

EVALUATION OF RESPIRATORY REHABILITATION IN PATIENTS WITH ANKYLOSING SPONDYLITIS

Georgiana-Cornelia Dimofte¹, Camelia Ciobotaru¹, Mădălina-Gabriela Iliescu^{2,3}, Irina Albadi^{1,2}, Andreea-Alexandra Lupu^{1,2}

¹“Saint Andrew” Country Hospital of Constanța

²Facultatea de Medicină, “Ovidius” University of Constanța

³Balneal and Rehabilitation Sanatorium of Techirghiol

Georgiana-Cornelia Dimofte

email: dimoftegeorgiana@yahoo.ro

ABSTRACT

Ankylosing spondylitis (AS) (spondylos = vertebra, ankylos = curved) is an inflammatory disease with predominant axial skeletal involvement and obligatory sacroiliac joint involvement, capable of affecting, with varying frequency and severity, peripheral joints and may also have extra-articular determinations. The main motivation of this study is the desire to demonstrate that there is a close relationship between respiratory muscle performance and exercise capacity in patients with ankylosing spondylitis. The methodological approach of the study consisted of a group of 21 patients. Statistical analysis was based on patient characteristics such as age, weight, height, body mass index, and thoracic expansion was measured. For the correct individualization of rehabilitation programs, the clinical form (with thoracic hyperkyphosis or straight spine), the age of the disease, the peripheral joints affected, the stage of injury, the degree of reducibility of the vicious attitudes, the impairment of thoracic breathing, the type of occupational spinal demands, the general condition and associated diseases will be taken into account. The results obtained proved that the application of respiratory physiotherapy procedures, based on the diagnosis, needs and limitations of the patients, correlated with tests to evaluate the quality and effectiveness of the recovery process, shows an increase in abdominal muscle strength that is not statistically significant. The 2-week rehabilitation cure is insufficient to modulate respiratory function and increase respiratory muscle strength. The subjective appreciation given by patients to the cure is due to other physiological changes produced by the rehabilitation cure such as: softening of connective and muscle structures, muscle relaxation.

Keywords: ankylosing spondylitis, respiratory rehabilitation, physiotherapy

Introduction

Ankylosing spondylitis (AS) is considered a disease dating back to ancient times, in the 17th century. 5th century AD. Caelius Aurelianus refers to a patient who „was suffering from pain in the buttocks, moved slowly and could neither sit upright nor bend over except with great difficulty” and which is not limited exclusively to the human species. Vertebral affections suggestive for ankylosing spondylitis have also been described in some animals: prehistoric crocodiles, monkeys (Zorab, 1961) and horses (Stecher and Goss, 1961) (1).

In recent years, advances in large-scale

techniques and studies involving large cohorts of patients have led to considerable developments in the identification of novel genetic associations and immune pathways involved in ankylosing spondylitis (AS). These discoveries include genes encoding cytokine receptors, transcription factors, signalling molecules and transport proteins. Although progress has been made in understanding the functions and potential pathogenic roles of some of these molecules, much remains to be done to understand their complex interactions and therapeutic potential in AS (2).

The Ankylosing Spondylitis Disease Activity Score, a validated and highly

discriminatory tool for assessing disease activity, has been developed but is not feasible because erythrocyte sedimentation rate and CRP values are often not available during a visit to the rehabilitation clinic (3).

Most studies have shown a positive effect of exercise on ankylosing spondylitis disease activity index, ankylosing spondylitis functional index, pain, mobility, function and quality of life (4), these shows that increased intensity and duration of exercise were associated with an improved BASDAI score (5).

Ankylosing spondylitis (AS) (spondylos = vertebra, ankylos = curved) is an inflammatory disease with predominantly axial skeletal involvement and obligatory the sacroiliac joint, capable of affecting, with varying frequency and severity, peripheral joints and may have extra-articular determinations. The clinical spectrum ranges from simple pelvic disease (sacroiliitis) to severe and progressive multisystemic distress, with numerous clinical subsets between these extremes that are not mutually exclusive. For these reasons, perhaps the synthetic and compressive definition of AS should be the involvement of symptomatic bilateral sacroiliitis (6).

