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ARTICLE

A Didactical Approach for Musculoskeletal Physiotherapy: The Planetary Model

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Abstract

Objective: Musculoskeletal physiotherapy has become a well-recognized and respected sub-discipline within the physiotherapy profession. The emergence of the biopsychosocial theory and the implementation of new insights into the pain mechanisms have been two of the most powerful catalysts for change at work within this profession. The fast evolution during past decades gave rise to the need for a structured framework. The purpose of this article is to introduce a didactical model which focuses on the relevant key elements within musculoskeletal physiotherapy.
Findings: A didactical model is put forward in the form of a "planetary model." The planetary model is not a new model, but is a didactic representation mainly inspired by an adapted model of the International Classification of Functioning, Disability and Health [ICF]. The structure of the ICF is reflected in a vertical plan, whereas the pain mechanisms and psychosocial factors surround this vertical structure, reflecting their continuous interaction with the different components of the vertical axis.
Conclusions: The planetary model enables the therapist to systematically analyze and appraise the impact of the different components as a basis for clinical decisions and aims to contribute to a more efficient way of managing patients.

Keywords: Musculoskeletal physiotherapy, clinical reasoning, didactical model

INTRODUCTION

Physiotherapy is an old discipline, dating back to Ancient Greece in the era of Hippocrates. In the meantime, there has been considerable evolution in which physiotherapy has evolved from simple massage and exercise to a complex approach with many specialized applications. Within these specializations, musculoskeletal physiotherapy has become a recognized and well-respected sub-discipline.

The fast evolution during past decades gave rise to the need for a structured framework that is both stable to provide students and professionals something to hold on, but also flexible in order to continuously incorporate new insights and evolutions. The planetary model introduced in this paper provides such structure and has been used now for several years in our musculoskeletal physiotherapy education. Based on the feedback of both students and professionals, this model has shown to be very valuable, as it provides a straightforward structure and contributes to a more efficient way of analyzing and managing patients. Therefore, we would like to present the planetary model in this issue.

The planetary model is not a new model, but is a didactic representation mainly inspired by an adapted model of the International Classification of Functioning, Disability and Health [ICF] (1,2). The ICF consists of a framework of classifications for defining functioning and disability as a multidimensional concept, relating to: 1. the body functions and structures of people, 2. the activities people do, and 3. the life areas in which they participate. By including contextual factors, in which environmental factors are listed, ICF can record the

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impact of the environment on the person's functioning. By shifting the focus from cause to impact, it places all health conditions on an equal footing, allowing them to be compared using a common metric, the ruler of health and disability (2). Based on this ICF-model, Simmonds (3) proposed a bidirectional interrelated component model in order to represent the current shifts in management and measurement concepts that specifically apply to musculoskeletal pain. Gifford (1) adapted this model and implemented tissue mechanisms, pain mechanisms, and psychosocial factors into it.

THE DIFFERENT COMPONENTS OF THE PLANETARY MODEL

The planetary model mirrors the structure of ICF in a vertical plan, while the pain mechanisms and psychosocial factors surround this vertical structure reflecting their continuous interaction with the different components of the vertical axis [Figure 1].

Pain Mechanisms

Within the context of the management of painful musculoskeletal disorders, specific attention should be drawn to the aspect "pain." The actual definition of pain is "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage" [IASP]. In order to make this clinically convenient, the concept of pain mechanisms was introduced into physiotherapy (3).

Pain mechanisms refer to the interactions of the fundamental pathways into and out of the central nervous system [CNS] that are necessary for survival and for the maintenance of health, as well as for the development and continuation of poor health (4). Pain mechanisms have been broadly categorized into 1. input mechanisms, including nociceptive pain and peripheral neurogenic pain, 2. processing mechanisms, including ascending pain pathways, central pain and central sensitization, descending pain control and the cognitive–affective mechanisms of pain and, 3. output mechanisms, including autonomic, motor, neuroendocrine and the immune system (5).

Input mechanisms are related to the peripheral elements [outside the CNS], which trigger activity within the CNS. These triggers can be located in the somatic tissues such as muscles and joints and within the peripheral nervous system (4,6).

