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Low Back Pain Rehabilitation Using Motor Imagery

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Abstract

Background: The "neuromatrix " theory of Melzack and the studies of Decety about the motor imagery (MI) open the way to new insights in the treatment of chronic pain rehabilitation. In the chronic pain genesis we have a perceptive dis-coherency and MI could remake a coherence of these afferences.

Aim: The aim of the study, referring to Melzak theory and Decety studies, is to evaluate the effectiveness of MI in the rehabilitation of chronic non-specific low back pain.

Design: case reports.

Setting: Outpatient academic hospital.

Population: Were included in the study three women with diagnosis of chronic non-specific low back pain.

Materials and Methods: Pain was assessed using the Visual Analogue Scale and the McGill Pain Questionnaire. Disability was evaluated using the Roland and Morris Disability Questionnaire. Rehabilitation Program: the rehabilitation treatment was centered on the fragmentation-perceived segments of the body with a neurocognitive approach. Ten sessions were performed, two times per week, lasting one hour.

Results: A reduction of pain and disability scores was observed at the end of rehabilitation treatment.

Conclusion: The exercise based on MI is a valid modality in a cognitive-perceptive therapeutic concept for non-specific chronic low back pain. The exercise is then considered an individually planned experience, who therapeutic value must emphasizes patient's skills which will enter become a stable behavioral repertoire, so they must be memorized and automated. The evocation of the correct MI, would allow a greater capacity to acquire the proper somesthesic information, generating a greater coherence in the body self and remission, if not disappearance, of the chronic pain.

Keywords: Rehabilitation; Motor imagery; Neuro cognitive rehabilitation; Low back pain

Introduction

Low back pain is a very common disease with a prevalence ranging from 15% to 45% in the population [1]. About 90% of people complain about an episode of low back pain at least once in their lifetime [2]. The lower back pain has become chronic in about 7-10% of cases, accounting for over 80% of total costs paid by the National Health Service for the disease. As the non-specific lumbar spinal pain constitute not only a social but an economic burden, a correct therapeutic approach is therefore important not only for the patient, but also for society. Our therapeutic approach relies on the interpretation of chronic pain according to recent theories of Melzack, Craig and Ramachandran and the use of motor imagery in rehabilitation [3-5].

The most important contribution of gate control theory to understanding pain was its emphasis on central neural mechanisms. The theory forced the medical and biological sciences to accept the brain as an active system that filters, selects and modulates inputs and the dorsal horns are not merely passive transmission stations but sites at which dynamic activities (inhibition, excitation and modulation) occurred. Understand brain function is our great challenge. Melzak has therefore proposed that brain has got a neural network-the body-self neuromatrix-which integrates multiple inputs to produce the output pattern that evokes pain. The synaptic architecture of the neuromatrix is determined by genetic and sensory influences. The 'neurosignature' output of the neuromatrix-nerve impulses patterns of varying temporal and spatial dimensions-is produced by neural programs genetically built into the neuromatrix and determines the particular qualities and other properties of the pain experience and behavior [3,6]. The motor imagery is a biological phenomenon and results from cognitive processes closely related to our world experience. Through mental images situations and actions can be anticipated, formulating behavioral strategies to be adopted. The image acts as a bridge between perception and memory and between perception and motor control. If the image is altered our perception is altered and the perception is conditioned by the image. Dick and Rashiq [7] examined how attention and memory are disrupted by chronic pain. They pointed to a specific cognitive mechanism, the maintenance of the memory trace that is affected by chronic pain during task performance. The research has consistently shown that cognitive function was not improved by short-term local analgesia [7]. Several studies show a cortex reorganization (S1) in people with chronic pain (as non-specific low back pain), and the extent of reorganization has been related both to the intensity of pain and the reduction in tactile acuity [8,9]. The rehabilitation exercise based on motor imagery could be a valid modality in a cognitive-perceptive therapeutic concept for non-specific chronic low back pain. Decety provides a definition of motor imagery in terms of phenomenological as "the ability to mentally represent action without producing movement" and uses another

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expressions which views MI as "a dynamic state during which a subject mentally simulates a given action, this implies that he feels himself like performing a specific action [10]. The aim of the study is to evaluate the motor imagery's effectiveness, in the rehabilitation of chronic non-specific low back pain in three case reports.

