

DEEP OSCILLATION – A MODERN ADDITIONAL PHYSICAL MODALITY FOR ANALGESIA IN PATIENTS WITH BACK PAIN

Magdalena G. Zehtindjieva, Borislav R. Ioshinov, Dobri R. Andonov, Vasil S. Ilkov, Antoaneta Bayraktarova, Student in Medical Rehabilitation and Ergotherapy, Medical Faculty, Medical University of Sofia

Ivet B. Koleva, Department of „Medical Rehabilitation and Occupational Therapy“ at the Medical University – Sofia

ABSTRACT

INTRODUCTION: *A lot of patients suffer from chronic pain. All modern scheduled drugs used for treatment of the persistent pain (opioids, NSAIDs, COX-2 inhibitors) are associated with limitations and side effects. Our purpose was to remind the wide public of the impact of physical modalities in pain management in adults. Deep Oscillation is a modern physical factor, based on the influence of the electrostatic field on tissues in profundity, explained with the Rahbek – Johnson effect.*

GOAL: *Comparative evaluation of drug, physical (including Deep Oscillation) and combined analgesia in patients with paravertebral and peripheral radicular pain.*

MATERIAL AND METHODS: *During last year a total of 81 patients with vertebrogenicradiculopathy were observed and investigated – in-patients of the Clinic of Physical and Rehabilitation Medicine of the University Hospital “St Ivan Rilsky” – Sofia. Patients were randomized to three treatment groups of 27 each one.*

The investigation was conducted with consideration for the protection of patients, as outlined in the Declaration of Helsinki, and was approved by the appropriate institutional review board and ethic commission. All patients gave written informed consent before undergoing any examination or study procedure.

Groups 1 received only drug therapy – paravertebral infiltrations. Patients of group 3 received only physical modalities [complex rehabilitation programme including deep oscillation (DO)]. In group 2 we applied drug and physical analgesia techniques.

For statistical evaluation we used t-test (ANOVA) and Wilcoxon rank test (non parametrical correlation analysis), performed using SPSS package. The treatment difference was considered to be statistically significant if the p value was < 0.05.

The comparative ANALYSIS of RESULTS shows a significant improvement of the symptoms of the patients, concerning: pain relief (visualized by the analysis of results of Visual analogue scale), radiculopathy (Lassegue’s sign), depression (scale of Zung).

The drug analgesia in group 1 is fast, but short. The efficacy in group 3 is slow, but stable, and durable. We observed best results in group 2.

DISCUSSION: *The drug therapy is efficient but with short duration. The physical analgesia with Deep Oscillation initiates its effect slowly, but the results are stable. Best efficacy was observed in case of combination of medication with physical modalities – in the beginning due to the anti-inflammatory drug, toward the moment of effective «input» of physical modalities.*

Current paper proposes personal opinions on some contemporaneous theories of pain and therapeutic concepts of analgesia, including physical analgesia. We explain different natural and preformed physical modalities, with effectiveness in clinical practice. Authors apply a conception of pathogenetic mechanisms of physical analgesia in case of application of Deep oscillation.

CONCLUSION: *We could recommend the complex program for treatment of the paravertebral pain.*

Key words: *physical modalities, rehabilitation, pain, analgesia, deep oscillation*

1. INTRODUCTION

1.1. A lot of patients suffer from chronic pain. All modern scheduled drugs used for treatment of the persistent pain (opioids, NSAIDs, COX-2 inhibitors) are associated with limitations and side effects [10, 11]. Our purpose was to remind the wide public of the impact of physical modalities in pain management in adults.

1.2. Deep Oscillation® Therapy was originated in Germany in 1988 [19]. Deep Oscillation (DO) is a modern physical factor, based on the influence of the electrostatic field on tissues in profundity, explained with the effect, named after Danish engineers F. A. Johnsen and K. Rahbek [20]. The Johnsen–Rahbek effect occurs when an electric potential is applied across the boundary between a metallic surface and the surface of a semiconducting material. Under these conditions an attractive force appears, whose magnitude depends on the voltage and the specific materials involved. R. Atkinson [1969] described a model expressing the attractive force between the contacting materials as a function of the voltage applied across them [2]. The model, which takes into account the presence of surface irregularities, is obtained by an assessment of the effect of field emission on the electrostatic capacitor forces between the contacting surfaces. This model is the base of modern devices: HIVAMAT & Deep Oscillation®.

