Osteoporosis – Treatment with Horizontal® Therapy

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Introduction

Osteoporosis is a disease characterized by decreased bone tissue mass and tissue structure disorders which result in weakness of bones and increasing risk of fracture. Bone fracture is most frequently the basic clinical symptom manifesting the disease. However, it should be remembered that it is only a complication of this symptomatic disease process that is occurring in the bones. Therefore, the situation is analogical as in the case of arterial hypertension and stroke or hyper-cholesterolaemia and cardiac infarct. Frequently the basic disease process is only one of many risk factors and it does not have to be present to result in catastrophe (bone fracture, stroke, cardiac infarct) which, in turn, is not always the effect of this process. It is possible to prevent osteoporosis and to treat it as it is possible in arterial hypertension and hypercholesterolaemia.

Fractures resulting from osteoporosis refer mainly to spine (compression fractures of vertebral bodies, resulting in height lowering, kyphosis and chronic pain), to distal part of radial bone (Colles' fracture) and proximal part of femoral bone (femoral neck fracture – clinically the most serious one). As osteoporosis refers to many or all bones, fracture may occur in any place. Taking into consideration the social aspect of osteoporosis impairing a patient's motor and manual efficiency and his/her ability to work, physiotherapy comes into particular prominence in these cases. Recently, within physical procedures, high frequency therapy has been introduced to treatment. In this type of therapy exclusively medium frequency alternating currents within high frequency from about 4 000 Hz to about 12 000 Hz are applied.

According to the principle of treatment two groups of effects may be distinguished in high frequency therapy:

1. Effects stimulating synchronous impulse frequency of action potentials in stimulated cells.
2. Electro biochemical and electro physical effects, and with increased doses – actions blocking nerve conduction.

Applying high frequency therapy makes it possible to act simultaneously with both types of mentioned above therapeutic factores within one pathological state. High frequency therapy acts in a stimulating way within high frequency sounds, according to the patented principle of "Horizontal Stimulation" (Ho-Sti). Such stimulation modulates and affects which aid in obtaining the following therapeutic results [8, 9, 10]:

1. Efficiency increase of diffusion processes in cells by forming the so-called electrochemical "shaking formation of one of the most important intracellular mediators: cyclic adenosine (cAMP).
2. Intercellular communication activation by electrical and biochemical processes by means of selective activation of "cell – cell" canal (gap junctions) during effect" taking place in extracellular matrix between capillary vessels and tissues supplied with products of metabolism.
3. Bio stimulating effects on enzymes and substrates of biochemical reaction in high frequency therapy. Owing to that there increases the probability of reacting substrates meeting and occurrence of their proper orientation in relation to each other in cell.
4. Metabolism activation by conveying moderate amounts of heat, released due to high frequency tones application.
5. Effect on tissue level, reducing pain owing to dispersion and concentration decrease of local pain mediators and inflammatory state as a result of "shaking effect" electrochemical action.
6. Stimulation of cell membrane receptors, manifesting itself with the effect on adenyl cyclase and thus on the passage of current through tissues.
7. Effects modulating information flow between cells taking part in the whole mechanism of shaking, activating the exchange of intracellular metabolism products.
8. Due to high frequency therapy substances such as calcium ions, 3', 5' – cAMP, 3',5' – cAMP and 1,4,5-inositol triphosphate, carrying information from cell to cell, function in them as carriers of currents in high frequency therapy, going through cells and to a greater degree use "cell – cell" canals.
9. Initiating resonant phenomena in the so-called "active centres" of enzymes. With appropriate range of frequency it results in action stimulating metabolic processes.
10. Affect cell potential in the range between stimulus threshold and depolarisation threshold (conduction threshold – nerve blockade), consisting in initiating

transient excitatory activity ("tea") with such depolarisation – repolarisation pattern which basically does not differ from natural processes in cell membrane. In high frequency therapy cells themselves regulate periods of action potentials occurrence, they are not imposed on them synchronously in relation to stimulating frequency as it is in the case of traditional current therapy.