Materials and Methods

The study, conducted in an outpatient academic hospital, were included three women, of twenty-four (case 1), forty-eight (case 2), sixty-five (case 3) years old respectively, with diagnosis of chronic non-specific low back pain. Case 1 was graduate, employed, not married, smoker, BMI 24, amateur sport. Case 2 was graduate, corporate executive, married, non-smoker, BMI 25, normal motor activity. Case 3 was licensed high school, married, and retired from work, non-smoker, BMI 28, no sport practiced. The patients signed an informed consent to participate in the research. During the treatment the patients received no other additional rehabilitation treatments, and have not changed the drugs they are taking (NSAIDs as needed). The inclusion criteria were: diagnosis of non-specific chronic low back pain; age between 20 and 70 years. The exclusion criteria were: infections, osteoporosis, fractures, structural deformities, and history of abdominal surgery or column surgery, abdominal aortic aneurysm, spondylolisthesis, lumbar disc herniation, serious and severe scoliosis or kyphosis, cancer, rheumatic disorders, cardiac disorders, pregnancy, diagnosis of mental disorders, respiratory or neurological disorders. Pain was assessed using the Visual Analogue Scale (VAS) [11] and the McGill Pain Questionnaire (MPQ) [12,13]. Disability was evaluated using the Roland and Morris Disability Questionnaire [14]. The scales were administered at the beginning of rehabilitation treatment (T0) and at the end of rehabilitation treatment (Tend). The Visual Analogic Scale (VAS) is the most widespread instrument to assess the intensity of pain. It visually represents the amount of pain suffered by the patient. The VAS is a ten centimeter horizontal line, where the starting point represents the absence of pain and the ending one represents an unbearable pain (0-10). The patient is asked to "show on the line the point that corresponds to the pain that he has been suffering". The McGill Pain Questionnaire (MPQ) is composed of 78 adjectives about the subjective pain experience and divided in 3 main groups: sensory, affective and evaluative characteristics of the present pain. The MPQ has been translated and validated in many languages; in our study we used the Italian version.

The result of the test consists of 5 score values: PRIS somatosensory score (0-35.5); PRIA affective score (0-21.3); PRIE: emotional score (0-4.6); PRIM score mixed (0-16.1); NWC number of words chosen (0-20); PPI present pain intensity (0-5); S/A: report between sensory and affective dimension. The total score is within a range from 0 to 80.50. The Roland and Morris-Disability Questionnaire is currently the system measurement for disability from low back pain most commonly used in clinical trials. A high score has been shown to correlate to outcome negative treatment. This rating scale consists of a number of statements that many people have used to describe their condition when they have a low back pain (range 0-24).

Rehabilitation Program

Rehabilitation, for a large part may be seen as a learning process where old skills have to be re-acquired and the new ones have to be learned on practice's basis. Active exercising creates a flow of sensory (afferent) information. The rehabilitation treatment was centered on the fragmentation-perceived segments of the lumbar spine with a neurocognitive approach to increase the flow of sensory (afferent) information. Ten sessions were performed, two times per week, lasting one hour. The proposed rehabilitation treatment was characterized by the use of the MI. MI is the mental execution of a movement without any overt movement or without any peripheral (muscle) activation. It represents a cognitive process in which a subject imagines that he=she performs a movement without actually performing the movement and without even tensing the muscles. It is a dynamic state during which the representation of a specific motor action is internally activated without any motor output. In other words MI requires the conscious activation of brain regions that are also involved in movement preparation and execution, accompanied by a voluntary inhibition of the actual movement. The MI has been the tool that has always been present in all the exercises that we will describe and allowed patients to anticipate the movement proposed. Therefore MI guided and facilitated the perception during the exercises. This tool has been allowed to find solutions to the muscular contractions characterizing this disease but also to modify the altered body schema. In particular, all movements of the proposed exercises should occur in the expiratory phase of respiration, in order to exploit the effect of muscle relaxation induced by exhalation. The execution of the exercises was gradually increased, constant, regular, and adjusted individually. All exercises have as their primary objective the overcoming of pain, but they also benefited other aspects, in particular helped to deepen: breathing, relaxation of the paraspinal muscles, improve the mobility of the lumbar spine, improve posture and symmetry and perception. All exercises have followed the rhythm of the breath, or rather, each session began with a few minutes of breathing, and then it remains in the background, to build on the exercises. Exercises were conducted to research the postural symmetry perception of the spine; the variability in the breath; work on the median line; recovery of fragmentation and perception in supine, prone, sitting position (Figures 1 and 2). A descriptive statistics was performed.