The name HIVAMAT is short for a rather wordy description: (HI) Histological (VA) Variable (MA) Manual (T) Technique [18]. Technically speaking, the HIVAMAT 200™ produces its unique method of micro-massage therapy based on the action of a pulsating, low-frequency, two-phase alternating electrostatic field generated between the practitioner's hands and patient's skin [19]. At the level of the connective tissue this intermittent electrostatic field produces an intense resonant vibration and the repetition of this phenomenon in rapid succession generates rhythmic deformations of the tissue (skin, connective, and muscular). The resulting effect includes improvement in microcirculation, better tissue nourishment, enhancement of cellular metabolism, promotion of faster healing even on open wounds, anti-oedema, lymph drainage, anti-fibrosis and

detoxifying properties, alleviation of pain and swelling, stimulation of collagen production and tissue regeneration. Deep Oscillation® Therapy has been proven as an effective therapy for: occupational injury and everyday conditions associated with pain, inflammation, swelling and scar tissue; sports injuries; general and surgery aftercare; laser re-surfacing rehabilitation; pre-chiropractic adjustment [1, 9, 12, 14].

1.3. The formulation of the gate-control theory [15] for explanation of pain deposited the base of a new epoch in the development of the orthodox medicine. This was the introduction of the principle of the „contra-stimulation“ – final effect reticence by stimulation of inhibiting systems or else final effect stimulation by embarrassment of inhibiting systems [6].

The science proved the existence of unsuspected reflectory relations and dependences between processes, apparently independent. There appear conditions for infringement of the traditional therapeutic thinking and for formulation of a principally new approach for creation of modern or for explanation of existing anti-pain methods – from the domain of electrology, thermo and kryotherapy, manual techniques, reflexology.

By our opinion the anti-pain effect of physical modalities is very important, with a high level of efficacy. Physical analgesia has not side consequences and may be applied in combination with other therapeutic factors.

PAIN is one of the most frequent sensations, formed in the nervous system, with different functional characteristics [8, 10].

Pain is a subjective experience, provoked by nociceptive activation, by changes in sensory nerves and roads, or by cerebral centres – regulating of the stress, the affects and the motivation.

Different factors (physical, chemical, psychological) can influence on the pain perception [4].

Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage [21].

The biological significance of pain perception is defense of the organism from negative external influences (signal attention).

The pain informs the organism and provokes a reflexory defensive reaction of the individual.

The French philosopher René Descartes explains the idea for the defensive character of pain (baby fire, boy fire) and the capacity to unchain a reflexory reaction „pulling on a thread“ (1662, 1664).

In 1965 the collaboration between two individual investigators – the British physiologist Patrick Wall and the Canadian psychologist Ronald Melzack, generates the theory of gate control [15]. Their common article „Pain Mechanisms: A New Theory“ was qualified like „the most influential ever written in the field of pain“ [6].

Melzack and Wall suppose the existence of a controlling mechanism in the spinal medulla, which is closed in response to the normal stimulation of fast fibers of tactile sense, but is open if the slow fibers of pain perception transport numerous and intensive sensory signals. The gate is closed if these signals are interrupted by a new stimulation of the fast fibers.

There are different types of pain: acute and chronic (persistent) [21]; nociceptive pain & neuropathic pain [7]; others (central pain). The combination of nociceptive (inflammatory hyperalgesia) and neuropathic mechanisms is one of the basic causes for our therapeutic impotence behind pain.

1.4. Drug or / and non-drug analgesia? That's the question.

In physical analgesia a lot of physical modalities are applied [10]:

Preformed modalities:

- Low frequency currents and low frequency modulated middle frequency currents

(sinusoidal-modulated, interferential, Kots currents);

- Transcutaneous electro-neurostimulation (TENS);

- High frequency currents (diathermy, ultra-high frequency currents, decimeter and centimeter waves);

- Ultra-sound and phonophoresis with NSAIDs;

- Low frequency magnetic field.

Natural modalities:

- Kryo-factors (ice, cold packs, cold compress-

es);

- Thermo-agents (hot packs, hot compresses),
- Hydro- and balneo-techniques (douches, baths, piscine); hydro and balneo-physiotherapy techniques (underwater massage, under water exercises, etc.);

- Peloidotherapy (fango therapy, thermal mud, sea lye compresses).

- Physiotherapy techniques – stretching, post-isometric relaxation, manual therapy (traction, mobilization, manipulation); massages (manual and with devices; periosteal, connective tissue massage, etc.);

Reflexory methods: electrotherapy, thermotherapy and physiotherapy in reflexory points and zones; acupuncture, laserpuncture, acupressure, etc.

2. OBJECTIVE

The GOAL of current study was to realize a comparative evaluation between the efficacy of pure drug therapy, physical analgesia and combined anti-pain therapy (drug and physical analgesia) on the paravertebral and peripheral radicular neuropathic pain.

