SHORT THESIS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY (PhD)

THE STRUCTURAL AND FUNCTIONAL EFFECTS OF AIMED EXERCISE THERAPY IN ANKYLOSING SPONDYLITIS

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The examination takes place at the Department of Ophthalmology, Faculty of Medicine, University of Debrecen
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The PhD defense takes place at the Lecture Hall of Building „A" Department of Internal Medicine, Faculty of Medicine, University of Debrecen
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1. INTRODUCTION

Ankylosing spondylitis (AS) is a chronic immuno-inflammatory disease that affects the axial skeleton and sometimes the peripheral joints as well. Pathologic alterations occur in synovial and cartilaginous joints and on sites of tendon and ligament attachments to bones. Most structures and tissues found in the low back, hip and pelvic areas are capable of producing symptoms. Sacroiliac pain may irradiate to the back, buttocks, groin and lower extremity similarly to pain patterns originating from other lumbosacral regions. However, there is still a delay of years from the first symptoms until the final diagnosis is established, influencing the physical conditions and functionality.

Due to the inflammation in the affected joints, structural deformities occur. The main symptoms are joint pain, restricted movement and associated functional decline. In cases when the onset of the disease is in early adolescence but is diagnosed late and treated improperly, the people affected become disabled in their work, may even lose their ability to work.

The development of AS cannot be avoided but family aggregation should be seriously considered, thus in adolescence even in the case of mild complaints aimed assessment is recommended. In the case of early diagnosis the condition can be treated effectively, progression can be slowed down. Drug treatment especially biological therapy can reduce inflammation, relieve pain thus mobility can be retained. Due to this fact patients do not consider regular, aimed physical activity important.

Besides drug treatment (non-steroidal anti-inflammatory medications and biologic drugs), physical therapy still has a key role in the treatment. Movement therapy in physical therapy plays a key role from prevention to rehabilitation because of the characteristic musculoskeletal complaints and symptoms of AS. The general aims of physical therapy treatment are – just like in inflammatory rheumatoid diseases – joint protection, pain relief and possible maintenance of range of movement, muscle strength, functional capacity and aerobic capacity.

Joint protection and effective use of muscles surrounding the joints in different activities (performed at work or at home), even when resting is very important and the actual condition of the patient, the structure, the mechanism and stability of the affected joints should be greatly considered.

In cases of acute shub, adequate treatment involves proper resting position, appropriate lying positions (emphasizing extension in the spine and great joint). The purpose of movement therapy is to slow down the process of ossification and to maintain the flexibility of the intervertebral and paravertebral muscles.

According to the present literature it is still questionable to what extent does physical therapy / movement therapy help the effectiveness of drug treatment and which physical and functional parameters can be improved.

Although traditional physical therapy involving the great joints, breathing techniques and posture correction exercises are well-acknowledged there are only a few studies in which different movements of joint protection exercises are analyzed.

AIMS

1. As part of the literature overview to analyze the rules of joint protection in the physical therapy treatment of ankylosing spondylitis and to summarize its biomechanical changes from the point of view of a physiotherapist.
2. To analyze physical and functional parameter changes depending on the duration and progression of ankylosing spondylitis and to evaluate data of a voluntary group of patients suffering from ankylosing spondylitis.
3. To make an individual, aimed movement therapy program – in accordance with the national guidelines – which is strictly based on the work of the physical therapist.
4. To involve patients receiving biological therapy (as a target group) in the movement program. To assess the following aspects in connection with the aims of the movement therapy:
   - improvement of spine and chest mobility
   - reduction of characteristic AS pain, pressure sensitivity of tender points as well as paravertebral stiffness,
   - improvement of pulmonary function and functionality

4. PATIENTS AND METHODS

4.1. Description of patients of the

Clinical data of AS patients with biological therapy (n=55) or without biological therapy (n=20) were retrospectively analyzed and compared at the Department of Rheumatology, Medical and Health Science Center of the University of Debrecen. All patients had definite AS according to the modified New York criteria. Informed consent was obtained from all participants. Anthropometrical data, duration since diagnosis and patient assessment of disease activity, functional capacity, BASDAI and BASFI, pain intensity on a VAS scale, drugs history, sacroileitis stage assessed by X-ray, levels of physical activity were recorded. Functional and physical tests were performed by the same physician as described below. None of the patients had history of any cardiopulmonary diseases.

