynamic exercises. It also appears that the use of physical therapy in their study did not contribute to greater efficacy in reducing anxiety and depression compared to the N.A.P. concept, in which these treatments were not used. And although Hattaboglu et al (105) observed improvements in anxiety and depression levels after a series of electromagnetic field treatments, TENS currents and hot compresses among patients with cervical disc herniation, the lack of a control group does not allow a definitive assessment of the effectiveness of this treatment. In contrast, the results of Guza et al (61) are consistent with those of the author's study. In fact, they showed that the MDT method, characterized by an individualized therapeutic approach, is more effective than traditional therapy in improving the mental state of patients with cervical spinal root pain syndromes. Thus, the results confirmed that MDT reduces anxiety as a condition and negative emotions, and increases the

positive emotions more effectively than traditional therapy, which includes infrared irradiation.

In the author's study, the final variable examined using the GSES questionnaire was belief in generalized self-efficacy. This trait refers to an individual's belief in his or her own ability to achieve results through action, i.e., it refers to a person's self-assessment of how capable he or she is of handling situations that confront him or her (106; 107). It is positively related to quality of life and can act as a psychological buffer against undesirable events and circumstances. It is associated with motivation and perseverance and influences the types of actions people are willing to take. Moreover, a higher sense of generalized self-efficacy is associated with improved physical and mental health (107). Krasawa et al (108) showed that a high GSES score is associated with reduced disability in patients with chronic pain. Thus, these findings suggest that focusing on improving this variable may be an effective strategy for treating these patients. Generalized self-efficacy is a cognitive trait. It has a positive effect on a patient's health-related behavior, but does not change in the short term. Therefore, in the author's study, it was assessed only before therapy (109). Based on the results, it was found that the average GSES in both groups was above 30 points, indicating its high intensity among patients. However, further analysis showed that the level of this variable did not affect the results obtained as a result of therapy in both groups. To the best of my knowledge, there are no available source items addressing this issue in BKS. However, there are studies that have used the Pain Self-Efficacy Questionnaire (PSEQ), which is an extension of one part of the GSES questionnaire. The PSEQ examines a patient's mental toughness in the face of obstacles and difficult situations related to chronic pain, as well as his or her confidence in performing a specific activity despite experiencing pain (110). A higher PSEQ score is associated with improved physical performance, regardless of pain severity. It has also been observed that psychological interventions targeting pain, such as CBT, induce a positive change among patients in terms of cognitive assessment of pain complaints. In contrast, lower PSEQ values are associated with movement avoidance, which consequently worsens the patient's condition and limits activity (106; 111). Woodman et al (112) indicated a beneficial effect of the Alexander Techniques on PSEQ levels and motor coordination and balance among patients with BKS. The techniques involve working with the body by

increasing awareness of the sensations from it, as well as changing the movement patterns and mindset of the patient. In the case of lumbar pain, Marshall et al (111) showed that three different treatment programs, i.e. yoga, physiotherapy and education similarly improved pain-related self-efficacy.

As mentioned earlier in the theoretical section, proper education is an important part of allowing the patient to understand both the complicated pain process and the feelings associated with it. The result is to change the beliefs about chronic pain that the patient holds (pain reconceptualization). Successful cognitive change during the period of experiencing chronic pain can effectively normalize beliefs and attitudes about pain complaints and reduce pain and disability as a result of treatment (26). Therefore, exploring the cognitive aspect of pain and how it is perceived in clinical practice can play an important role in the treatment of BKS. Moraes et al (106) showed that combining education with exposure, which involves gradually exposing the subject to a feared situation (e.g., performing a certain movement or activity), allows the patient to confront the dysfunctional belief of movement avoidance and lack of dexterity in this area. Malfliet et al (113) demonstrated that pain neuroscience education combined with motor control and cognitive function training more effectively reduced pain intensity, catastrophizing and fear of pain, and improved pain awareness and quality of life compared to standard back school education combined with general neck muscle strengthening exercises. The patients studied experienced cervical or lumbar pain syndromes. The authors emphasize that motor control training enabled the principles of pain neuroscience education to be incorporated into daily life. As a result, participants felt more empowered, whereas previously they had viewed pain as a controlling factor in their lives. In light of neuroscience, treatment is therapy of the brain and changing its patterns of functioning, not just correcting the patient's motor deficits (113). The above conclusions are consistent with the approach used in the experimental group of our own study. Although an educational component was not applied, the assumptions and techniques used in the N.A.P. concept can influence the change in cognitive function (57). The inclusion of teaching on the neurobiology of pain could provide even greater benefits to the patient.

In the author's study, the effect of both therapies was examined not only after completion, but also after a further three months. Since epidemiological studies show that back pain tends to recur and exacerbate, it therefore seems worth evaluating whether the improvement obtained, which is visible after the end of the treatment, will persist for a longer period of time (1). Based on the results of the author's study, it was found that the achieved effects of the therapy did not change for a further three months in both groups, in terms of most of the evaluated variables such as pain, disability, CVA angle and anxiety as a condition. Similar results were observed by other authors, who found that the therapeutic effect was maintained after the applied BKS treatment. However, the duration of these observations varied, ranging from one to twelve months (81; 87; 90; 89; 113). For example, it was shown that the achieved decrease in pain intensity and level of disability did not change after the PNF method (81), exercise combined with physical therapy treatments (89), TENS treatment (87), neck stabilization exercises (90), and education combined with motor control and cognitive function training (113). In the author's study, however, it was observed that in the case of two variables, the effect obtained from the end of treatment changed significantly after a three-month follow-up period. In the T group, the FHT angle increased, but despite this deterioration, analysis of variance still indicated greater efficacy of the N.A.P. concept on this variable, compared to traditional therapy. Additionally, in the T group, there was a significant increase in depressive levels three months after the end of therapy. The N.A.P. method did not prove more effective in this case.