The information from these peripheral structures then reaches the CNS, where excitatory and inhibitory influences are constantly balanced and gated, which is referred to as processing mechanisms. Pain pathways are not necessarily the same between individuals and no single pathway or center in the brain exists for the processing of pain. Instead, processing occurs in meshes of nerve fibers, whose functions vary and are integrated with other domains such as attention, emotion, memory, cognition, motor control, autonomic function, and general behavior (4,7). Repeated or sustained noxious stimulation may lead to increased neuronal responsiveness or central sensitization (8). Although the exact mechanism by which the spinal cord becomes sensitized remains unknown, it is hypothesized that central sensitization encompasses altered sensory processing in the brain (9), malfunctioning of descending anti-nociceptive mechanisms (10), increased activity of pain facilitatory pathways,

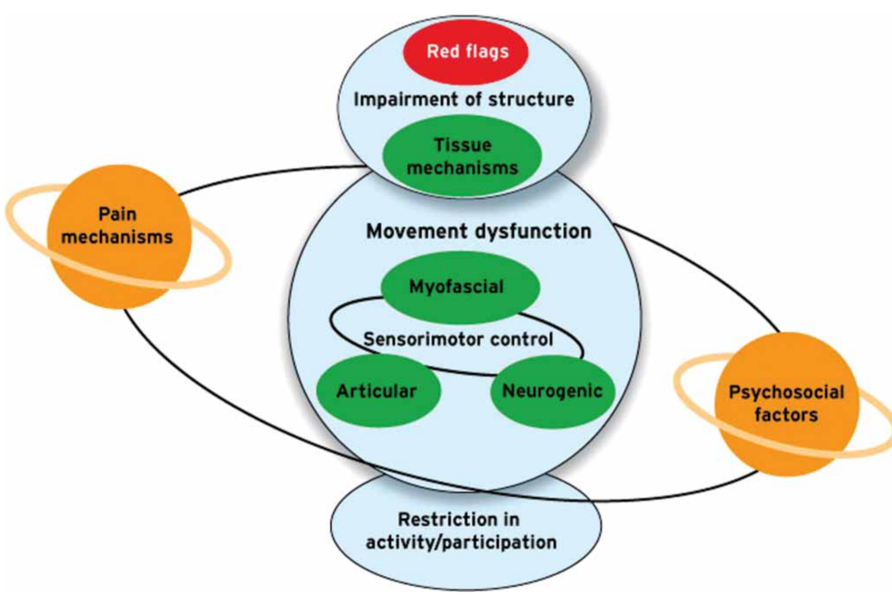

FIGURE 1. The planetary model.

temporal summation of second pain or wind-up (9,11), and long-term potentiation of neuronal synapses in the anterior cingulate cortex (12).

Output mechanisms are the means by which the CNS regulates the mechanics and physiology of the musculoskeletal system. In order to maintain the homeostasis within the sensorial system, output mechanisms operate through the motor, autonomic, neuroendocrine and immune systems (6,13). While the output via the motor and autonomic system is often visible, the responses of the other systems remain hidden, at least initially (6).

Overlap of mechanisms is the key feature because the boundaries are often hazy. There will be differing contributions of mechanisms to the injury state over time, person, and injury (6). Pain mechanisms may influence one another resulting into a vicious circle. The diverse mechanisms may influence the different planets, like sensorimotor control, tissue mechanisms, and psychosocial factors.

Psychosocial Factors

The emergence of the biopsychosocial theory has been one of the most powerful catalysts for a change at work within the physiotherapy profession (14). Psychosocial factors are important determinants of pain intensity and disability in patients with disabling musculoskeletal pain. The psychosocial aspects include cognitive [e.g., beliefs, expectations, and coping style], affective [e.g., depression, pain anxiety, heightened concern about illness, and anger], behavioral [e.g., avoidance], social [e.g., secondary gain], and cultural factors (15–17). It is important to recognize fundamental individual differences in affective, cognitive, and behavioral responses to pain and to understand their interactions with physiology. The importance of psychosocial factors in the development of chronic spinal pain has been emphasized and underestimation of these factors may have a significant influence on the therapeutic results (18).

A significant conceptual advance to integrating these approaches into the early management of musculoskeletal pain problems was made by developing Psychosocial Yellow Flags as an analog to the widely used red flags (19). Yellow flags are best conceptualized as barriers to recovery and have shown to be indicative of long-term chronicity and disability (20). Every practitioner should recognize unique barriers to recovery in each individual patient and deal with them appropriately by using cognitive and behavioral methods. The following categories are provided to make recognition and conceptualization of such factors easier: Attitudes and Beliefs about pain, Behaviors, Compensation Issues, Diagnosis and Treatment, Emotions, Family, and Work (20).

Impairment of Structure

The *superior planet* entails the impairments of structure with the associated tissue mechanisms and red flags. "Impairment of structure" refers to the pathoanatomy of an injury, although a large part of complaints can be labeled as non-specific as it lacks a specific provable cause (15).

While most patients will have a benign non-specific pathology as an explanation of their symptoms, a small number will have a serious underlying pathology. The people at risk need to be identified and require a referral to a medical specialist before any physiotherapeutic intervention. The medical community has developed a series of routine enquiries to be performed at the time of consultation and these are referred to as "red flags" (21).