4.2. Subjective, functional and physical tests

Degree of pain intensity and disease activity were recorded by patients on a 10 cm horizontal visual analog scale (VAS).

BASFI and BASDAI scores were used for the assessment of functional ability with AS. These comprised of some items, which were answered on a 10 cm horizontal visual analogue scale.

BASFI scores consisted of eight specific questions regarding functions and two questions reflecting the patient's ability to cope with daily life.

BASDAI scores consisted of six questions pertaining to the five major symptoms of AS, including fatigue, back pain, joint pain, local tenderness, and quality and quantity of morning stiffness evaluated by VAS.

The Bath Ankylosing Spondylitis Functional Index (BASFI) is a functional index which can accurately assess a patient's functional impairment due to the disease, as well as improvements following therapy.

The BASFI is not usually used as a diagnostic tool, but rather as a tool to establish a patient's current baseline and subsequent response to therapy.

The Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) developed in Bath (UK), is an index designed to detect the inflammatory burden of active disease. The BASDAI can help to establish a diagnosis of AS in the presence of other factors such as HLA-B27 positivity, persistent buttock pain which resolves with exercise, and X-ray or MRI evident involvement of the sacroiliac joints. It can be easily calculated and accurately assesses a patient's need for additional therapy; a patient with a score of four out of a possible 10 points while on adequate NSAID therapy is usually considered a good candidate for biologic therapy.

Modified Schober index (MSI) is a distance between two marks placed 15 cm apart in standing (10 cm proximal and 5 cm distal to the PSIS) following maximal forward flexion of the spine. Larger difference indicates greater lumbar movement, measured by a plastic tape.

Occiput-to-wall distance (OWD) is the horizontal distance between occiput and wall, standing with heels and buttocks against the wall, knees extended and chin drawn in. Larger distance indicates worse spinal/upper cervical posture, measured by a retractable plastic tape.

Finger-to-floor distance (lumbar forward flexion; FFD) is the distance between the tip of the right middle finger and the floor following maximal lumbar flexion, whilst maintaining knee extension. Smaller distance indicates greater movement, measured by a retractable plastic tape measure.

Chest expansion (CE) is measured with a tape measure in centimeters, placed circumferentially around the chest wall at the fourth intercostal space.

Lumbar lateral flexion (LLF) is a distance between the tip of the ipsilateral middle finger and the floor following maximal LLF, maintaining heel contact on the floor and without trunk rotation. Smaller distance indicates greater movement, measured by a retractable plastic tape measure.

Stiffness: the tightness of the paravertebral muscles were subjectively indicated by patients on the different regions of the spine (cervical, thoracic and lumbar)

Tender points: showing the enthesitis with palpation. Characteristic tender points connection with the spine and chest are the sternocostal and costochondral junctions, over the manubriosternal junction, the vertebral spinous processes and the xiphoid process. Other points, according to disease are the coracoid process, the greater tuberculum, the superior angles of the scapula, over the upper trapezius sacroiliac joint, the greater trochanter, the ischial tuberosities and the calcaneus.

Spirometric study was performed at baseline and week 12.

The measured parameters:

Forced vital capacity (FVC): was accepted as the total amount of air that could be forcebly blowed out after full inspiration. It depends on limited chest expansion, deformities of the chest and thoracic spine.

Forced expiratory volume during the first second (FEV1): was accepted as the amount of air that could be forcebly blowed out in one second. It is a ratio showing the amount of the FVC expelled in the first second. For healthy adults this should be approximately 80%.

Peak expiratory flow *(PEF)*: a person’s maximum speed of expiration. It is measured during a forced blow out after full inhalation.

Maximum voluntary ventilation *(MVV)*: the greatest volume of gas that can be breathed per minute by voluntary effort. It depends on the endurance of breathing muscles.

The values were expressed as a percentage of the predicted normal values according to the European Respiratory Society criteria.

4.3. Aimed exercise therapy

10 out of the 55 AS patients with biological therapy described above were volunteers for this study (6 men with age of 55.2 ± 13.32 years and 4 women with age of 48.25 ± 14.97 years). This part was based on a prospective, non-randomized physiotherapeutic intervention, including a controlled physical therapy program. The participation was voluntary. Informed consent was obtained from all participants. Age, height, weight, disease duration, drugs history, radiological stage and physical activity level were recorded.