The genetic predisposition has long been known, with statistics showing familial aggravation of the disease: spondylitis is 30 times more common among the relatives of patients (7).

Ankylosing spondylitis is an insidiously progressive and debilitating form of arthritis involving the axial skeleton. The long delay in diagnosis and insufficient response to currently available therapies argue for a better understanding of the pathogenesis of the disease. Genome-wide association studies of this genetic disease have implicated specific immune pathways, including the interleukin (IL)-17/IL-23 pathway, control of nuclear factor kappa B (NF- κ B) activation, amino acid composition for the major histocompatibility complex, antigen presentation (MHC), and other genes controlling CD8 and CD4 T-cell subsets (8).

As for the patients occupational capacity, it is preserved for a longer period of time and in a relatively high percentage. However, in a large number of cases, occupational change is required. A serious prognosis is given to forms

with peripheral involvement or hip-femoral ankylosis (9).

The clinical picture in men is characterised by a characteristic dorso-lumbar kyphosis (Bechterew form), which is thought to be due to hypotonia of the extensor muscles, related to posterior interapophyseal arthritis. (However, there are also clinical forms without kyphosis, especially in women). Lumbar lordosis disappears. Physiological dorsal kyphosis progressively increases, forcing the patient to keep the cervical spine in hyperextension in order to maintain a horizontal field of vision. The head and shoulders are projected forward, while the thorax is immobilised in the expiratory position, breathing becoming abdominal. Extensive syndesmosis of the entire spine, as well as synostosis of the posterior interapophyseal joints, turns the spine into a rigid block (10).

Ankylosing spondylitis (AS) affects one in 200 people and is usually diagnosed many years after the onset of symptoms. Chronic back pain is common and early recognition of the disease requires clinical experience. Moreover, inflammatory markers are invariably not elevated and radiographic changes are often late findings (11).

The functional prognosis becomes worse when shoulder joint buckling or hip flexion buckling (forcing the patient to keep the knees bent to maintain balance) is associated. The biomechanical „erector spinae” system is also compromised by the tendency of the paravertebral muscles to atrophy (10). Regular exercise or an active lifestyle (12) may increase exercise capacity in patients with ankylosing spondylitis (13).

It is important to know that a study carried out showed that fatigue was, in the opinion of patients, strongly associated with pain (70% of patients) and stiffness (54% of patients). Logistic regression analysis showed that BASDAI, BASFI, BAS-G and mental health status (SF-36) scores were independently associated with fatigue ($R(2)=0.52$). Multiple regression analysis showed that BASDAI questionnaire scores were significantly associated with quality of life (14). A high load-capacity ratio of inspiratory muscles makes these muscles susceptible to fatigue and may contribute to exercise limitation (Bellemare

and Grassino 1982) (15).

Vanderschueren et al (1989) speculated that the reduction in maximal respiratory pressures could be the result of intercostal muscle atrophy due to reduced chest wall expansion (16).

Many patients with ankylosing spondylitis complain of reduced exercise capacity and are referred to a physiotherapist. The goal of treatment is to increase exercise capacity using different interventions based on different assumptions. These assumptions stem from several proposed explanations for reduced exercise capacity, such as impaired lung function, chest wall restriction, poor respiratory muscle performance, muscle weakness (17). Inspiratory and expiratory pressure are both significantly related to exercise capacity (18). It is important to know that a home exercise programme can have an effect on certain measures of respiratory muscle and functional status. Greater emphasis should be placed on maintaining cardiorespiratory fitness as well as spinal mobility (19).

The main motivation for this study is the desire to demonstrate that there is a close relationship between respiratory muscle performance and exercise capacity in patients with ankylosing spondylitis.