Results

The data shown are the preliminary results of three case reports, and follow-up has not yet been carried out. A reduction of pain and disability scores was observed at the end of rehabilitation treatment, especially for the VAS scale (Table 1) and Roland Morris Scale (Table 2), with an improvement of 50% for the case 1, of 61% for the case 2, of

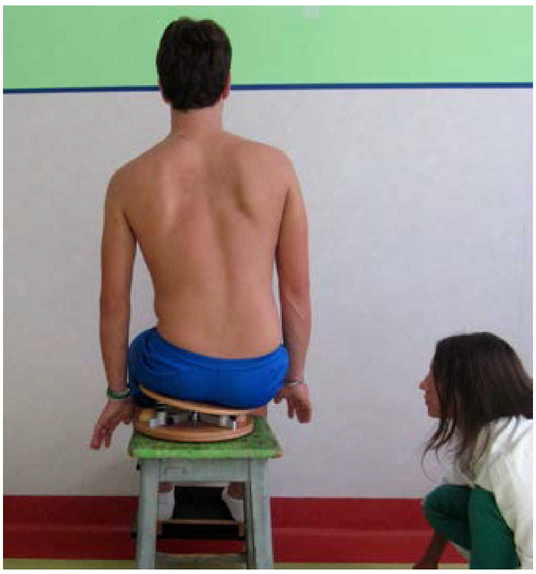

Figure 1: Recognition's exercise of different heights.

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Figure 2: Recognition's exercise of different consistencies.

VAS SCALE	T0	T1
Case 1	6,6	3,3
Case 2	7,5	2,9
Case 3	5,4	2,3

Table 1: Visual Analoge Scale (range 0-10).

Roland and Morris scale	T0	T1
Case 1	8	0
Case 2	15	8
Case 3	20,8	12,5

Table 2: Roland- Morris Disability Questionnaire (range 0-24) at T0 and T1.

57% for the case 3, respect to the VAS scale. At the Roland and Morris Disability Questionnaire Scale, the data show a complete improvement after treatment in case 1, with no residual disability related to back pain.

Regarding MPQ we observed for the first case Ptot value of 61,50 to T0 and 16,50 to T1, for the second case Ptot value of 44,50 to T0 and 8,90 to T1, for the third case Ptot value of 31,50 to T0 and 21,10 to T1 (Table 3). The results show the effectiveness of rehabilitative treatment in the different age groups (respectively 24, 48 and 65 years old for the first case, for the second case and for the third case) and also in different demographic conditions.

Conclusion

A limit of this research is the low sample size, because we report three cases report as preliminary data. Furthermore, low back pain rehabilitation using MI is still an innovative and a little studied field. Our results suggest that the therapeutic exercise based on MI could be a valid modality in a cognitive-perceptive therapeutic concept for non-specific chronic low back pain. However it shouldn't be considered a substitute for physical exercise, even better a relevant complementary technique to improve motor learning. The exercise is then considered an individually planned experience, whose therapeutic value must emphasize patient's skills which will become a stable behavioral repertoire, so they must be memorized and automated [15]. Rehabilitation, for a large part may be seen as a learning process where old skills have to be re-acquired and new ones have to be learned on the basis of practice. Active exercising creates a flow of sensory (afferent) information. It is known that motor recovery and motor learning have many aspects in common. Both are largely based on response-produced sensory information.