The full exercise program took 1.5 hours and had been carried out twice per week for 12 weeks (24 treatments in total). During the first 4 weeks, individualized physical therapy program was conducted, while during the following 8 weeks, group physical therapy was applied in groups of 2-3 patients, based on physical conditions and doing exercises.

The primary targets of the exercise program were to increase mobility of the spine and chest, pulmonary function, moreover, to decrease the paravertebral pain and stiffness.

Observing the general clinical features the secondary aims were to apply global posture exercises, to learn pelvis centered position, to increase muscle stretching and strengthening around the shoulder and hip, to develop the scapula control and general physical condition, without cardiopulmonary exercises.

4.4. Detailed description of movement therapy

In the first four weeks of the therapy during the individual exercise program the patients learned the correct body positions for resting as well as for starting an exercise program. The exercises ranged gradually from supine positions to vertical body positions. After the warming up exercises, elongation of the spine was performed followed by chest mobilization techniques.

The mobilization exercises helped patients to acquire simple but effective techniques to increase chest expansion and control flow of air. The most significant part of the program consisted of mobility-stretching and strengthening exercises accompanied by breathing techniques in different body positions. Patients did cool-down stretches at the end of the exercises.

4.4.1. Rules of positioning

It is important to learn and use the correct lying, sitting and resting body positions paying attention to the individual deformities. The different positions are good for starting the exercises as well as for resting and cooling down. *Supine position:* The most important is to protect and unburden the spine as well as to relieve pain, to achieve this, the lumbar spine should lie flat on the supporting surface. This position can be achieved if at least one of the feet is flat on the surface or if a pillow or physioball is placed under the bent knees. The hip joint is in straddle position, arms next to the trunk loosely (depending on the condition of the shoulder joint), palms flat on the surface. To stretch the soft tissues around the shoulder, both arms should be in „lying – baby" position: elbows bent at shoulder height, back of the hands flat on the floor. The protection of the extremities, the waist and the back are important as well as the protection and positioning of the cervical spine. As long as the functional movements of the neck are not damaged, a pillow or a so-called anatomical pillow should be positioned at the continuation of the spine. Even in case of any neck deformity the cervical neck should be positioned by a pillow.

Lateral supine position: The head should be the continuation of the trunk supported by a pillow, lower arms are bent next to the pillow, upper arms are on the pillow over the chest or flat on the palms. The lower extremities are bent at the hip and knees with a pillow between the knees to be parallel thus the middle position of the pelvis and the lumbar spine are kept, muscle stretching is minimal and pain in the lumbar spine can decreased.

Prone position: Prone position is perfect for the elongation of muscles around the hip, to elongate spinal curves and to improve stretching of the affected shoulder girdle muscles. A pillow should be put (if it is comfortable) under the lower back to protect the lumbar spine. The head – neck just like in the previous cases is supported by a pillow or kept up by the forehead.

The arms can be situated at the trunk, palms flat, back of the hands are under the forehead. The shoulders are bent at shoulder height, palms on the floor.

On all fours position and other crawling positions: These body positions are aimed for movement therapy and not for resting. These positions offer a possibility to make the spine work unburdened, to mobilize and to stretch.

Proper sitting: We should use a chair with arms adequate for our height (to make getting up easier). While sitting the sole and the thigh should be supported, legs should not dangle, propping the lumbar spine up with a pillow may be necessary as well. The basic of proper sitting is setting the physiological position of the spine which can be carried out not only on a chair but on a large size ball and also on „dynair" pillow (rubber pillow filled with air). The sitting surface should be flat or have a forward slant (about 15°).

4.4.2. Improvin breathing and chest function

Our physical therapy program included conventional exercises, global posture reeducation, breathing exercises, manual mobilization of the chest, stretching of the shortened muscles (back, lumbar spine, around hip and shoulder) and functional exercises with joint prevention strategies.

Conventional exercise: - Common exercise therapy to increase mobility of the spine and greater joints (shoulder and hip), combination with stretching.

- flexibility exercises for cervical, thoracic and lumbar spine and major muscle groups

Global posture reeducation: Based on mainly the column's elongation, extension. It includes specific strengthening and flexibility exercises in which the shortened muscle chains are stretched. A global and functional approach is more efficient than analytic exercises in AS patients. Muscle chains are constituted by gravitational muscles (erector spine muscles, piriformis muscle, scalene muscles, suboccipital muscles) which work synergistically with each other. The analytic stretching of any individual gravitational muscle would be inefficient if not associated with a stretching of the whole muscle chain.