11. Reversible, depolarising effects on excited structures with applying high frequency therapy manifesting themselves with: reversible nerve conduction blockade producing fibrillary contraction physiological effect. Actions relieving pain in high frequency therapy are characterized by [2, 8]:

    a) Occurrence of immediate therapeutic effect in the form of: blocking peripheral nerves conduction, produced by constant reversible depolarisation, and the occurrence of central analgesic effect, being the reaction to irritating stimulus or the result of scanner operation, producing cell transient excitatory activity ("tea")
    b) Occurring with delay but remaining for a long time therapeutic effect causing both the decrease of oedemas and peripheral and central analgesic activity by stimulating release of endorphins in central nervous system.

High frequency therapy in treating geriatric patients with motor organ involutional pathological states affects metabolism and enzymatic processes efficiency improvement in cell owing to obtained definite position of molecules in variable electric field and increases probability of substrate molecule meeting with enzyme molecule in appropriate for them space orientation. Such reactions take place both in chondrocytes and in cells with reconstructive role in inflammatory and degenerative processes. On the other hand, in synovial fluid and in rich with water cartilage tissue matrix variable electric field in high frequency therapy acts only towards compensating differences in organic and inorganic ion concentrations, owing to which they remain in constant motion and they are carriers of currents passing through tissues. Substances not occurring in ionic form, such as glucose, are only indirectly set in motion, modifying intracellular diffusion, which is particularly important in case of patients with degenerative joint disease, in whom pain results in limitation of movement range within joint.

Medium frequency currents are characterized by analgesic activity through acting on nociceptive receptors in tissues and blocking nociceptive stimuli conduction, owing to which it is possible to obtain considerable alleviation or complete suppression of peripheral painful reaction coming from Control group was included into investigations. The group comprised 60 persons who underwent only pharmacological treatment, with no high frequency therapy program.

muscle fibres changed by arthrosis. Owing to that it is easier for a patient to perform a full movement in the joint during and after surgery and consequently to improve articular cartilage alimentation, mechanically forcing translocation of synovial fluid within the affected joint [1, 2, 8]. High frequency therapy with medium frequency currents strengthens not only transverse striated muscles but also smooth muscles of vessels muscular coat. At the same time draining function of capillary and lymphatic vessels is supported in the course of surgery.

After the surgery there comes to reactive congestion of the treated tissues. Repeated procedures with medium frequency currents are a specific kind of blood vessels training. Moreover, it is assumed [2, 5] that metabolism in endothelial tissue of vessels and also in all cells in the area of current passage is stimulated as a result of current acting on cell wall. Considerable changes of cyclic adenosine level after high frequency therapy procedures with medium frequency currents [11, 12] have been described in the literature.

Systematic application of electrotherapy with high frequency therapy in treating degenerative joint disease both in its early and advanced stages in geriatric patients allows to relieve or completely suppress pain. There is also great likelihood of reconstructing and maintaining normal functions of joints and of controlling or delaying changes progressing within them.

Aim of the study

The aim of the study is a comprehensive effectiveness evaluation of long-term and systematic program of high frequency therapy in patients with osteoporosis, taking into consideration clinical state, selected indices of motor organ functions and interdependence between these parameters and changes in osseous mass density.

Material

The study comprised 65 women in menopausal period, the patients' age was 45-55 years. These women were subjected to high frequency therapy procedures for 3 months. The patients were treated pharmacologically due to osteoporosis. Drugs decreasing resorption and stimulating bone tissue formation were administered with the assumption of such effect on this tissue reconstruction that would result in predominance of formation processes over resorption and consequently – improvement of osseous balance. Pharmacological treatment was similar in all patients.

Patients were selected at random according to established earlier way of drawing on the basis of random numbers table by Fisher and Yates. The selection was made inde-

pendently on the authors of the study. Values of clinical and biomechanical indices in initial examinations did not differ significantly, testifying to the homogeneity of the groups. All patients from the examined group agreed to take part in motor training program. No coexisting pathological states which would significantly affect the examination results, were found in all patients.