It has been shown that motor imagery leads to the activation of the same brain areas as actual movement. Central reorganization, however, takes place not only as a result of sensory input's deprivation but also as a result of sensory input's increase [16].

The rehabilitative exercise, built by referring to the MI, is strongly correlated to the theory of neuromatrix.The pain's neuromatrix theory proposes that pain is a multidimensional experience produced by characteristic "neurosignature" patterns of nerve impulses generated by a widely distributed neural network in the brain-the "body-self neuromatrix". These neurosignature patterns may be triggered by sensory inputs, but they may also be generated independently of them. Chronic psychological or physical stress is often associated with chronic pain, but the relationship is poorly understood. The pain's neuromatrix theory provides a new conceptual framework to examine these problems. It proposes that the output patterns of the body-self neuromatrix activate perceptual, homeostatic, and behavioral programs after injury, pathology, or chronic stress. Pain, then, is produced by the output of a widely distributed neural network in the brain rather than directly by sensory input evoked by injury, inflammation, or other pathology. The neuromatrix genetically determined and modified by sensory experience, is the primary mechanism that generates the neural pattern that produces pain. Its output pattern is determined by multiple influences, of which the somatic sensory input is only a part, that converge on the neuromatrix [6]. The body-self neuromatrix comprises a widely distributed neural network that includes parallel somatosensory, limbic and thalamocortical components that subserve the sensory-discriminative, affective-motivational and evaluative-cognitive dimensions of pain experience. Multiple inputs that act on the neuromatrix programs and contribute to the output neurosignature include. (1) sensory inputs (cutaneous, visceral and other somatic receptors); (2) visual and other sensory inputs that influence the cognitive interpretation of the situation; (3) phasic and tonic cognitive and emotional inputs from other areas of the brain; (4) intrinsic neural inhibitory modulation inherent in all brain function; (5) the body's stress-regulation systems activity, including cytokines as well as the endocrine, autonomic, immune and opioid systems. A genetically determined template for the body-self is modulated by the powerful stress system and the cognitive functions of the brain, in addition to the traditional sensory inputs [3]. The evocation of the correct MI, would allow a greater capacity to acquire the proper somesthesic information,

MPQ-T0	Pri S	Pri A	Pri E	Pri M	Ptot	P S/A	NWC
Case 1	29,10	6,7	8,7	17	61,50	2,96	21
Case 2	20,80	10	2,1	11,6	44,50	1,94	16
Case 3	16,10	2,8	2	10,6	31,50	3,26	11
MPQ-T1	**Pri S**	**Pri A**	**Pri E**	**Pri M**	**Ptot**	**P S/A**	**NWC**
Case 1	8,80	2,8	2	2,9	16,50	3,80	6
Case 2	6,10	2,8	0	0	8,90	2,90	4
Case 3	11,50	0	2,1	7,5	21,10	2,8	7

Table 3: McGill Pain Questionnaire (MPQ) at T0 and T1. Pris: sensory pain rating index (0-35,50), Pria: affective pain rating index (0-21,30), PPI: Present Pain Intensity (0-5), emotive pain rating index (0-4.60), Prim: evaluative pain rating index (0-16,10), Ptot: total point (0-80,50), NWC: number of words chosen (0-20); P S/A: Pain rating index sensory/pain raiting index affective.

generating a greater coherence in the body self and remission, if not disappearance, of the chronic pain [17]. The results seem to confirm the correctness of theoretical premises about the chronic pain genesis and the hypothesis that MI is an effective instrument against chronic pain, restoring the somesthesic channel suppressed and thus re-establishing the coherency of afferences to the central level [18,19]. Stanton et al. [20] have demonstrated how there is a disrupted cortical representations of tactile acuity that contribute to the chronic pain in musculoskeletal disease and osteoarthritis. Graded motor imagery (GMI) shows promising results for patients with complex regional pain syndrome (CRPS). Our case report develops a design capable of differentiating cerebral changes associated with behavioral therapy of CRPS type I study [21,22]. The evocation of a correct MI would allow a greater coherence in the body self, causing then the pain relief. It should also be noted that the evocation of a correct MI, necessary to increase the ability to gain correct somesthesic information and so to generate the chronic pain remission, has been the most difficult element to achieve during the rehabilitation process for both cases studied. The MI thus provides a means at the service of thinking and learning, as it allows simulating and anticipating, guiding and facilitating the perception.