Breathing exercises: Specialized exercises to increase chest expansion, muscles endurance, to improve diaphragmal-abdominal synergist. Pursed-lip breathing, expiratory abdomen augmentation and synchronization of thoracic and abdominal movement.

Manual chest mobilization: during expiration, in supine or sitting position, we asked the patients to take the hands over the ribs and pull the chest diagonally toward the umbilicus, paying respect to the movements of the ribs. The expiration had to be carried out without force and the mouth had to be open. We instructed the patients with the following words: “Pay attention to steady and deep breathing!”

Exercise therapy: It could be performed in any positions with the harmonized movements of the column and the extremities, always working against the deformity and typical AS posture. It was important to avoid the abdominal exercises which start with chest-elevation, because it would have increased the kyphosis. These exercises are used not only for breathing harmonization but play an important role in the joint mobilization, too. During the exercises, when the inspiration was in the starting position, the expiration meant shifting toward the end-position. The movements of the column and the chest could be combined with the action of the upper and lower extremities, producing a complex exercise. Besides the column’s elongation we focused on the tilting of the hip and on scapula stabilization. The complex exercises, made in a closed kinematic chain, could increase the muscles’ elongation.

Lying and vertical positions help to develop:

- spine elongation, to ensure global posture reeducation,
- pelvis tilting forward and backward,

- analytical and complex movements of the spine,
- combined breathing with spine elongation, increasing expansion of the chest,
- analytical and complex movements of the upper extremities, developing the scapula control,
- to increase the stretching of the shoulder complex,
- analytical and complex movements of the lower extremities, developing the pelvis control,
- to increase the stretching of the hip complex,
- to integrate the breathing to the whole movements,
- synergist function of the lateral flexors and adductors
- to increase endurance of the diaphragm,
- synergist function of the flexors and extensors, stabilizing the spine
- synergist function of the spine extensors

4.5. Statistical analysis

Data are presented as means ± standard deviation (S.D.). In the first part of the study correlations among variables were evaluated by Pearson correlation analysis, based on linear regression. In the second part of the study the values before versus after the treatment were compared and evaluated by Wilcoxon signed rank or paired t-test, depending on normality of data distribution. A p value of <0.05 was considered as statistically significant.

5. RESULTS

5.1. Retrospective analysis of 75 AS patients

5.1.1. Subjective, functional and physical tests

Both duration (2-50 years) and activity of the disease (1-98 mm) varied in wide range, and did not show obvious gender differences. However, in this study, men were presented in higher numbers (55 vs 20) and showed wider distribution in age and disease duration. Mean values of BASFI were slightly higher in men than in women (4.64±2.84 vs 4.25±2.95, p=NS).). In contrast, BASDAI values were found to be higher in women compared to men (4.01±2.81 vs 3.49±2.35, p=NS), however, the maximal values were higher.

5.1.2. Correlation analysis

Using Person correlation analysis, pain intensity, BASFI, BASDAI, MSI, CE and OWD values showed significant correlations with duration (r=0.314, p=0.008; r=0.408, p<0.001; r=0.322, p=0.012; r=0.398, p=0.002; r=0.346, p=0.008 and r=0.435, p<0.001, respectively) and activity of the disease (r=0.887, p<0.001; r=0.685, p<0.001; r=0.826, p<0.001; r=0.307, p=0.021; r=0.336, p=0.011 and r=0.387, p=0.003, respectively). SI average state significantly correlated only with the disease duration (r=0.527, p<0.001), the lumbar flexion (MSI: r=0.49, p<0,001), the chest expansion (r=0.456, p<0.001), the occiput-to-wall distance (r=0.583, p<0,001).

5.1.3. Retrospective analysis of AS patients with or without biological therapy

We found differences in disease activity (42.28 ± 27.35 vs. 56.67 ± 25.99; p=0.019) and pain intensity (39.53 ± 25.76 vs. 51.42 ± 24.7; p=0.017) between the groups. Degree of the occiput-to-wall distance, posture and spine bendings were better in the biological therapy group. Pain and tenderness of the thoracic spine were observed in both groups. The back pain, without biological therapy, was slightly higher than in the other group.

