

# Porównanie skuteczności terapii falą akustyczną i jonowym rezonansem cyklotronowym w chorobie zwydrodneniowej kręgosłupa lędźwiowego. Część I

*Comparison of effectiveness of the acoustic wave therapy and ion cyclotron resonanse in degenerative vertebral freed column disease. Part I*

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## **Streszczenie:**

Wiele metod fizjoterapeutycznych jest stosownych w terapii choroby zwydrodneniowej kręgosłupa, co dowodzi, że brak jest metody idealnej dla wszystkich pacjentów. Kolejne nowe metody w tym zakresie są dowodem na poszukiwanie *personal treatment*, czyli leczenia spersonalizowanego. Metody te, co oczywiste, wymagają weryfikacji. Celem pracy jest ocena przydatności stosowania fali akustycznej i jonowego rezonansu cyklotronowego oraz ich łącznego stosowania w terapii choroby zwydrodneniowej kręgosłupa lędźwiowego.

**Materiał i metody.** Badaniami objęto grupę 80 chorych, mężczyzn i kobiet w wieku 35-75 lat (średnia wieku 50,6 lat) z chorobą zwydrodneniową kręgosłupa lędźwiowego. Pacjenci zostali losowo przydzieleni do czterech grup terapeutycznych. K – grupa leczona pozorowaną falą akustyczną i kinezyterapią wg. zmodyfikowanych ćwiczeń Meina, FA – grupa leczona falą akustyczną i kinezyterapią wg. zmodyfikowanych ćwiczeń Meina, JRC – grupa leczona jonowym rezonansem cyklotronowym i kinezyterapią wg. zmodyfikowanych ćwiczeń Meina, FA+JRC – grupa leczona falą akustyczną i jonowym rezonansem cyklotronowym. Przed i po trzytygodniowej terapii oceniano: ruchomość kręgosłupa-w płaszczyźnie strzałkowej w teście Schobera, w płaszczyźnie czołowej w teście Molla i Wrighta.

**Wyniki.** Test Schobera pokazał podobny poziom różnicy ruchomości przed i po terapii dla grupy JRC  $2,8 \text{ cm} \pm 0,84$  i gr. FA+JRC  $2,83 \text{ cm} \pm 1,1$  przy  $p < 0,001$ . Procent zmian względem gr. K dla gr. JRC wyniósł 56% poprawy dla gr. FA+JRC 70% poprawy. W teście Molla i Wrighta różnica ruchomości w płaszczyźnie czołowej przed i po terapii w gr. FA to  $1,15 \text{ cm}$ , w gr. JRC  $2,47 \text{ cm}$ , gr. FA+JRC  $2,90 \text{ cm}$  przy  $p < 0,001$

**Wnioski.** Jonowy rezonans cyklotronowy i fala akustyczna z jonowym rezonansem cyklotronowym zwiększą zakres ruchomości kręgosłupa w chorobie zwydrodneniowej odcinka lędźwiowego kręgosłupa.

## **Słowa kluczowe:**

fala akustyczna, jonowy rezonans cyklotronowy, choroba zwydrodneniowa kręgosłupa lędźwiowego

## **Abstract**

Many physiotherapy methods are appropriate in spine osteoarthritis treatment, which proves, that there is not an ideal method for all patients. Another new methods in this area are evidences in search of 'personal treatment'. It means personalized treatment. These methods, what is obvious, need to be verified. The aim of the study was to evaluate the utility of the acoustic wave and ion cyclotron resonance, and their combined use in the treatment of osteoarthritis of the lumbar spine.

**Material and methods.** The study group involved 80 patients, both men and women aged 35-75 years (average age 50.6 years) with osteoarthritis of the lumbar spine. Patients were randomly assigned to four treatment groups. K – group treated with simulated acoustic wave and kinesitherapy according to modified Mein's exercises, FA – group treated with acoustic wave and kinesitherapy according to modified Mein's exercises, JCR – group treated with ion cyclotron resonanse and kinesitherapy according to modified Mein's exercises, FA +JRC – group treated with acoustic wave and ion cyclotron resonance. Before and after three weeks of therapy there was an assesment of: the mobility of the spine in the sagittal planein Schober test and the frontal plane in Moll and Wright test.