In summary, chronic BKS is a complex condition that not only affects the body, but also the human psyche (1; 12). The results of the author's work and the results of the cited reports suggest that various types of exercises and techniques, especially those selected for apparent disorders, show the greatest effectiveness in treating pain, disability, FHP and mental status among these patients. Behavioral variables such as anxiety, depression and a sense of generalized self-efficacy are important aspects in BKS, and therefore require the use of appropriate therapeutic methods (31; 101; 102; 103; 106; 107). Although traditional therapy has been shown, based on an in-house study, to be effective in the treatment of BKS, the functional approach proposed by the concept of

N.A.P. seems a better and more effective solution. It can be the basis of

multimodal treatment, which is recommended in BKS (1; 2; 5; 12; 14). It also appears that an important aspect of BKS therapy is patient education and social support. Knowledge of the impact of psychosocial factors on the patient is crucial, and should be an important part of physiotherapists' education (26; 113; 106). Future research should focus on incorporating approaches that combine psychotherapy with physiotherapy and education from the neurobiology of pain in the treatment of BKS.

As a limitation of the work, one can point to the duration of the therapy, which was two weeks. In our own work, such a choice was dictated by the top-down rules of the treatment facility. Extending the duration of therapy to three or four weeks seems advisable to achieve better and more lasting therapeutic results. Due to the use of diaphragm activity-stimulating exercises in therapy, future subjects would also need to include an assessment of breathing patterns.

6. Applications

1. Both therapies had a positive effect on pain intensity, disability, FHP, anxiety as a condition and depressive levels.
2. The results obtained were maintained during the three-month follow-up period, with the exception of the FHT angle in the N.A.P. therapy group and the level of depression in the traditional therapy group.
3. The N.A.P. concept is more effective in reducing pain and FHP among BKS patients compared to traditional therapy.
4. The level of anxiety as a trait and overall self-efficacy do not moderate the results obtained as a result of the two therapies.
5. The N.A.P. concept is an effective method of treating patients with BKS.

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Summary

INTRODUCTION: Cervical spine pain (SCI) is one of the leading causes of disability worldwide. This disorder is influenced by individual, physical and psychosocial factors. The latter contribute to the disease's progression to a chronic state. For this reason, BKS therapy appears to be a difficult process. The most common treatment in medical institutions is traditional therapy, which includes kinesitherapy, physical therapy and massage. The patient in such a model is mostly a passive recipient of therapeutic measures. A different approach is presented by the concept of Neuro-Orthopedic Activity-Dependent Plasticity (N.A.P.), which, while involving the patient in the therapeutic process, focuses on functional activities that are important to the patient in everyday life, thus arousing his natural motivation.

Objective: The purpose of this study was to evaluate the effectiveness of the N.A.P. concept and traditional therapy in the course of BKS of discopathic origin.

Material and method: 74 patients in the age range of 30-50 years complaining of cervical disc pain syndrome were enrolled in the study. The respondents were randomly divided into two groups. The study group received N.A.P. therapy, while the control group received traditional therapy. In both groups, treatment took place daily for two weeks. Pain intensity (NRS), disability (NDI), craniovertebral angle (CVA) and level of head tilt (FHT), anxiety as a condition (STAI-X1) and level of depression (CESD-R) were measured before and after therapy, as well as at three-month follow-up. Anxiety-as-state (STAI-X2) and generalized sense of self-efficacy (GSES) were examined only at the beginning of therapy, as they were moderating variables of the results obtained.

Results: Both therapies had a favorable effect on all variables studied. However, the therapy N.A.P. proved more effective in reducing pain intensity ($p<0.001$), improving CVA angle ($p < 0.001$) and FHT ($p<0.001$). In both groups, the obtained effects persisted without significant changes after three months of follow-up for most of the analyzed variables. The exceptions were the FHT angle in the group treated with N.A.P. therapy and the level of depression in the group treated with traditional therapy. **Conclusions:** N.A.P. therapy is more effective in reducing pain and frontal head alignment among BKS patients compared to traditional therapy.

Keywords: N.A.P. therapy, chronic neck pain, anterior head positioning, motor learning.

Index Figures

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Annex

Komisja Bioetyczna
w Krakowie

Oplnla

No. 4a/KBLJ iIL/20Z0 dated March 19, 2oao.

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INFORMATION FORM FOR THE TEST PERSON

Project title: Effectiveness of Activity-Dependent Neuro-Orthopedic Plasticity and Traditional Therapy in Cervical Discopathic Pain Syndromes

Project manager: Jagoda Chmiel, M.Sc. (AWF Kraków)

Procedures: You will be asked to fill out a form containing questions characterizing the study group and several pre-treatment questionnaires, such as the NDI, CESD-R, STAI, GSES and NRS scale. A photo of the head and shoulder area in the forward and side standing positions will also be taken. At the end of the two-week treatment, you will be asked again to complete the questionnaires and position yourself for the photos. You will be informed of a follow-up visit 3 months after the end of treatment, at which you will be asked to complete the questionnaires and position yourself for photographs for the last time.

Benefits: There are no direct benefits to you other than participating in a therapy, more commonly used for cervical pain syndromes, and the opportunity to discuss your neck pain experience with a specialist. The information you gain will help researchers better understand the problem of treating neck pain.

Risks: There are no physical risks to you while conducting this research. All information obtained from you will be anonymous. Your name and image will not be used in either this study or in reports.

Confidentiality: All research records will be confidential and properly secured. Records will be released only with your consent or by court order or as required by law. No publication resulting from this study will use identifying information, such as your name or image.

Freedom to opt out: Participation in the study is completely voluntary and free of charge. You can withdraw from this study at any time without any consequences.