Methods

Evaluation of the following indices was carried out in the examined group before and after kinesitherapy:

1. *Densitometric evaluation*
Densitometric examination with QCT method (Quantitative Computed Tomography) with the use of Siemens Somato AR/CT apparatus.

The examination included 2 scans: longitudinal of the whole trunk in midline and transversal at the 3rd lumbar vertebra. If that vertebra had been destroyed, the densitometric examination was carried out on adjacent vertebra: L_4 or L_2. The results of BMD (bone mineral density) were presented in mg/ml absolute values of trabecular bone or cortical bone osseous tissue (separately) and shown in diagram in relation to norms for age and sex. BMD value was also given in SD values which might be also given in per cent in conversion 1 SD = 10%. For the purpose of medical documentation the most important elements of the reading are repeated in one of the fields of the plate – a physician may cut it out and attach it to the patient's case record.

2. *Evaluation of Pain Complaints*
Articular index according to Ritchie consists in determining pain during pressure or passive movement. Three-stage scale of evaluation is used:

a) patient notifies the sensation of pain
b) patient clearly reacts to touch,
c) patient draws back the examined limb after effort.

In this index 26 joints or – strictly speaking – 26 locations of changes are generally examined. Cervical section is counted as one location, also both mandibular joints, sternoclavicular joints and metacarpophalangeal joints of each foot are treated as one location. If all examined sections were affected and pain was most intensive, the maximal value of index would be 78.

3. *Point Evaluation of Clinical Examination*
The point notation principle of the found deviations was their estimation in the scale from 0 to 3 points. Zero meant no deviations, 1 point – the slightest deviation, 2 points – medium deviation, 3 points – deviations of considerable intensification. The following factors were evaluated: posture, active movements of spine, efficiency of gait, intensification of pain, segmental symptoms (passive movements and symptoms found palpably) and neurological symptoms. As there were 6 subgroups of symptoms, 18 points meant the most serious state, not so serious states fewer less points and zero meant no deviations from normal state.

4. *Range of Spine and Big Joints Mobility Evaluation*
Mobility range of cervical, thoracic and lumbar sections and big joints was estimated with Rippsetein's plurimeter, assuming the percentage of physiological mobility range as index.

5. *Resting Muscle Tone Examination*
Resting muscle tone of the examined motor organ sections was measured with "Szirmai" myotonometer and the result was given in myotones, where 1 myotone determined force in milli Newtons needed to deflect skin above the muscle with constant surface of pin equal 0.18 cm^2.

6. *Force Indices Evaluation*
Measuring dynamic force of the examined motor sections we determined half-life of muscle maximal force increase with the use of electronic set for force measurement – "Tilmel 21", constructed in the Technical University of Łódź. The decrease of maximal force during 15 seconds of maximal tone was accepted as static resistance index to estimate muscle static resistance of the examined motor sections. The result was determined as difference of force in Newtons (N). The examination was performed with the use of electronic set for force measurement – "Tilmel 21". Similar examinations were carried out after a year in the control group.

7. *The Applied Kinesitherapy Program*
Patients form the examined group were subjected to kinesiotherapy for a year. Program of exercises according to Ayalon with Janiszewski's modification was applied. The training took place 3 times a week and lasted for one hour each time.

Results

The results were statistically processed with the use of parametric and non-parametric tests, accepting significance level 0.001 and 0.002 and with correlation coefficient evaluation. After the carried out therapy course

significantly bigger growth of bone density was found in the examined group than in the control group. This growth was most marked in patients in whom before treatment the biggest deficiency of osseous mass was found, in theexamined group and control group significant decrease of Ritchie's index was found as well as improvement of clinical state.

While analyzing biomechanical indices, it was found that resting muscle tone decreased in the examined group and control group, whereas improvement of force indices and increase of mobility range were observed only in the examined group. High correlation coefficients were found between the growth of osseous mass density and the examined parameters, with the exception of resting muscle tone.