"Tissue mechanisms" refer to both normal and abnormal processes that are active within the different tissues and are responsible for the condition of these structures and their tolerance to forces and load. In order to structure the therapeutic intervention and to increase the exposure to activity, it is essential to have an idea about the actuality of the disorder [acute, subacute, chronic], the tissue tolerance, the dominant pain mechanism, and the state of tissue repair (18). It is important to recognize whether the clinical presentation is in line with what would be expected during the corresponding stage of the normal tissue healing process.

Movement Dysfunction

Whereas ICF encloses impairment in all body functions, the planetary model is restricted to neuromusculoskeletal and movement-related dysfunctions, as these are the key features within musculoskeletal physiotherapy (2).

Movement and stability are dependent on normal function of the articular, nervous, and myofascial system. This interrelationship has originally been described as a theoretical model by Panjabi (12) and is also depicted in the planetary model. Dysfunction in one of these systems may lead to dysfunction in another system, and as a consequence the quality of movement may be altered, i.e., movement dysfunction.

Articular Dysfunction

The function of a joint is to transfer load from one bone to another and to permit limited movement. The movement available at a joint includes physiological and accessory movements (22,23).

The signs and symptoms of joint dysfunction are directly related to these functions and can occur in isolation or in any combination. Hypomobility refers to a reduction in range of movement of one or more accessory and physiological movements, which is often associated with an altered quality of movement and production of symptoms. Hypomobility in joints can be due to congenital factors, degenerative changes, or rheumatologic pathology [stiff joints]. A joint can also be fixated due to traumatized or pathological tissues, which may produce a physical resistance to further movement, including intra-articular structures, such as joint capsule, a torn meniscus or a loose body. The joint rest position is often altered in these conditions. Joint mobility can also be reduced due to a muscle spasm [compressed joint] often when peri-articular structures such as the ligament, muscle or nerve are involved, but also in any other acute condition of joint pathology. Hypermobility indicates that there may be an increased range of movement of one or more accessory and physiological movements. Constitutional hypermobility is characterized by a general laxity of the connective tissue, ligaments and muscles and may lead to instability (24). Instability refers to a significant decrease in the capacity of the articular system to maintain the motion within the physiological limits.

Neurogenic Dysfunction

In order to maintain good function, nerves are designed to slide, tension, and withstand pressure during daily activities. The close relationship between neural mechanics and physiology is referred to as neurodynamics (25). Nerves are well equipped to do that and are not sensitive to such events except when those forces are excessive. Maintained excessive pressure can cause a tourniquet effect: venous congestion, less oxygenation, and inflammation (26). Repeated mechanical irritation can also cause inflammation (27). Both events result in an upregulation of the sensitivity of the nociceptive and/or neurogenic structures of a nerve.

Some disorders affecting the nerve root actually damage the axons or the myelin coverings [neuropathy], while others only result in inflammation or irritation [often referred to as preneuropraxis or minor peripheral nerve injury] (28). Although these conditions may coexist, this is not a necessity and their presentations are quite different.

Symptom quality and behavior are key defining features of pain that has neurogenic origins (29). Increased neural tissue mechanosensitivity can be examined by nerve trunk palpation and neurodynamic tests, which challenges the physical capabilities of the nervous system by using multijoint movements of the limbs and/or trunk to alter the length and dimensions of the nerve bed surrounding corresponding neural structures (6,30). All of the physical examination findings should be consistent with subjective examination information that revealed the features of the symptomatic complaint and its history.

Myofascial Dysfunction

Dysfunction of myofascial structures can play an extremely important role in the pathogenesis and management of various musculoskeletal pain syndromes (31). The description myofascial is quite accurate because the skeletal muscle is structurally and functionally integrated by fascia, on both a macroscopic and a microscopic level. The functions of a muscle are essentially to exert force and allow movements to occur. That is, it will contract with strength and endurance, it will lengthen and shorten with movement and, under the control of the CNS [neuromuscular control], it will produce coordinated movements (32). The signs and symptoms of muscle dysfunction are related to these functions and encompass reduction in muscle strength and endurance, alterations in muscle length, changes in muscle tone, and myofascial pain.

Reduced muscle strength is reflected in its inability to generate the required force, whereas reduced endurance may be manifested by a reduced ability to repeat a contraction, or a reduced ability to hold an isometric contraction over a period of time (33).

Muscle imbalance describes the situation in which some muscles become inhibited and therefore weak, whereas others become tight, losing their extensibility. As a consequence, both muscles may be weak. This is in accordance with the concept of length-tension diagram which indicates that every change from the neutral position may influence the force production of the muscle (34). Muscle imbalance can occur between agonists and antagonists, but the imbalance that develops between synergists with offsetting actions is believed to be more common (34,35).

Muscle tone is the characteristic resiliency or resistance to stretch in the relaxed muscle (31,36). It can be argued that muscle tone has at least two components: 1. active – due to partial contraction of the muscle through reflex activity of the nervous system, and 2. passive – due to the natural elasticity or turgor of muscular and connective tissues, which is independent of nervous innervation. As a muscle increases in its degree of tone, it becomes tighter and less compliant which is referred to as hypertonicity.