3. DESIGN OF THE STUDY

3.1. Material and methods: During last years a total of 81 patients with a vertebrogenic radiculopathy were observed and investigated – in-patients of the Clinic of Physical and Rehabilitation Medicine of the University Hospital “St Ivan Rilsky” – Sofia. Patients were randomized to three treatment groups of 27 each one.

The distribution women : men was 46 : 35, mean age 47 years +/- 1,2y. All patients suffer from back pain – with cervical (24 p.) or lumbar (57 p.) localization. In all patients we observed vertebral syndrome and radicular syndrome (L5 in 13 patients, S1 – in 19 patients, L5 & S1 – in 49 patients). The vertebral syndrome was total in 68 patients (paravertebral muscle spasm, diminished range of motion of the spine, reduction of the cervical / lumbar lordosis, changes in the thoracic kyphosis, functional scoliosis. All patients had radicular syndrome – in 23 of them only with positive sensory symptoms (numbness, paresthesias,

dysesthesias, pain), in 17 patients – with positive and negative sensory symptoms (+ radicular hypesthesia), 41 patients had too negative reflectory symptoms (hypo or areflexia). A detailed kinesiological and pathokinesiological analysis was performed for every patient with functional status, manual muscle test, goniometry, centimetry [4, 5]. Finally, an ICF testing was applied – according the WHO requirements of the International Classification of Functioning, Disabilities and Health, 2001 [17].

In the major part of patients (89 %) the clinical diagnosis was osteochondrosis, spondylosis and / or spondyloarthrosis, proved by neuro-imagery (X-ray, CT or MRI). Neuro-functional exams (excitomotory electrodiagnostics, electroneurography or electromyography) proved L5 and / or S1 radicular lesions in all patients.

All patients of the three groups were investigated according this Protocol before (B.Th.), during (Day 5) and after (A.Th.) therapy (the complex PRM programme of 20 days), and one month after the end of the rehabilitation (1 month later).

3.2. Ethic aspects

The investigation was conducted with consideration for the protection of patients, as outlined in the Declaration of Helsinki, and was approved by the appropriate institutional review board and ethic commission. All patients gave written informed consent before undergoing any examination or study procedure.

3.3. Physical and Rehabilitation Medicine (PRM) programme

Groups 1 received only drug therapy: paravertebral infiltrations with cortico-steroids (Hydrocortisone), B vitamins (B1, B6, B12) and local anesthetic (Lidocain).

Patients of group 3 received only physical modalities: complex rehabilitation programme including deep oscillation (DO – fibromyalgia programme) and kinesitherapy – active analytic exercises (including isometric exercises) and soft tissue techniques (post-isometric relaxation, stretching of the lumbar fascia, manual massage) [13].

In group 2 we applied parallel drug and physical analgesia techniques.

3.4. Statistical analysis was performed with SPSS electronic package, version 11.5. We applied options for two samples comparison) with parametrical analysis of variances ANOVA and non-parametrical distribution and correlation analysis:

- t-test (t-criterium, p value),
- Signed test,
- Signed rank test,
- Kolmogorov – Smirnov test,
- Mann – Whitney (Wilcoxon) W test (W медиана).

The treatment difference was considered to be statistically significant if the p value was < 0.05. In some cases we received lower results of the p-value (p<0.01).

4. RESULTS AND ANALYSIS

The comparative analysis of results shows a significant improvement of the symptoms of the patients, concerning:

- pain relief (visualized by the analysis of results of Visual analogue scale VAS 0-20, fig.1),
- radiculopathy (Lassegue's sign – fig.2),
- depression (express scale of Zung – fig.3).

The drug analgesia in group 1 is fast, but short. The efficacy in group 3 is slow, but stable, and durable.

We observed best results in group 2.

Fig.1. Pain relief (VAS 0-20)