5.2. Prospective analysis on the evaluation of the complex physiotherapy program

5.2.1. Subjective, functional and physical tests

In all patients, disease activity and pain intensity significantly improved after 12 weeks of treatment (from 37.7±23.3 to 27.9±22.2 p=0.002 and from

40.5±23.4 to 25.8±19.5, p<0.001, respectively). In all cases, improvement in functional parameters and disease activity were observed after the complex physical therapy program. Both BASFI and BASDAI increased after treatment (p=0.004 and p<0.001, respectively). When analyzing the individual changes, almost the same ratio was found when evaluating the “before treatment” versus “after treatment” differences.

Mobility evaluations also revealed significant improvement. Significantly increased finger-to-floor distance, chest expansion and modified Schober index were observed after versus before treatment (19.45±12.89 cm – 12.4±9.25 cm, p=0.008, 2.42 ± 1.29 cm - 4.28 ± 0.71 cm, p<0.001 and 2.44 ± 2.1 cm – 2.6 ± 1.8 cm, p=0.031, respectively). The occiput-to wall distance did not change significantly. Chest expansion exerted a two-fold increase in the majority of patients. Although the increase of lumbar spine flexion was not significant compared to the modified Schober index, the finger-to-floor distance greatly improved since the stretching of the ischiocrural muscles increased.

The values of lateral flexion on both sides showed significant improvement (right side: from right side 6.95 ± 8.3 cm to 10.55 ± 8.13 cm; left side: from 7.65 ± 8.17 cm to 10.65 ± 8.55 cm, p=0.006). The aim was not only to increase the range of motion but to acquire symmetry on both sides.

5.2.2. Respiratory function tests

Despite the improvement in mobility and functionality, pulmonary function tests including FVC, FEV1, PEF and MVV showed only a non-significant tendency towards improvement (Figure 5). There were no obvious individual differences and the degree of FVC improvement seemed to be independent of the magnitude of chest expansion.

Tenderness of typical tender points of the chest indicated improvement and decreased sensitivity to pressure, mainly over the sternocostal, chondrocostal, manubriosternal junction and xiphoid process regions. The tenderness of the sternocostal and costosternal junctions decreased remarkably, but the sacroiliac pain did not change the influence of motion. From the characterized tender points, the tenderness of the coracoids process, the superior angle of scapula, the great trochanter and the ischial tuberosities were marked less after exercise therapy. The tenderness of the spinous processes – it was provoked with palpation–decreased, except for the thoracic region. The pain and stiffness of paravertebral muscles showed improvement, with lower number of markings by the patients.

5. DISCUSSION

The duration of the disease among the examined 75 patients was significantly correlated with the intensity of pain, the sacroiliac value, lumbar spine mobility, chest expansion, occiput-to-wall distance, as well as with BASFI and BASDAI values. Chest mobility and occiput-to-wall distance showed significant correlation with age ($p<0.001$), duration of the disease ($p<0.001$), duration of symptoms ($p<0.001$), and the BASFI values ($p<0.001$) (Vesović-Potić et al.).

There was significant correlation between the radiological state of SI and lumbar flexion ($r=0.49$, $p<0.001$), chest expansion ($r=0.456$, $p<0.001$), and occiput-to-wall distance ($r=0.583$, $p<0.001$) (Lee et al. 1997).

In patients who have undergone biological therapy the pain is more moderate, the values of lumbar flexion and chest expansion are higher. The difference in wall-to-occiput distance shows that spinal curvatures are milder due to biological therapy. Moderate pain and better physical condition are shown in the BASFI and BASDAI values (Davis et al. 2003).

The primary aim of the 12-week movement therapy was to increase chest and spine mobility thus to improve breathing mechanisms and the quality of movement. Considering the typical muscular deformities of AS, the exercises improved the functions not only of this region. Aimed movement therapy had significant effects in the measured parameters except in the case of the wall-to-occiput distance and respiratory functions. Pain and disease activity significantly decreased, range of motion increased which could be seen in functions as well.

Based on the literature short-term movement therapy (3-6 weeks) has a significant influence on the finger-to-floor distance, trunk lateral flexion, chest expansion and thoracolumbar rotation. Meanwhile the Schober index, thoracolumbar flexion and wall-to-occiput distance show only slight improvement (Heikkila et al, 2000). A six-week long aimed home therapy program can be effective, just as it was proved by an examination carried out by Ortancil and colleagues (2009). The program consisted dominantly of breathing- and upper extremity exercises which significantly improved chest expansion, maximum inspiratory and expiratory pressure values and BASFI values. The few-week-long movement therapy has not only short term effects but it has been found that months after the exercise program certain mobility values were similar to the ones measured at the end of the therapy.