It is also important to be informed, to be equally aware of older and newer studies. The research method is at the basis of the development of this study, both for the theory part and for the research part and the development of hypotheses and conclusions.

Another motivating aspect was that ankylosing spondylitis presents with both musculoskeletal and cardiorespiratory pathophysiological manifestations, which is why inspiratory muscle training is a useful intervention to address deficits in respiratory and functional status. I have understood during my research that this aspect is very important, and even more so, training is necessary to be performed at home, which is why I teach and encourage patients in this direction.

During my work with patients I have learned a very important lesson, people who develop a chronic disease such as spondylitis learn over time to cope with emotional and physical situations. Learning to live with this disease often requires accepting change. Changes may be needed in

relationships, work habits and leisure activities. Changes in physical appearance may be needed. All of these possible changes may sadden, stress, depress or upset the patient. By going through all these aspects we have been able to understand the patient and we have been helping them with all the necessary information.

Another important criteria that tipped the balance in favour of choosing this topic was its high incidence, which in the general population is 8%. The incidence is 2-3 times higher in men, more frequently in young men, with onset in the third decade of age. Recent studies show that patients are affected by the disease in the most productive period of their lives, and the severe, chronic, disabling course of the disease means that a large number of sufferers take early retirement or are unable to work, which substantially increases the social costs of the disease.

The final reason we chose this topic was that there is no cure, but a range of non-medical measures which can reduce the intensity of symptoms, improve the course of the disease or induce remission. A sad truth but one that spurred us on to gather as much information as possible to help as many people as possible.

Being a condition that gives a degree of stiffness, we aimed to analyze the evolution of patients who followed a hydro-balneo-physio-kinetic rehabilitation package used in parallel with drug treatment to demonstrate its effectiveness.

The present study aims to demonstrate some beneficial effects of complex functional rehabilitation of ankylosing spondylitis using natural therapeutic factors.

The proposed objectives are:

To evaluate the effectiveness of complex respiratory function rehabilitation therapy in patients with AS;

To assess the circumference index in patients with AS before and after balneotherapy;

To evaluate the muscle strength of the abdominal muscles necessary for better breathing in patients with costo-vertebral joint damage

Material and Methods

The materials used in the study were:

Sapropelic mud from the deposit at the bottom of Lake Techirghiol, mineral water from Lake Techirghiol, herbal extract;

The facilities of the treatment base of the Techirghiol Spa and Recovery Sanatorium where the patients of the studied group underwent spa treatment.

Working method

Patients were examined clinically and evaluated paraclinically to establish the diagnosis and institute physical treatment.

Cirtometric index measurement was performed at the nipple level. Chest diameter was measured in forced inspiration and expiration and the difference of the two measurements was recorded in the table.

Determination of muscle strength was performed according to the standard working methodology for abdominal muscles: i.e. supine for muscle strength equal to or greater than 3 and lateral decubitus for lower strengths. For the statistics of these data we used an artifice whereby values conventionally noted with + or - were noted with 0.5 in addition to the conventional value. Thus, force 3+ or 4- was introduced in our table measurements.

The treatment applied daily to patients admitted to the Balneal and Rehabilitation Sanatorium of Techirghiol consisted of hydrotherapy and a variable number of adjuvant procedures (electrotherapy, physiotherapy, massage therapy), administered for 12, 18 or 21 days. To carry out the study we selected patients who completed the 12-day treatment. No modifications were made to this treatment as the aim was to evaluate the effects obtained under real treatment conditions.

The balneal prescription consisted of saline baths in the tub or in the therapeutic pool applied as the only hydrotherapy procedure or alternatively with mud baths in the tub.

Massage was indicated on the cervical-dorsal-lumbar region for its analgesic and decontracting effect.

All patients were prescribed electrotherapy with analgesic, vascular-active and decontracting

character.