**Results.** Schober test showed a similar level of mobility difference before and after treatment for a ICR group  $2.8 \text{ cm} \pm 0.84$  and thickness. ICR+AW +  $2.83 \text{ cm} \pm 1.1$  at  $P < 0.001$ . According to group K, 56% percentage changes of improvement gained ICR group, group AW+ICR gained 70% of improvement. In the Moll and Wright test mobility difference in the frontal plane before and after treatment in AW group is  $1.15 \text{ cm}$  in thickness. ICR  $2.47 \text{ cm}$  thick. AW+ICR  $2.90 \text{ cm}$  at  $p < 0.001$

**Conclusions.** Ion cyclotron resonance and acoustic wave with ion cyclotron resonanse increase the range of motion for osteoarthritis of the lumbar spine.

## **Key words:**

acoustic wave, ion cyclotron resonanse, degenerative disease of the lumbar spine

## Introduction

Osteoarthritis (OA) is a group of disorders that despite having different etiology lead to similar structural and functional pathologies in joints.

Clinically, OA is manifested by spontaneous joint pain, pressure tenderness, limited mobility, crepitus and morning stiffness of joints. The pathological process most commonly involves lumbar spine region. Since causal treatment is unavailable in a vast majority of cases, the objectives of therapeutic management of OA include elimination or minimization of risk factors, reduction of pain, conservation or improvement of joint function and reduction of disability [1].

The progress in physical medicine leads to novel methods for treatment of articular disorders so as to meet today's requirements regarding the quality of life of the patients. Therefore, the study assesses the usefulness of acoustic waves as physical factors in the treatment of lumbar OA as compared to the standard treatment using ion cyclotron resonance magnetic fields.

Acoustic waves are longitudinal mechanical waves that may propagate in solids, liquids and gases. The physical phenomenon of acoustic waves consists in transient changes in the density of the medium leading to momentary differences in pressure. The speed of acoustic wave propagation depends on elastic properties of the medium in which the phenomenon occurs. Thus, variable force (pressure) may be exerted on the tissue, leading to a significant restoration effect as well as potential analgesic effect by interaction with hydroxyapatite crystals. Acoustic wave therapy makes use of microvibrations of the amplitude and frequency of vibrations approximately resembling similar movements of muscle filaments due to the physiological muscle tone. The source of vibrations in the acoustic wave therapeutic instrument consists in microvibrations of elastic membranes stimulated by an electromagnet. The frequency of vibrations generated by the device changes over time to prevent the effect of tissue adaptation to a constant stimulus [2, 3]. The mechanical effect of microvibrations are accompanied by acoustic vibrations coupled with microvibrations of the applicators.

Simultaneously, the variable magnetic field absorption system used in the Viofor JPS device makes use of the magnetomechanic and electrodynamic effect of the cyclotron resonance of cations and anions contained within the bodily fluids that can be expressed using the following formula. Ion cyclotron resonance (ICR) is achieved when the following condition is met:  $T = 2\pi m/Bq$  where T – Resonance period [s], m – mass of the ion [kg], q – charge of the ion [c], and B – magnetic induction [T]. This leads to a change in distribution of ions within the extra- and intracellular spaces. This leads to changes in the resting potentials both within the

membranes of organelles as the cellular membranes of living biological systems. As a result, bioelectric, biochemical and bioenergetic effects of the treatment are achieved.

The objective of this study was to assess the usefulness of acoustic wave and ion cyclotron resonance as well as combination of both of these methods in the treatment of lumbar osteoarthritis.

### **Material and Methods**

The study was conducted in a group of 80 patients, both male and female, aged 35-75 (mean age of 50.6 years) suffering from lumbar osteoarthritis diagnosed according to the criteria of the Polish Society of Rheumatology treated in the Clinic of Internal Diseases, Angiology and Physical Medicine in Bytom. The study was approved by the Bioethics Committee of the Medical University of Silesia in Katowice, resolution no. KNW/0022/KB1/100/13.

Patients were randomized into four therapeutic groups with the exception of the kinesitherapy group K, which included patients who did not work professionally. Patients in this group were not aware of the Sham (simulation) mode activated on the equipment during the procedures.