The effectiveness of physical activity carried out in the several-week-long term (12 weeks) is out of question. A therapeutic program similar to our therapy in terms of duration and content was carried out by Ince et al. (2006) and had similar improved results. 30 people participated in the program, during the three months they had three sessions every week. Participants had to carry out stretching and breathing exercises which significantly changed chest expansion, lumbar flexion and wall-to-occiput distance. The wall-to-occiput distance of our patients in the study did not change significantly but in a bigger group other results could have been found.

An individualized exercise program has the advantage to make the program especially for the individual - keeping the original concerns and aims. In the first four weeks of our program we carried out individualized exercises (one patient at a time) where the patients acquired and learned to use the exercises based on joint protection strategies.

Group physical therapy has a positive effect on mobility, function and another benefit of it over home exercise programs is that is has a social and inspiring impact (Analay et al., 2003; Karapolat et al., 2008). Physical therapy conducted and controlled by a professional makes continuous correction possible thus enabling the patient to carry out the exercises precisely. The literature also advises to implement home exercises if possible combined with controlled exercises (Hidding et al. 1993). Exercises adapted for AS, if carried out daily for 20 minutes, can significantly improve mobility and function and decrease pain (Lim et al., 2005).

The effectiveness of exercises carried out at home should be investigated after a longer period of time. 4 -8 months long follow-up studies have shown that home exercise programs decreased pain and stiffness, increased mobility, improved function and in general patients were in good general condition. In short term only a 20-30-minute aimed exercise program can have significant benefits (Kraag et al., 1994; Sweeney et al., 2002).

The type of movement (defined by the aim) is the third important factor. The literature highlights and gives proof for the effectiveness of posture correction and breathing exercises along with the traditional-conventional exercise programs. All three movement therapies can be used alone for mobility and function improvement (Fernandez de Las Penas et al., 2005). Our exercise program combined the three movement types. Our movement therapy was supplemented with chest manual therapy and the measured parameters showed similar improvement to those of the literature.

The criteria of normal / physiological chest expansion are undamaged structures in the spine and chest joints and their attachments. Any affected joint can influence its mobility and function. The results of the literature and our study show that the duration of the disease and the symptoms, the radiological changes and disease activity are related to spinal and thoracic involvement. It is evident that physical therapy / movement therapy has a key role in the treatment.

Considering the type of movement (individual, group; controlled, carried out at home alone) and the duration (3-12 weeks) physical therapy has positive long term effects after aimed therapy is carried out (Ortancil et al., 2009; Widberg et al., 2009).

Although chest expansion almost doubled after our therapy had been carried out, respiratory function values did not improve significantly. Breathing exercises increase chest expansion greatly but they only enhance the endurance of the respiratory muscles when applied under definite and age-appropriate pulse rate (Berdal et al., 2012).

Daily or weekly exercises carried out regularly affect the respiratory parameters. Significant changes are brought on by intense exercises carried out daily for 3-4 weeks. Viitanen et al., (1992) reported an average of 1 centimeter increase at chest expansion and 7.4% improvement in vital capacity($p<0,001$) when exercises were performed regularly every day. Contrast to these findings we could report double size chest expansion, but only a 4.9% increase in vital capacity, since movement intensity did not reach the level of endurance training. Daily carried out intense exercise programs improved greatly the endurance properties of respiratory muscles, which was shown by vital capacity changes but improved chest expansion to a less extent. Contrary to this, weekly carried out exercise programs focusing on chest mobility expansion increased chest expansion significantly but did not affect respiratory muscle endurance at all.

If we consider the duration of the disease from the first diagnosis, over a ten- year -long duration chest expansion is significantly less as well as the VC, FEV1 and MVV values while the BASFI values are higher than on the onset of the disease. Also the decline of chest expansion correlates to respiratory muscle strength and stretching (Sahin et al., 2006).

Literature findings and our study prove the fact that the intensity of exercising greatly affects respiratory muscle endurance and pulmonary functions. The different types of movement highly improve physical and functional conditions. If we combine the before mentioned movement types supplemented by endurance training, not only mobility and functionality will have a positive effect but also respiration.