Individual kinetotherapy was performed and the programmes were individualized for each patient according to the clinical examination.

Inclusion criteria

Normal or medically controlled values of blood pressure, radial pulse;

Complete and correct diagnosis of AS according to ACR (American College of Rheumatology) standards;

Exclusion criteria

Presence of clinical or paraclinical inflammatory syndrome;

The presence of cardiovascular co-injury contraindicating hydrotherapy and physiotherapy;

The presence of neurological co-injury requiring appropriate rehabilitation techniques (different from those applied to the hip).

Statistical analysis

Statistical analysis was based on patient characteristics such as age, weight, height, body mass index, and thoracic expansion were measured. Height was not taken into account because height measurement in patients with ankylosing spondylitis might be hampered due to the flexed position of the spine. 21

For the correct individualization of rehabilitation programs, the clinical form (with thoracic hyperkyphosis or straight spine), the age of the disease, the progressive vertebral segments, the peripheral joints affected, the lesional stage, the degree of reductibility of the vicious attitudes, the impairment of thoracic respiration, the type of occupational spinal demands, the general condition and associated diseases should be taken into account.

In order to correctly design the recovery programme and method, it is necessary that the file of each case contains complete data not only clinico-biological and radiological, but also functional. Among all, the following data should not be missing for a quantified, objective assessment:

Waist, measured periodically (its decrease is a function of the accentuation of kyphosis; but the waist also depends on the state of lumbar lordosis, as well as on the damage to the hip and knee joints).

Occiput-wall distance, which increases as

thoracic kyphosis increases. If the patient has associated flexion of the hip joints, the occiput-wall distance is measured from the orthostatic position, with the lumbar region against the wall. The best results in kyphosis rehabilitation are obtained when the occiput-wall distance is less than 6-7 cm; for cases of „medium” kyphosis (with a distance between 7-15 cm) only rarely is a reduction in kyphosis obtained.

Cervical, dorsal and lumbar mobility testing.

Measurement of the thoracic perimeter (at the level of the bimamellar line, in forced inspiration and expiration) indicates the degree of damage to the costo-vertebral and costo-transverse joints, with limitation or compromise of thoracic breathing (normally, the difference is 6 cm or more).

Vital capacity, measured by spirometry and other ventilation tests (in general, limiting thoracic breathing and substituting it with abdominal-thoracic or abdominal type of breathing does not affect vital capacity, if prophylactic respiratory gymnastics has been applied persistently).

Testing of paravertebral muscles, trunk flexors and pelvic and scapular girdle muscles. Joint and muscle balance of the affected peripheral segments.

The treatment period was 12 days. Initially it started with a number of 4x2 repetitions as during the program, depending on the physical condition and pathological state of the patient, the number of repetitions increased to 4.

Exercises to mobilise the lumbar spine (4x2 repetitions):

- from supine position perform calf flexion on the thigh and thigh flexion on the pelvis, with each lower limb and then with both;
- from the prone position, repeated extension of the lower limbs with the knees extended;
- from a supine position with the spine flexed or from a squatting position with the hands resting on the bar, flexion and extension of the lumbar spine around the pelvis;
- from the sitting position with the knees bent, anterior flexion of the trunk followed by straightening, with the

upper limbs extended;

- from standing with the lower limbs apart or seated, repeated flexion followed by straightening of the trunk
- with one hand resting on the bar and the opposite lower limb resting on a higher plane, anterior trunk flexion and posterior arches are performed;
- from the quadrupedal position, trunk flexion and extension are performed simultaneously with alternate extension of the lower limbs;
- from the same position, the spine is curved and depressed;
- from the quadrupedal position the torso is directed to the right and left and the pelvis simultaneously in the opposite direction;
- from the suspended position the lower limbs are swung together from side to side.