Discussion

The obtained results testify to beneficial effect of high frequency therapy in osteoporosis. Most probably the mechanism is the following:

1. High frequency therapy WaDiT acts in a stimulating way in high frequency range, according to the patented principle of "horizontal stimulation" – "ho-Sti". Such stimulation modulates metabolism and affects obtaining the following therapeutic effects:
2. Increasing diffusion processes in cells by producing the so-called "shaking effect", taking place in extracellular matrix between capillary vessels and tissues provided with metabolism products.
3. Biostimulating activity on enzymes and substrates of biochemical reactions in high frequency therapy. Owing to that there is a greater probability of reacting substrates meeting and of their proper orientation in relation to each other in cell
4. Activation of metabolism by conveying moderate amounts of heat, released as a result of applying high frequency currents
5. Acting on tissue level, removing pain due to dispersion and concentration decrease of local pain mediators and inflammatory state as a result of electrochemical "shaking effect" activity. Analgesic activity should not be ignored here, either.
6. Processes relieving pain in high frequency therapy are characterized by: occurring with delay but remaining for some time therapeutic effect, causing decrease of oedemas and peripheral and central analgesic activity by stimulating the release of endorphins in central nervous system.
7. Analgesic activity in high frequency therapy is characterised by therapeutic effect: 1. blocking conduction of peripheral nerves by constant, reversible depolarisations of cells, 2. occurrence of central analgesic effect as a reaction to irritating stimulus of scanner, evoking periodic stimulation of cells activity – "tea". 3. It affects cell potential in the range of stimulation and depolarisations by initiating transient excitatory activity – "tea" with such depolarisation – repolarisation pattern which basically does not differ from natural processes in cell membrane. In high frequency therapy cells themselves regulate periods of action potentials occurrence, they are not imposed upon them synchronously in relation to impulse frequency of current.
8. Reversible depolarisations of the stimulated structure with the use of high frequency therapy manifest themselves with: 1. temporary blockade of nerve conduction, 2. producing effect of physiological fibrillary contraction.

Conclusions

1. High frequency therapy in patients with osteoporosis significantly affects the increase of osseous mass density;
2. Application of high frequency therapy in osteoporosis reduces pain complaints and affects the improvement of clinical state;
3. The best results – as regards the increase of bone density in patients subjected to high frequency therapy – may be expected in persons with high deficiency of osseous mass;
4. High frequency therapy in women with osteoporosis significantly improves some biomechanical indices of motor organ, which is not found in persons undergoing only pharmacological treatment.

Tables of results:

Table: Results of biochemical investigations
Evaluation of investigations on the basis of Ca^{2+}

Duration of treatment	Improveme	No improvement	Index %
4 weeks	18	12	60
6 weeks	20	10	66
8 weeks	24	6	80
10 weeks	26	4	86
12 weeks	28	2	93

Number of the examined: 30 persons

Table: Evaluation of force according to indices Static

DU2-1	DU2-2
-38.46	-33.50
-33.70	-48.78
-51.15	-32.80
-41.59	-45.47
-43.90	-40.20

Table: Evaluation of force according to indices Dynamic

DF2-1	DF2-2
431.4	440.10
449.1	437.12
435.7	438.98
431.4	446.19
444.6	441.70

Table: Evaluation of patients and analysis of densitometric indices

Duration of treatment	Improvement	No improvement	Index %
4 weeks	16	14	53
6 weeks	18	12	60
8 weeks	24	6	80
10 weeks	24	6	80
12 weeks	26	4	86

Number of the examined: 30 persons

Table: Densitometric indices in the examined group

Before Treatment X from SD	After treatment	P	One year after treatment X from SD	P
-7,12	-7.93	0,05	-7,91	non st.

Table: CA** level in the examined group

Before Treatment X from SD	After treatment	P	One year after treatment X from SD	P
-1,954	-0,853	0,05	-0,891	non st.

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