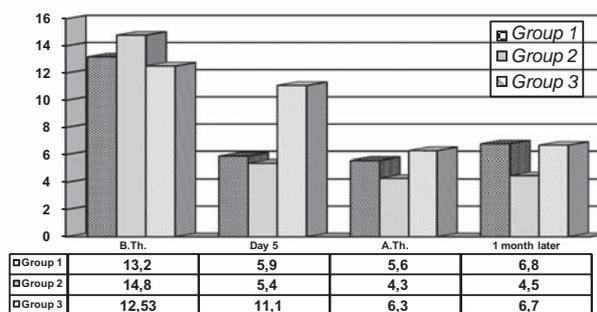


Fig.2. Lassegue's sign

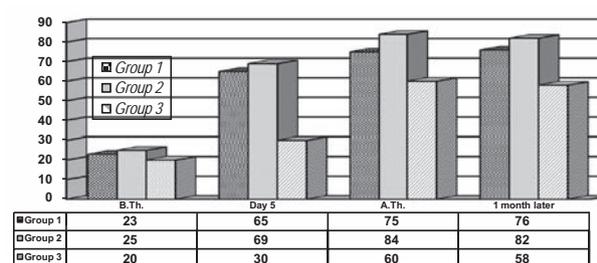
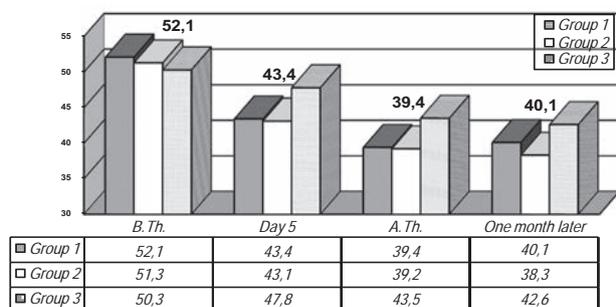


Fig.3. Psychological tests: ZUNG – Dépression



5. DISCUSSION

5.1. The drug therapy is efficient but with short duration. The physical analgesia with Deep Oscillation initiates its effect slowly, but the results are stable. Best efficacy was observed in case of combination of medication with physical modalities – in the beginning due to drugs towards the ‘input’ of physical analgesia.

5.2. We expose our own conception of pathogenetic mechanisms of physical analgesia.

In physical medicine we applied the principles of gate-control theory of Melzack&Wall for central nociceptive influence. Investigations of prof. Yordanka Gacheva demonstrate that the selective electrostimulation of tactile A β -nerve fibers (with high velocity of conduction) provokes a previous stimulation of suppressive neurons, they inhibit the tardily arrived nociceptive stimuli of A- δ and C-fibers (with slower conduction velocity) [citation by 10, 11]. It is considered that a closer suppressive transfer mechanism exists at spinal level.

At the peripheral level the direct anti-adaptation electrostimulation of the receptors probably provokes a hyperpolarization with a decrease of the sensibility of the nociceptors. A direct low frequency electrical stimulation of the A δ and C fibers may cause an analgesic effect.

We propose our own theory for explanation of mechanisms of action of physical modalities on the nociceptive and neuropathic pain [we introduce the notion physical analgesia or anti-pain effect of physical modalities] :

Our hypothesis: The used physical complexes may provoke an analgesic effect by the following mechanisms [10, 11]:

- By influence on the cause for irritation of pain receptors – consequence of stimulation of circu-

lation, metabolism and trophy of tissues (by low and medium frequency electric currents, magnetic field, ultrasound, He-Ne laser; massages; manual techniques);

- By blocking of nociception (low frequency currents, including transcutaneous electrical nerve stimulation or TENS; lasertherapy);

- By peripheral sympaticolysis (low frequency currents like dyadinamic currents, peloids);

- By stopping the neural transmission (by C and A δ delta – fibers) to the body of the first neuron of the general sensibility (iontophoresis with Novocain in the receptive zone – the region of neuro-terminals);

- By input of the gate-control mechanism (TENS with frequency 90-130 Hz and interferential currents with high resulting frequency – 90-150 Hz);

- By activation of the reflexory connections: cutaneous – visceral, subcutaneous-connective tissue-visceral, proprio-visceral, periostal-visceral and motor-visceral (classic manual, connective tissue and periostal massage, post-isometric relaxation and stretching-techniques);

- By influence on the pain-translation in the level of posterior horn of the spinal medulla – using the root of activation of encephalic blocking system in the central nervous system (increasing the peripheral afferentation) and influence on the descending systems for pain – control (TENS with frequency 2-5 Hz and interferential currents with low resulting frequency 1-5 Hz, acupuncture and laserpuncture; reflexory and periostal massage, zonootherapy, acupressure, su-dgok massage; preformed factors in reflexory zones /palms of hands, plants of feet, paravertebral points; zones of Head, of Mackenzie, of Leube-Dicke, of Vogler-Krauss/);

- By influence on the psychic state of the patient – the drug «doctor» and the drug «procedure».

5.3. We consider that the application of Deep Oscillation can alleviate the pain through different mechanisms: by influence on the cause for irritation of pain receptors, By blocking of nociception, by peripheral sympaticolysis, by activation of the reflexory connections.

