EFFECTS OF LOCAL VIBRATION THERAPY ON UPPER LIMB'S SENSORIMOTOR CONTROL IN WORKERS SUFFERING FROM PARKINSON'S DISEASE – STATE OF ARTS AND STUDY ON A NEW PREVENTION AND THERAPEUTIC SYSTEM.

S. Gentili, S. Mugnaini, S. Lanzi, M. Richetta, A. Pietroiusti

[1] *Department of Systems Medicine - Section of Rehabilitation Medicine - University of Rome "Tor Vergata"*
[2] *PhD School in Industrial Engineering "Technological Rehabilitation" - University of Rome "Tor Vergata"*
[3] *Master School on Clinical Posturology - University of Rome "Tor Vergata"*
[4] *Department of Industrial Engineering - University of Rome "Tor Vergata"*
[5] *Department of Biopathology - Section of Occupational Health - University of Rome "Tor Vergata"*

I. Introduction

Our study arises from the growing and consistent body of scientific investigations conducted for several years on the vibration in the therapeutic area, the effects of which may positively affect the quality of life in people affected by Parkinson's disease but still engaged with working activities. Parkinson's disease is characterized both by typical motor symptoms (tremor, rigidity, bradykinesia), and by cognitive impairments, which can sometimes severely affect the quality of life. The average age of onset is around 58/60 years, but about 5% of patients may have a juvenile onset between 21 and 40 years. Over 60 years the disease may affect about the 2% of the population while the percentage rises above 4% if the age exceeds 80 years. Although until recently it was considered as an aging-associated disease, today epidemiological data show that on an incidence of 247/100000 inhabitants the 30% of cases fall within the range of the working age. Given the importance of the symptoms caused by this disease, we decided to choose Parkinson's affected workers, in an active and productive phase of their lives. In this way, our aim was to better understand the impact of the disease on work activities with particular attention to the upper limb and to test if the local vibration therapy could provide positive results on the use of the upper limb affected both in the daily and working activities, that must be well preserved in relation to changes in the welfare state. In Parkinson's disease, several studies on the effect of Whole Body Vibration (WBV) have been conducted, showing encouraging but often contradictory results, especially in relation to the spread of the vibration to the whole body. Therefore, the aim of our study was to provide a local application of vibrations to a specific area of the body in order to assess its effects on people suffering from Parkinson's disease, thus enabling new rehabilitative opportunities that still remain to be exploited. Local vibration therapy can offer its advantages by removing the discomfort and lack of security related to the standing position on the vibration plate requested to patients, while offering the benefit of treatment that can be performed in comfortable positions and focused on suitable facilities, conveniently chosen for the trial. Therefore, the aim of our study was to assess whether the effects of local vibration therapy are able to improve the main symptoms affecting the upper limb of people affected by Parkinson's disease. We want to try to reduce rigidity, bradykinesia and tremor around the upper limb, decreasing the shoulder pain, thus increasing balance and walking stability, the ability and the speed when performing a more controlled movement, and the hand skill in the ADL and working activities.

II. Materials and methods

Device

Figura 1 *Device EVM used in our research work*

EVM is a mobile device with a control desk, designed in physical therapy for the administration of muscular vibratory energy by air compression-decompression. In the upper part of the rear panel fourteen pneumatic connectors are located, for as many pressure pipes connected to the cup applicators that emit the vibratory waves (transducers). The EVM can generate mechanical vibrations transmitted through the displacement of an air column through a compression \ decompression (within a range of ± 400mBar) cycle of the air columns inside the tubes, and then applied to the surface the patient's body through one or more of the fourteen cup transducers, each with its own seal. The device is equipped, for each diffuser, of a stopcock which allows to control each route of application during opening and closing stage, thus avoiding useless dispersions of both pressure and noise. Cup transducers establish a mechanical connection with the membrane skin causing a displacement of the skin synchronous to compression \ decompression of + \ - 3 mm. These transducers are fixed to the areas subjected to the treatment by elastic bands with a maximum frequency of 300Hz (therapeutically lower at around 30 Hz) on a sinusoidal frequency. Through the control desk, this device can be set in delivery times, frequencies, any pauses and changes of frequencies at specified times and the personalized therapy for each patient can also be recorded.
EVM is designed in accordance with the requirements of Directive 93/42 EEC (implemented in Italy with DL46 of 24/02/1997, and following amendments), and it meets the essential requirements set out in Annex I. The European Norm IEC 60601-1 third edition (CEI 62-5, Issue 8858, May 2007) is the standard adopted safety technology, along with the relevant applicable Collateral rules. The therapeutic contraindications of this device are, of course, all those typical of physical devices that should be applied on the outer body surface (which can cause endogenous heating and a repeated