Enthesitis related pain can range from moderate pain to severe. With the progression of the disease, the involved areas become tender when pressure is applied. This tenderness can be reinforced by palpation. This symptom appears at early stage of the disease hence it helps in setting up the diagnosis (Kaya et al.; 2007).

Pain and stiffness of the thoracic region were dominant in the 75 patients of our study. Pain in the lower back depends greatly on sacroiliac activity, partial SI ankylosis is accompanied by limited range of motion of the lumbar spine and paravertebral stiffness. More intense pain is caused by the inflammation of the dorsal spine and chest.

In the movement therapy group the tenderness under pressure of the cervical and dorsal spinous processes were significant before the therapy. At the thoracic region no change occurred because inflammation was not affected by moving exercises.

At the tender points the pressure sensitivity of the areas of muscle insertion and origin decreased significantly. These changes were proven by decrease of pain intensity and significant improvement of disease activity after movement therapy. The BASDAI value changed positively due to decreased stiffness and pain, which positively affected the BASFI value due to increased work ability (Roussou et al., 2011). Pain manifested by enthesitis correlates to functionality changes, pain intensity as well as to disease activity proved by our findings, too.

SUMMARY OF THE MAIN RESULTS AND CONCLUSIONS

1. Following the international national guidelines of movement therapy methods, we developed a new movement program which combines traditional mobilization and stretching exercises emphasizing posture correction and exercises based on breathing techniques. The exercises were carried out in sessions lasting 1,5 hours, which was longer than the international recommendation of 30-50 minutes. We also applied chest mobilization exercises for the patients as extra techniques. Our exercise program puts emphasis on precise and correct implementation of exercises, close kinematic chain exercises are of high priority.
2. The analysis of the parameters of 75 patients using standard ankylosing spondylitis protocols suggested that disease activity, duration since diagnosis is significantly correlated with mobility and functionality decrease. The radiological condition of the sacroiliac joint was an exception. We could obviously prove that the subjective assessment of patients was highly determined by spinal and peripheral changes.
3. Having movement therapy completed we noticed significant improvement of the following parameters which were similar to the literature data: disease activity, pain intensity, chest expansion, modified Schober index, lateral flexion of the spine, finger – to – floor distance, BASFI and BASDAI values.
4. The change in chest mobility was one of the key results of our movement therapy. After the twelve-week- long therapy of the group of 10 patients, chest expansion almost doubled, what’s more, in three cases it almost tripled. We proved that although radiological changes occur with the progression of the disease, the chest can be mobilized well and adequate breathing techniques can be taught and acquired.
5. The positive changes in the joints and muscles due to aimed movement therapy could be measured in decreasing spine ache and stiffness. Moreover, movement therapy had positive impact on the decrease of pressure sensitivity

of tender points. Decrease of pain in the sternocostal and chondrocostal junctions under pressure was significant. We assessed the pressure sensitive anatomical points of the upper and lower extremities and found that pain of the muscle insertion and/or muscle origin areas significantly decreased.

6. According to the findings of our study we can conclude that patients undergoing biological therapy had better structural and functional condition than those who had not received it. The efficiency of biological therapy in AS treatment is well proved, but a movement therapy program considering the musculoskeletal complications and joint protection strategies can greatly improve the disease itself. Thus physical exercises should have a key role in AS treatment.

Our findings support the fact that physical therapy still has a significant role in a successful AS complex therapy. An effective way to achieve this can be an aimed movement therapy paying attention to the condition of the patient and implementing joint protection strategies.

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Candidate: Zsuzsanna Némethné Gyurcsik

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List of publications related to the dissertation

1. **Gyurcsik, Z.**, Bodnár, N., Szekanecz, Z., Szántó, S.: Treatment of ankylosing spondylitis with biologics and targeted physical therapy: Positive effect on chest pain, diminished chest mobility, and respiratory function.
   Zeitsch. Rheumatol. Epub ahead of print (2013)
   DOI: http://dx.doi.org/10.1007/s00393-013-1240-8
   IF:0.45 (2012)

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Total IF of journals (all publications): 9.107

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The Candidate's publication data submitted to the Publication Database of the University of Debrecen have been validated by Kenezy Life Sciences Library on the basis of Web of Science, Scopus and Journal Citation Report (Impact Factor) databases.

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