All patients in four groups of 20 individuals were subjected to a three week therapeutic session with 10-minute physical procedures performed one after the other for the total time of 20 minutes involving acoustic waves and/or ion cyclotron resonance magnetic field being delivered from flat and coil applicators, respectively, for 5 days a week, no treatment being delivered on weekends. Mein's kinesitherapeutic exercises were used in kinesitherapy group K, acoustic wave group AW and ion cyclotron resonance group ICR. No kinesitherapy was applied following physical procedures in the AW+ICR group. Following parameters were assessed before and after the three-week therapy: spinal mobility – sagittal plane mobility measured by Schober test, frontal plane mobility measured by Moll and Wright test, pain intensity measured by visual analog scale (VAS) and modified Latinen questionnaire, quality of life measured by Euro QoL(EQ5D) questionnaire in 5 dimensions of mobility, self-care, usual activities, subjective pain and anxiety, and the intensity of NSAID use.

Statistical analyses were performed using 10.0 PL software. Changes were considered statistically significant at the significance level of  $p<0.05$ .

**Table 1. Characteristics of people with division into groups**

|                                 | Group K (n=20) |      | Group FA (n=20) |      | Value<br>p | Group JRC (n=20) |      | Value<br>p | Group FA+JRC (n=20) |      | Value<br>p |
|---------------------------------|----------------|------|-----------------|------|------------|------------------|------|------------|---------------------|------|------------|
|                                 | Mean           | SD   | Mean            | SD   |            | Mean             | SD   |            | Mean                | SD   |            |
| Age                             | 62.2           | 5.64 | 49.4            | 12.1 | <0.001     | 50.2             | 11.3 | 0.001      | 50.0                | 11.5 | 0.001      |
| Weight                          | 74.4           | 13.3 | 77.9            | 12.5 | 0.365      | 79.8             | 9.79 | 0.072      | 83.2                | 14.3 | 0.072      |
| Height                          | 1.65           | 0.10 | 1.70            | 0.10 | 0.087      | 1.71             | 0.12 | 0.057      | 1.72                | 0.11 | 0.057      |
| BMI                             | 27.2           | 3.65 | 27.1            | 3.89 | 0.579      | 27.5             | 2.68 | 0.365      | 28.2                | 3.40 | 0.365      |
| Time of pain syndromes (months) | 6.70           | 3.18 | 3.70            | 1.45 | 0.001      | 4.63             | 2.49 | 0.031      | 4.68                | 2.22 | 0.031      |
| Sex (% men)                     | 30%            |      | 60%             |      | 0.062      | 60%              |      | 0.062      | 65%                 |      | 0.030      |

K – group treated with simulated acoustic wave and kinesitherapy according to modified Mein's exercise, FA – group treated with acoustic wave and kinesitherapy according to modified Mein's exercises,

JRC – group treated with ion cyclotron resonanse and kinesitherapy according to modified Mein's exercises, FA+JCR – group treated with acoustic wave and ion cyclotron resonanse

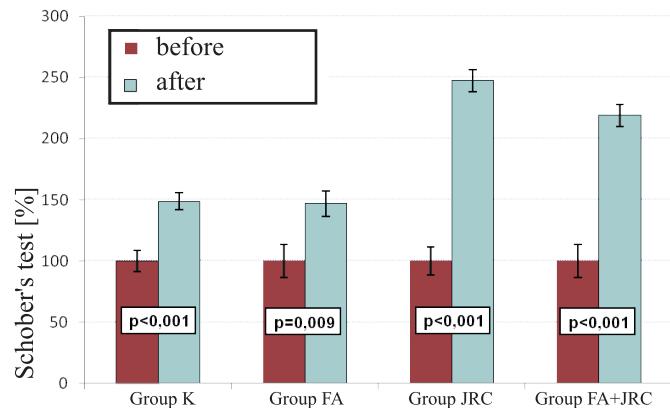
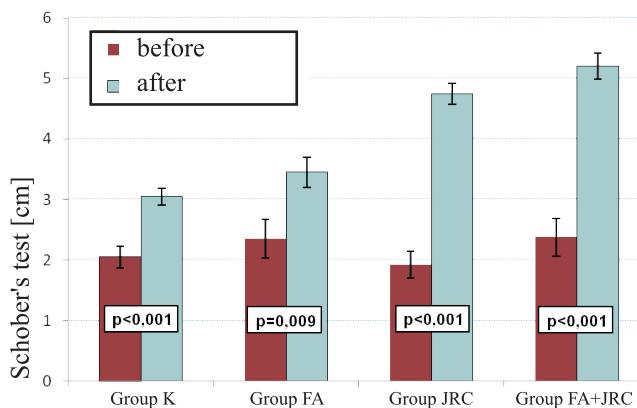
### Results