microtrauma on sensitive structures). Therefore, its use in the presence of neoplasms and \ or vascular diseases in areas to be treated (such as varicose veins, thrombophlebitis, bleeding, arterial disease), as well as of inflammations or evident skin lesions, should be avoided. In the presence of synthetic devices its use should be carefully evaluated. Instead, with regards to active implantable devices (eg. Pacemakers) carriers, although there is (for EVM) no generation of direct and \ or induced electric currents, directly provided on the patient, the treatment should be carefully evaluated, according to the EMC immunity degree, because the generator, even if shielded, can generate a weak electromagnetic field. The machinery is produced by J & S s.r.l. and distributed by Endomedica.

Local vibration (L V)

This kind of stimulation shows some interesting aspects that differentiate it from whole-body vibration. The local vibration makes it possible to use very precise vibratory stimulus. The non-diffusion along the body and its ability to remain confined to small areas prevent a phenomenon typical of the propagation of mechanical signals through inhomogeneous structures such as biological tissues (adipose, skin, muscle, bone, cartilage, connective, etc.) and the distortion of the applied signal. With the local vibration is it is therefore possible to know, with precision, what stimulus is applied, to define the parameters with greater accuracy and to find out which nerve endings are stimulated and what signal arrives at the nerve centers. In some studies of 1963 (1) showed that the mechanical vibration applied directly to a suitably prepared single muscle belly, with appropriate amplitudes and frequencies, was able to selectively activate in a differentiated manner to the primary afferent fusals (Ia), secondary (IIb) or GTO, depending on the characteristics of the stimulus. Our study differs from this work and from Whole Body Vibration as we tried to minimize the fusal stimulation, and to maximize the stimulation on perceptual skin areas. This was our starting point in order to decide on which areas to work, and we used a frequency of 30 Hz and an amplitude of 2 mm. The vibration perception constitutes a mechanical sensitivity and, for this reason, involves the receptor structures sensitive to mechanical stimulation, such as mechanoreceptors(2). The Meissner corpuscles are mechanoreceptors located in the dermis that cover the most relevant role in the context of vibratory perception, showing an activation of the selective type for vibratory stimuli at low frequency. (4)

III Statistical sample

For this study where recruited patients with Parkinson's disease. To selection the patients where used some peculiar inclusion parameters, so that study could be as homogeneous as possible:

- cooperative patients;
- absence of contraindications related to the use of machinery;
- diagnosis of Parkinson's disease;
- second stadium on the amended scale Hone & Yard;
- workers (tough not professionally exposed personnel to vibrations);
- patients fall into an age range between 50 and 65 years.

The limited number of patients taken care of 10, is in relation to the specific characteristic required for the study; contraindications of physical means to be applied on the outer surface and the number of patients who have given their availability to taken part.

IV Executions

Patients are selected according to the previously described parameters. The therapist explains in details the method and the ratio of potential treatment, to focuse the expected effects, contraindications and procedures. Signed consent and agree to the experimental protocol, patients are evaluated according to the described parameters, that is through the specific rating scales, the gate analysis and the Jebsen test. Gate analysis is conducted in a laboratory. Patients put off their shirt and they put on some stickers, walking along the part previously described. They are bilaterally filmed by a video recording.

Figura 2 *In the picture we can see the result of skill program spector used to gate analysis The position of the upper extremity is underlined in red.*

The Jebsen test is played within the same room, where the patients do the tests previously described.