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References

1. Juniper M, Le TK, Mladsi D (2009) The epidemiology, economic burden, and pharmacological treatment of chronic low back pain in France, Germany, Italy, Spain and the UK: a literature-based review. Expert Opin Pharmacother 10: 2581-2592.
2. Parthan A, Evans CJ, Le K (2006) Chronic low back pain: epidemiology, economic burden and patient-reported outcomes in the USA. Expert Rev Pharmacoecon Outcomes Res 6: 359-369.
3. Melzack R (1999) From the gate to the neuromatrix. Pain Suppl 6: S121-126.
4. Ramachandran VS (2005) Plasticity and functional recovery in neurology. Clin Med 5: 368-373.
5. McCrystal KN, Craig KD, Versloot J, Fashler SR, Jones DN (2011) Perceiving pain in others: validation of a dual processing model. Pain 152: 1083-1089.
6. Melzack R (2001) Pain and the neuromatrix in the brain. J Dent Educ 65: 1378-1382.
7. Dick BD, Rashiq S (2007) Disruption of attention and working memory traces in individuals with chronic pain. Anesth Analg 104: 1223-1229.
8. Berthoz A (1996) The role of inhibition in the hierarchical gating of executed and imagined movements. Brain Res Cogn Brain Res 3: 101-113.
9. Mannion RJ, Woolf CJ (2000) Pain mechanisms and management: a central perspective. Clin J Pain 16: S144-156.
10. Decety J (1996) Do imagined and executed actions share the same neural substrate? Brain Res Cogn Brain Res 3: 87-93.
11. Scott J, Huskisson EC (1976) Graphic representation of pain. Pain 2: 175-184.
12. Maiani G, Sanavio E (1985) Semantics of pain in Italy: the Italian version of the McGill Pain Questionnaire. Pain 22: 399-405.
13. Melzack R (1975) The McGill Pain Questionnaire: major properties and scoring methods. Pain 1: 277-299.
14. Roland M, Fairbank J (2000) The Roland-Morris Disability Questionnaire and the Oswestry Disability Questionnaire. Spine (Phila Pa 1976) 25: 3115-3124.
15. Roth M, Decety J, Raybaudi M, Massarelli R, Delon-Martin C, et al. (1996) Possible involvement of primary motor cortex in mentally simulated movement: a functional magnetic resonance imaging study. Neuroreport 7: 1280-1284.
16. Lotze M, Cohen LG (2006) Volition and imagery in neurorehabilitation. Cogn Behav Neurol 19: 135-140.
17. Decety J, Jeannerod M (1995) Mentally simulated movements in virtual reality: does Fitts's law hold in motor imagery? Behav Brain Res 72: 127-134.
18. Deschaumes-Molinaro C, Dittmar A, Vernet-Maury E (1992) Autonomic nervous system response patterns correlate with mental imagery. Physiol Behav 51: 1021-1027.
19. Rommel O, Gehling M, Dertwinkel R, Witscher K, Zenz M, et al. (1999) Hemisensory impairment in patients with complex regional pain syndrome. Pain 80: 95-101.
20. Stanton TR, Lin CW, Bray H, Smeets RJ, Taylor D, et al. (2013) Tactile acuity is disrupted in osteoarthritis but is unrelated to disruptions in motor imagery performance. Rheumatology (Oxford) 52: 1509-1519.
21. Walz AD, Usichenko T, Moseley GL, Lotze M (2013) Graded motor imagery and the impact on pain processing in a case of CRPS. Clin J Pain 29: 276-279.
22. Bowering KJ, O'Connell NE, Tabor A, Catley MJ, Leake HB, et al. (2013) The effects of graded motor imagery and its components on chronic pain: a systematic review and meta-analysis. J Pain 14: 3-13.