The studies revealed that application of physical therapy afforded an improvement in spinal mobility and subjective perception of pain. The assessment of therapeutic methods on the basis of sagittal plane mobility of the spine measured by means of Schober test revealed similar mobility levels before and after treatment in the ICR group ( $2.8 \text{ cm} \pm 0.84$ ) and AW+ICR group ( $2.83 \text{ cm} \pm 1.1$ ), with statistical significance ( $p<0.001$ ) being achieved in both groups. The percentage change in relation to group K was 56% improvement in ICR group and 70% improvement in AW+ICR group. According to the Moll and Wright test, the difference in mobility within the frontal plane was 1.15 cm in group AW, 2.47 cm in group ICR, and 2.90 cm in group AW+ICR, with the two latter groups achieving statistical significance at the level of  $p<0.001$ . The percentage change in relation to K was 28% of improvement in group ICR, 46% of improvement in group AW+ICR at statistical significance level of  $P<0.001$ . Subjective pain as assessed in the visual analog scale changed in all groups, with most favorable results being obtained in the ICR group: 59 mm ( $p<0.001$ ) and in the AW+ICR group: 65 mm ( $p<0.001$ ). Modified Latinen questionnaire pain scores were reduced in group AW by  $7.65 \pm 2.60$  points, group ICR by  $8.90 \pm 2.02$ , and group AW+ICR by  $9.25 \pm 2.36$  points with statistical significance at the level of  $p<0.01$ .

**Table 2. Results of the lumbar spine mobility in the sagittal plane in Schober test in each therapeutic group before and after 3 weeks treatment with statistical assessment according to group K – kinesitherapy**

| Schober's test<br>[cm] | Group<br>K (n=20) |      | Group<br>FA (n=20) |      | % changes    | Value<br>p | Group<br>JRC (n=20) |      | % changes    | Value<br>p | Group<br>FA+JRC (n=20) |      | % changes | Value<br>p | ANOVA<br>p |
|------------------------|-------------------|------|--------------------|------|--------------|------------|---------------------|------|--------------|------------|------------------------|------|-----------|------------|------------|
|                        | Mean              | SD   | Mean               | SD   | in rel. to K |            | Mean                | SD   | in rel. to K |            | Mean                   | SD   | toward K  |            |            |
|                        |                   |      |                    |      |              |            |                     |      |              |            |                        |      |           |            |            |
| Before                 | 2.05              | 0.81 | 2.35               | 1.42 | 15%          | 0.485      | 1.92                | 0.99 | -6%          | 0.658      | 2.38                   | 1.41 | 16%       | 0.420      | 0.560      |
| After                  | 3.05              | 0.63 | 3.45               | 1.10 | 13%          | 0.041      | 4.75                | 0.77 | 56%          | <0.001     | 5.20                   | 0.95 | 70%       | <0.001     | <0.001     |
| Difference             | 1.00              | 0.54 | 1.10               | 1.07 |              | 0.648      | 2.83                | 0.84 |              | <0.001     | 2.83                   | 1.10 |           | <0.001     | <0.001     |

K – group treated with simulated acoustic wave and kinesitherapy according to modified Mein's exercises, FA group treated with acoustic wave and kinesitherapy according to modified Mein's exercises, JRC – group treated with ion cyclotron resonanse and kinesitherapy according to modified Mein's exercises, FA +JRC – group treated with acoustic wave and ion cyclotron resonanse, p Anova indicates statistical significance at the level of significance – according to groups among themselves



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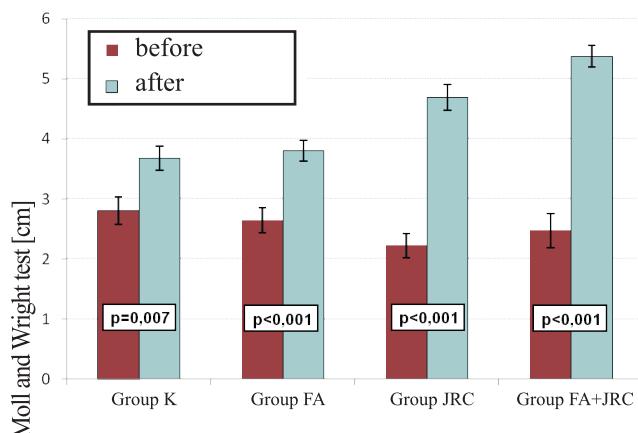
**Fig. 1. Results of the lumbar spine mobility in the sagittal plane in Schober test with osteoarthritis of the lumbar spine before and after three weeks of treatment with statistical assessment in each treatment group**