Exercises to mobilise the thoracic spine (4x2 repetitions):

- from the supine position with the knees bent and the arms extended sideways, the knees are brought towards the chest and the starting position is returned;
- from a sitting position, sideways bending of the trunk, rotation of the trunk;
- from a quadrupedal position, raising the lower limbs to maximum extension (alternately) while bending the upper limbs at the elbows;
- from the quadrupedal position, rotation of the trunk with the arms;
- from the bent quadrupedal position, crawling on the stomach;
- „on horseback” on a bench, two patients standing with their backs to each other (separated by an arm’s length) rotate their torso with their upper limbs outstretched, passing a ball from one to the other, sometimes to the right and sometimes to the left.

Exercises to mobilise the cervical spine (4x2 repetitions):

- from a seated position, free active mobilizations of flexion, extension, lateralization and rotation of the head;

- the same movements can also be performed from the quadrupedal position;
- from the sitting position with arms outstretched horizontally, the arms are thrown backwards alternately, the patient following the movement each time with the head turned to the side;
- from the sitting position the trunk is bent forward, placing the right ear on the left knee, then the head is lifted by turning it to the right; the exercise is continued by performing the movement with the left side;
- from orthostasis, balls are thrown up and caught.

Exercises to mobilise the entire spine (4x2 repetitions):

- Balls, hoops, sticks, pulleys and counterweights may be used.

Exercises to increase breathing range:

Expiratory exercises(4x2 repetitions):

- diaphragmatic breathing with relaxation of the abdominal wall on inhalation and contraction of the abdominal wall on exhalation;
- breathing with pressure on the lower ribs during exhalation;
- pressure is exerted on the chest with the lower limbs during exhalation (knees and hips flexed);
- from a sitting position with the trunk bent: the trunk is lifted in inspiration and relaxed with a forced exhalation.

Inspiratory exercises (4x2 repetitions):

- deep inspirations expand the lower rib area, possibly against resistance from the physiotherapist's hands or against a strap wrapped around the thorax;
- from a sitting position with the trunk bent, arching the back while inhaling deeply;
- from a seated position, rotation of the arms outwards, concomitant with a deep inspiration;
- from a sitting position, raising the arms upwards and raising the torso with a yawning inspiration.

Results

The group consisted of 21 patients: 6 women (29%) and 15 men (71%).

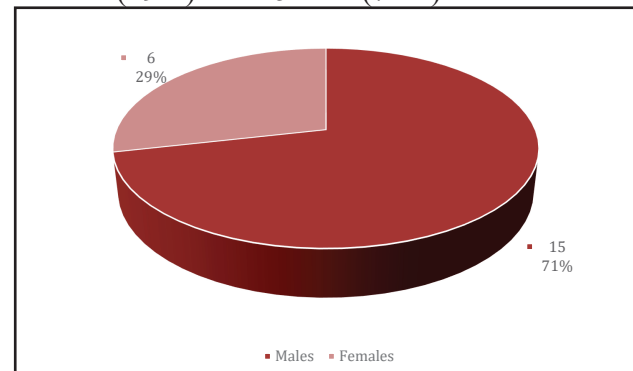


Figure 1- Distribution of patients by sex

Table 1 Distribution of the group according to the age of the patients

	lot	women	men
average	40.86	43.33	39.87
dev std	10.86	11.93	10.68
t-test fem-barb			0.55

The mean age of the group was 40.86 ± 10.86 years, of the females 43.33 ± 11.93 years and of the males 39.07 ± 10.68 years. The difference in mean age between females and males was not statistically significant: $p=0.55 > 0.005$.

The distribution of patients by age group shows that most patients belong to the 30 - 39 years age group, while the 40 - 49 and 50 - 59 years age groups have an equal number of patients (4) and the 20 - 29 years age group (3), and over 60 years only 1 patient.

Analysis of the distribution of patients according to disease stage reveals a balanced group: 6 patients (29%) were stage II, 8 (38%) stage III and 7 (33%) stage IV.