The construction of a complex physical and rehabilitation programme is needed, because the mechanism of action of different procedures is diverse [11]. This opinion is synchronized with

modern tendencies in drug treatment of distal symmetrical diabetic neuropathy (during last ten years), in contemporaneous studies a combination of symptomatic and pathogenetically oriented therapy is prescribed.

5.4. The influence of physical modalities on the interstitium or milieu intérieur of Claude Bernard [3] is the theoretical base for combination of drugs and physical modalities.

The synergy between different physical modalities is the logical base for prescription of complex physical program.

6. CONCLUSION

We could recommend our complex programme for treatment of the paravertebral and radicular neuropathic pain.

7. REMARKS

Declared opinions and conclusions of authors are based on the traditions of Bulgarian rehabilitation school, on analysis of scientific literature (including electronic media), on our modest experience – clinical observations, scientific and applied investigations; and on the results from systematic interviews with in-patients and out-patients [treated in the Rehabilitation Clinic of the University Hospital „St Ivan Rilsky”].

8. ACKNOWLEDGMENTS

Authors thank the Council of Medical Science of the Medical University of Sofia for the support via scientific project 53 / 2013, Contract 31 / 2013.

9. REFERENCES

1. Aliyev R., Mikus E.W.J., Reinhold J.G. Hochsignifikante Therapieerfolge mit DEEP OSCILLATION® in der orthopädischen Rehabilitation. *Orthopädische Praxis* 44, 9, 2008, 448-453.
2. Atkinson R. A simple theory of the Johnsen-Rahbek effect. *Journal of Physics D: Applied Physics*, 2, 1969, 3, 325.
3. Bernard CI. *Introduction à l'étude de la médecine expérimentale*. – Paris: Hachette, 1943.
4. Boubee M. *Bilans analytiques et fonctionnels en rééducation neurologique. Tome 1. Troncet membres inférieurs*. – Paris: Masson: 1975.
5. Boubee M. *Bilans analytiques et fonctionnels en rééducation neurologique. Tome 2 – Membres supérieurs et bilans spécifiques*. – Paris: Masson, 1975, pp.12-25 & 89-97.
6. Boureau F, Willer JC. *La Douleur – exploration, traitement par neurostimulation et électro-acupuncture*. – Paris – New York – Barcelone – Milan: Masson, 1979.
7. Calcutt NA, Dunn JS. *Pain: Nociceptive and Neuropathic Mechanisms*. *Anesthesiology Clinics of North America*, 1997.
8. Cox JM. *Low Back Pain – Mechanism, Diagnosis and Treatment*. 5-th ed. – Baltimore: Williams & Wilkins, 1990, 437-467.
9. Gasbarro V, Bartoletti R., Tsolaki E. et al. Ruolodell'oscilazione profonda (HIVAMAT® 200) nel trattamento di focoli di infiammazione degli arti. *La medicina estetica*, 30, 2006, 473-478.
10. Koleva I. *Repetitorium physiotherapeuticum (basic principles of the modern physical and rehabilitation medicine)*. Book for English speaking students of Plevan Medical University. – Sofia: Publishing house „SIMEL”, 2006, 95 p.
11. Koleva I. Chronic pain and physical analgesia: the impact of physical modalities to reduce pain. – *Journal of Biomedical and Clinical Research*, 1, 2008, 1, 12-17.
12. Krämer, K., Maichl F. Scores, Bewertungsschemata und Klassifikationen in Orthopädie und Traumatologie. Stuttgart – New York: Georg Thieme Verlag, 1993, p.418–444.
13. LaFrenière JG. *Le patient lombalgique (techniques de traitements kinésithérapeutiques)*. – Paris – New York – Barcelone – Milan – Mexico – Sao Paulo: Masson, 1983, 194 p.
14. Luther C., Germann G., Holle G. et al. Das komplexregionale Schmerzsyndrom (CRPS). *CHAZ* 6, 2005, 59–67.
15. Melzack R, Wall PD. Pain mechanisms: A new theory. *Science*, 1965, 150, 971-979.
16. Merskey H, Bogduk N Eds. *Classification of chronic pain – descriptions of chronic pain syndromes and definition of pain terms*. – Seattle: IASP press, 1994.
17. World Health Organization. *International Classification of Functioning, Disability and Health (ICF)*. – Geneva: WHO, 2001.
18. <http://lewisvillemassage.com/hivamat/>
19. http://en.wikipedia.org/wiki/Johnsen%E2%80%93Rahbek_effect
20. <http://www.holistichealing.me/hivamat-deep-oscillation-massage-therapy/>
21. <http://www.iasp-pain.org>