**Fig. 2. The average percentage changes of mobility of the lumbar spine in the sagittal plane in Schober Test's patients evaluated with osteoarthritis of the lumbar spine**

**Tab. 3. Results of the lumbar spine mobility in the frontal plane in the Moll and Wright test in each treatment group before and after three weeks of treatment according to statistical assessment of K – kinesis.**

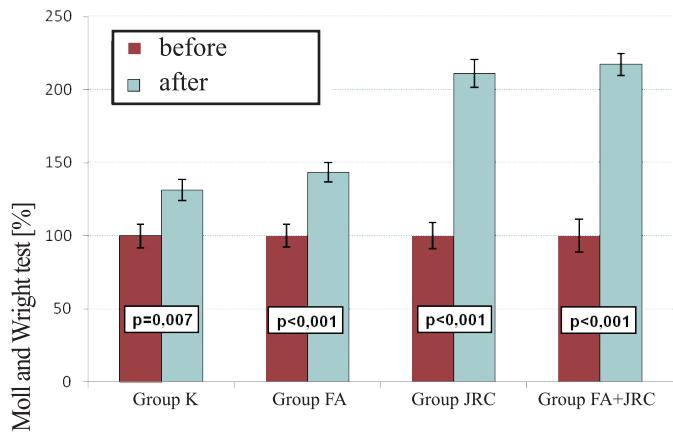
| Moll and Wright test<br>[cm] | Group K (n=20) |      | Group FA (n=20) |      | % changes in rel. to K | Value p | Group JRC (n=20) |      | % changes toward K | Value p | Grupa/Group FA+JRC (n=20) |      | % changes in rel. to K | Value p | ANOVA value p |
|------------------------------|----------------|------|-----------------|------|------------------------|---------|------------------|------|--------------------|---------|---------------------------|------|------------------------|---------|---------------|
|                              | Mean           | SD   | Mean            | SD   |                        |         | Mean             | SD   |                    |         | Mean                      | SD   |                        |         |               |
| Before                       | 2.80           | 1.02 | 2.65            | 0.93 | -5%                    | 0.644   | 2.23             | 0.91 | -21%               | 0.090   | 2.48                      | 1.26 | -12%                   | 0.592   | 0.343         |
| After                        | 3.68           | 0.91 | 3.80            | 0.77 | 3%                     | 0.616   | 4.70             | 0.97 | 28%                | 0.002   | 5.38                      | 0.83 | 46%                    | <0.001  | <0.001        |
| Difference                   | 0.88           | 0.84 | 1.15            | 0.67 |                        | 0.204   | 2.47             | 1.08 |                    | <0.001  | 2.90                      | 1.51 |                        | <0.001  | <0.001        |

K – group treated with simulated acoustic wave and kinesitherapy according to modified Mein's exercises, FA group treated with acoustic wave and kinesitherapy according to modified Mein's exercises, JRC – group treated with ion cyclotron resonanse and kinesitherapy according to modified Mein's exercises, FA +JRC – group treated with acoustic wave and ion cyclotron resonanse, p Anova indicates statistical significance at the level of significance – according to groups among themselves



K – group treated with simulated acoustic wave and kinesitherapy according to modified Mein's exercise, FA – group treated with acoustic wave and kinesitherapy according to modified Mein's exercises, JRC – group treated with ion cyclotron resonanse and kinesitherapy according to modified Mein's exercises, FA+JRC – group treated with acoustic wave and ion cyclotron resonanse

**Fig. 3. The results of the assessment of mobility of the lumbar spine in the frontal plane in Moll and Wright test's patients with osteoarthritis of the lumbar spine before and after three weeks of treatment with statistical assessment in each therapeutic group**



**Fig. 4. The average percentage changes for each treatment group of mobility evaluation of the lumbar spine in the frontal plane in Moll and Wright test's patients with osteoarthritis of the lumbar spine**

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