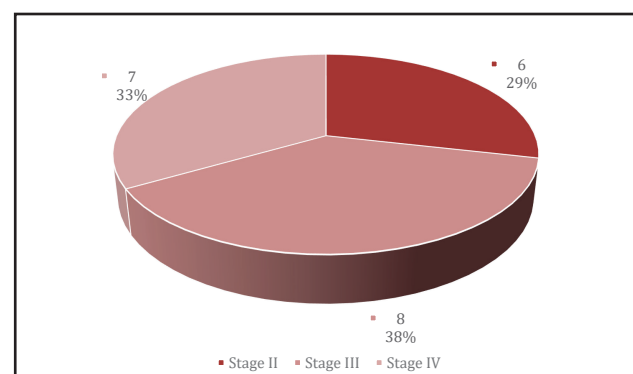


Figure 2 Distribution of patients by stage of spondylitis

The analysis of the variation of the cirtometric index at the end of the 2-week course was not statistically significant: $p=0.47 > 0.05$ (statistical significance).

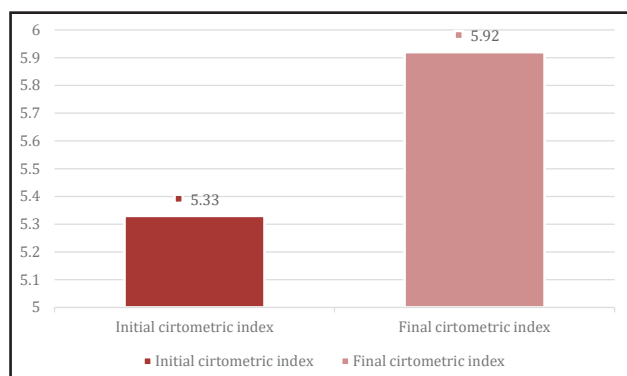


Figure 3 Mean initial and final cirtometric index

The increase in rectus abdominis muscle strength is very small and not statistically significant $p=0.17 > 0.05$.

Table 2 Initial and final abdominal rectus muscle strength

	MF i	MF f
average	3.74	4.05
dev std	0.75	0.67
t-test sign $p < 0.05$		0.17

Analysis of the change in muscle strength during the 2-week course is statistically insignificant. This is due to the short duration of the fast compared to the time required for muscle strength growth.

It can be seen that the younger age groups, as in the case of the cirtometric index, still have a better evolution.

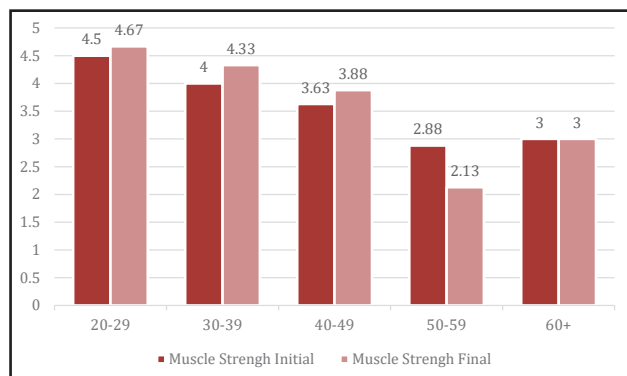


Figure 4 Muscle strength by age group

Conclusions

Following the analysis of the results obtained by measuring the variation of the cirtometric index and the strength of the abdominal muscles required for efficient abdominal breathing, the following conclusions can be drawn:

The variation of thoracic diameter during the respiratory act is statistically insignificant.

During the 2-week rehabilitation programme the muscle strength of the abdominal muscles, although it showed an increase at the end of the course, is not statistically significant.

The 2-week rehabilitation cure is insufficient to modulate respiratory function and increase respiratory muscle strength.

Subjective appreciation given by patients to the cure is due to other physiological changes produced by the spa cure such as: softening of connective and muscle structures, muscle relaxation.