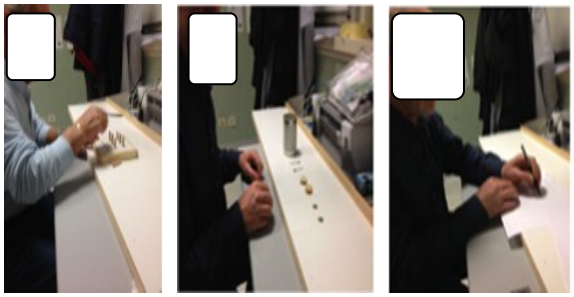

Figura 3 *In the first figure on the left we can see one of the patients doing the peg test. In the second and in the third picture we can see our patients doing the Jebsen test.*

The patient is accompanied into the room, used for the treatment, equipped with more privacy and quiet, in which it is subjected to vibration therapy. The therapy is conducted with patients lying on the conch, in the supine position, then in functional discharge. The vibration is confined to specific areas that are more affected by rigidity of the upper extremity, typical of Parkinson's disease. Reducing the hypertonia we work on proprioception of the upper extremity, highlighted by the resumption of the shuttle arm movement physiological during walking. Such stimulation helps us to control the pathological function of the subcortical structures, hypertonia and the ataxia. It is also used to reduce the pain that affects the shoulder district, increasing the perception of the entire limb, improving the use of the hand in AVQ. Target body regions were created by local vibration through the following application of transducers on both upper limb:

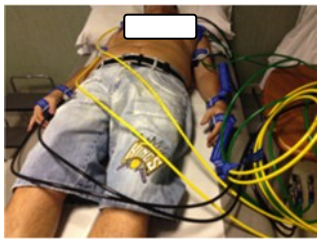

Figura 4 *EVM machinery applied with the cups at the level of the upper extremity of our patient.*

- a transducer applied to the palmar surface;
- a transducer applied to wrist ulnar flex;
- a transducer applied to elbow level of brachioradialis;
- a transducer applied at the level of the caudal portion of the biceps brachial muscle;
- a transducer applied to the level of the trapezoid, caudal portion, avowing any interference with the vascular system of the neck. The five cups are converters fixed with a special piston system and connected to x-connection hose to the machine.

The five trasducers are fixed by special band system and connected at its tube connectivity to machinery. Once Guaranteed stability of the transducers and the connection provided between the ' device and the patient , as well as the ' opening of the taps that can supply Correspondents For transducers used , and Past It 's Programming Machinery, the same for all patients . Duration: 15 minutes, Frequency: 30 hertz and Power: 3 (sinusoidal displacement amplitude +- 2mm). The Patient State and then subjected to treatment without interference from the outside environment with good privacy and quiet .The Therapeutic application of local vibration Has Been conduct for 10 sessions , but the complete procedure described Has Been Just made only during the first session (Initial Evaluation) and ' last session (evaluations final) . A final evaluation without Treatment Has Been done come the follow-up to 30 days from the tenth and final session of therapy. The patient is subjected to therapy without interference from the outside environment with good privacy and quiet. The therapeutic application of local vibrations was conducted for ten sessions, however the full procedure just described is made only during the first session (final evaluation). Last assessment without treatment is made as a follow up to 30 days from the tenth and last session.

V Result

When the cycle is finished and datas are collected, it is possible to observe a positive effect of the local vibration therapy, applied on the pathological upper extremity in subject selected by us. The rating scales, thanks to the Costant Scale, highlight the improvement of the parameters (pain, upper extremity use in AVQ, range of motion, muscle strength). The interesting data is related to the shoulder pain, which in all patients decreased by severe pain in little pain or moderate pain to absent. We also obtained an increase in the use of the upper extremity in the activities of daily life and work. The UPDRS scale shows an improvement in the Part II of the scale (motor experience of every life) and in the part III (physical evaluation). This indicates that the therapy has a positive influence to the daily activities and also to the working life, thanks to a greater security of patient mobility. The questionnaire SF36 shows what the patient thinks of his health in relation to what the patient can perform in usual activities. It represents an indirect index of liking. On overage all patients appreciate the therapy since they have improved the use of the uppe extremity in AVQ. We used the minimental state to go to assess whether patients taken care of a cognitive situation in normal range. In fact we have got in all patients a borderline value bigger than 27. Since this value to +24>, maximum correction factor for schooling etc, we had 27 as cut of inclusion\ esclusion. In the Jebsen test, compared to other scales of assessment, the patient is placed in front of seven trials that must play while he is timed. It means that the ability of the hand can interact with objects of different shapes, sizes and weights. It shows how the time spent in each exercise is decreased to T2, compared to T1, and timed times remained even at T3. This shows us the movimental slowness, typical of Parkinson's disease. On the contrary, it is increased the hand dexterity in daily activities (eating, writing, lift object more or less heavy etc.) As regards the assessment carried out using gait analysis system, interesting variations are recorded in relation to the movement of the upper extremity, with an increase of breadth and fluidity and a reduction of the rigidity of the entire limb. Observing datas from the Skill Spector program, we can also observe an improvement of walking ability due to a better balance given by the best commuting of the limb. It is possible to observe, once the treatments are stopped, in one month, the decrease of the results; however they show different improvements compared to the previous condition.