Symptoms from muscle dysfunction are commonly a pain or an ache, which may be felt when the muscle is at rest, when it is lengthened or when it contracts. Muscle pain may derive from myofascial trigger points, which can be associated with a number of other sensory, motor, and autonomic phenomena (37). Secondly, myofascial pain may also refer to soft tissue pain in general, particularly in circumstances where a more specific diagnostic category, such as tendinopathy is not apparent.

These features may influence the whole motion pattern and may result in changes in movement: shortened muscles will reduce joint movement and will produce compensatory movements in other joints. Therefore, myofascial dysfunctions may not be separated from sensorimotor control dysfunctions.

Sensorimotor Control Dysfunction

Although muscles must have sufficient strength and endurance to satisfy the demands of control of the different body segments, the efficacy of the muscle system is dependent on its controller, the CNS (38). Sensorimotor control is defined as the strategy of the CNS, based on the continuous interplay between input [visual, vestibular, and somatosensory information] and output [coordinated muscle action] in order to maintain a position or to produce movement. The CNS must interpret the afferent input from the peripheral mechanoreceptors and other sensory systems, compare these requirements against an "internal model of body dynamics," and then generate a coordinated response of the muscles so that the muscle activity occurs at the right time, at the right amount, and in the right sequence (39). Disturbances in the sensorimotor system may compromise the sensorimotor control function and may lead to changes both in proprioception and in neuromuscular control and vice versa.

Proprioception is defined as the afferent information, arising from peripheral areas of the body that contributes to sensorimotor control, which has three submodalities: joint position sense [the ability to determine where a particular body part exactly is in space], kinesthesia [the sensation that the body part has moved], and sensation of force [the ability to appreciate and interpret force applied to or generated with a joint] (40). Multiple sensors contribute to the sensation of movement and position. These include free nerve endings and receptors in the muscles, ligaments, annulus fibrosus, joint capsules, and skin, with contributions from other senses such as vision and the vestibular system (41). Sensory acuity may be affected by pain, inflammation, injury, and may lead to changes in proprioception.

The commands of the CNS to generate a coordinate response of the muscles to keep the body in a desired position and orientation or to move in a controlled way are referred to as neuromuscular control. There is an emerging body of research demonstrating changes in the amplitude and the timing of muscle activation associated with musculoskeletal disorders.

Regarding amplitude, a reorganization of muscle activity in persons with musculoskeletal pain has been demonstrated (42). However, this change in muscle activity is highly variable among individuals (43). Although there is some evidence that the variability may be related to the magnitude of pain and disability, it is also in accordance with the notion of redundancy in the muscle system. As many muscles can achieve the same goal, different individuals may select different combinations of muscle activity to achieve this goal and this strategy may be task-dependent. The current evidence suggests that subjects with musculoskeletal pain prefer to activate simple strategies that involve an increase in superficial muscle activity, which is associated with changes in deep muscle control (42).

Correct timing implies good functioning of the feed-forward mechanism. Feed-forward postural responses are preplanned by the nervous system prior to the onset of movement and contribute towards the maintenance of stability. A change in the timing of the different muscles has been observed in people with musculoskeletal dysfunction, which may leave the involved body segment vulnerable to further strain (44–48).

Restriction in Activity and Participation

The *last planet* describes the impact of the first two planets onto a restriction in activity and participation, and vice versa. Activity restriction refers to difficulties an individual may have in executing activities such as descending/ascending stairs, walking, lifting, prolonged sitting, etc., where participation restriction refers to problems an individual may have with involvement in life situations such as restrictions in participation in work or family duties or limitations in sport or leisure participation. However, the patient's presentation cannot fully be understood by only identifying activity and participation restrictions (18). Rather, it is equally important for therapists to identify what their patients can do, that is their activity and participation capabilities. Where restrictions will often correlate with patients' goals, capabilities usually provide the point from where retraining or reactivation must commence (18).

In the presentation of the planetary model, the planet of activity and participation comes in last, whereas in clinical practice the examination of the musculoskeletal problem often starts with paying attention to the restricted activities and influence on participation. This emphasizes that the planetary model allows a flexible approach pointing out the different relevant factors in evaluating and treating musculoskeletal patients, without placing them in a chronological or hierarchical order.

CONCLUSION

A didactical model used by physiotherapists is proposed to assist clinicians and students in conceptualizing the organization of knowledge. A structure is put forward in the form of a "planetary model." Although the different categories will not necessarily be appropriate for all clinicians in all clinical settings, this form of personal reflection and assessment should lead to more effective management for each patient and a more rapid acquisition of expertise for the physiotherapist.

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