To objectively assess the impact of rehabilitation treatment on respiratory function, further studies are needed to evaluate oxygen blood levels and tissue respiration.

References

1. Şuța M, ; Şuțeanu Ș. Actualități în spondilita anchilozantă și artritele reactive: Editura Comandor; 2000.
2. Ranganathan V, Gracey E, Brown MA, Inman RD, Haroon N. Pathogenesis of ankylosing spondylitis - recent advances and future directions. *Nat Rev Rheumatol*. 2017 Jun;13(6):359-67.
3. Magrey M, Ritchlin C. Measuring outcomes in ankylosing spondylitis: pearls and pitfalls. *Curr Opin Rheumatol*. 2019 Mar;31(2):109-17.
4. Zão A, Cantista P. The role of land and aquatic exercise in ankylosing spondylitis: a systematic review. *Rheumatol Int*. 2017 Dec;37(12):1979-90.
5. Tyrrell JS, Redshaw CH. Physical Activity in Ankylosing Spondylitis: evaluation and analysis of an eHealth tool. *J Innov Health Inform*. 2016 Jul 4;23(2):169.

6. Bolosiu HD. Ghid de reumatologie. Spondilita anchilozanta: Editura Dacia; 1989.
7. Gherasim L. Medicină internă – Bolile aparatului respirator și reumatice. II ed: Editura medicală; 2000.
8. Smith JA. Update on Ankylosing Spondylitis: Current Concepts in Pathogenesis. *Current Allergy and Asthma Reports*. 2014 2014/11/22;15(1):489.
9. Șuțeanu Ș, Ionescu-Blaja V, Moangă M. Clinica și tratamentul bolilor reumatice: Editura Medicală; 1977.
10. Stroescu I. Recuperarea funcțională în practica reumatologică, : Editura medicală; 1979.
11. Golder V, Schachna L. Ankylosing spondylitis: an update. *Aust Fam Physician*. 2013 Nov;42(11):780-4.
12. Seçkin U, Bölükbaşı N, Gürsel G, Eröz S, Sepici V, Ekim N. Relationship between pulmonary function and exercise tolerance in patients with ankylosing spondylitis. *Clin Exp Rheumatol*. 2000 Jul-Aug;18(4):503-6.
13. Fisher LR, Cawley MI, Holgate ST. Relation between chest expansion, pulmonary function, and exercise tolerance in patients with ankylosing spondylitis. *Ann Rheum Dis*. 1990 Nov;49(11):921-5.
14. van Tubergen A, Coenen J, Landewé R, Spoorenberg A, Chorus A, Boonen A, et al. Assessment of fatigue in patients with ankylosing spondylitis: a psychometric analysis. *Arthritis Rheum*. 2002 Feb;47(1):8-16.
15. Bellemare F, Grassino A. Effect of pressure and timing of contraction on human diaphragm fatigue. *J Appl Physiol Respir Environ Exerc Physiol*. 1982 Nov;53(5):1190-5.
16. Vanderschueren D, Decramer M, Van den Daele P, Dequeker J. Pulmonary function and maximal transrespiratory pressures in ankylosing spondylitis. *Ann Rheum Dis*. 1989 Aug;48(8):632-5.
17. Rosenow E, Strimlan CV, Muhm JR, Ferguson RH. Pleuropulmonary manifestations of ankylosing spondylitis. *Mayo Clin Proc*. 1977 Oct;52(10):641-9.
18. van Noord JA, Cauberghs M, Van de Woestijne KP, Demedts M. Total respiratory resistance and reactance in ankylosing spondylitis and kyphoscoliosis. *Eur Respir J*. 1991 Sep;4(8):945-51.
19. Ortancil O, Sarikaya S, Sapmaz P, Basaran A, Ozdolap S. The effect(s) of a six-week home-based exercise program on the respiratory muscle and functional status in ankylosing spondylitis. *J Clin Rheumatol*. 2009 2009/03//;15(2):68-70.