tabella spostamento polso rispetta all'asse del corpo	valori in cm
PAZIENTE 1	
T1	0
T2	5,6
T3	5,5
PAZIENTE2	
T1	0
T2	5,8
T3	4,6
PAZIENTE 3	
T1	0,2
T2	5,9
T3	4,8
PAZIENTE 4	
T1	0,3
T2	5
T3	4,2
PAZIENTE 5	
T1	1
T2	7,1
T3	6,3
PAZIENTE 6	
T1	0,5
T2	6,2
T3	6
PAZIENTE 7	
T1	0
T2	4,5
T3	4,1
PAZIENTE 8	
T1	0,2
T2	5,3
T3	4,9
PAZIENTE 9	
T1	0,4
T2	4,6
T3	4,3
PAZIENTE 10	
T1	0,3
T2	5,5
T3	5,3

Figura 5 *Table of Data obtained from the analysis port information related to the movement of the wrist to the shoulder respect .*

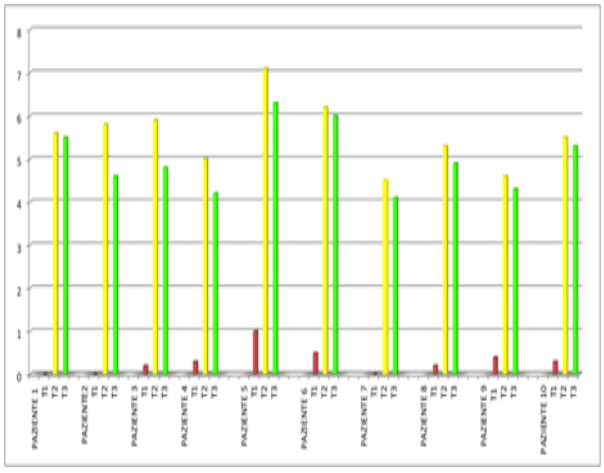

Figura 6 *Histogram Relative to the movement of the wrist to the shoulder respect, of the 10 patients .*

Thanks to the gate analysis system it was possible to assess the value data of the displacement of the value data of the upper extremity (commuting), given by the movement of your wrist relative to the axis of the body. In the histogram (2) you can see that in Q1 (red column), the pulse related to the axis of the body doesn't make any movement or small movement of 0.2\0.5 cm, then in T2 (yellow column) commuting increased limb of about 4\5 cm in each patient. This shows us that the limb that is less rigid is more free to move. In T3 you can see that the parameters are slightly decreased, however higher than the time T1.

VI Conclusion

This study of experimental research shows that the local vibration therapy , applied on the upper pathologic limb in subjects suffering from Parkinson's disease it allowed achieve significant improvements on the proprioceptive sensitivity , stiffness, pain reduction and increased commuting upper limb. We demonstrated thanks to the positive results obtained from the evaluation scales, that this therapy in patients with Parkinson's disease, improves the ability to use of upper pathologic limb , both professionally and in the activities of daily life . Our patients have in fact achieved an improvement in activities carried out with the pathological limb of which have regained consciousness , decreasing the time spent on specific activities, increasing the accuracy in performing, participation in working life and their satisfaction in using of the pathological limb. It is hoped in other further work in this area supporting the possibility of introducing this treatment like a complementary to drug treatment and of rehabilitation conventional for this pathology .

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