FLEXIBILITY, CHEST EXPANSION AND RESPIRATORY MUSCLE STRENGTH IN SUBJECTS WITH ANKYLOSING SPONDYLITIS SUBMITTED TO AQUATIC PHYSICAL THERAPY EXERCISES

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ABSTRACT

Ankylosing spondylitis is a rheumatic illness characterized by inflammation of ligament insertions and joints, particularly in spine. Alterations result in loss of flexibility, mobility and chest expansion, besides reduction in respiratory muscle strength. This study intends to evaluate flexibility, chest expansion and respiratory muscle strength of ankylosing spondylitis subjects submitted to a program of aquatic physical therapy exercises. Four subjects with ankylosing spondylitis were selected. Initially, they were submitted to a physical therapy, chest expansion, flexibility of spine and pelvis and respiratory muscle strength evaluation. Then, they were submitted to an aquatic physical therapy exercises program, three times per week, 10 weeks. In the end of the program, they were reevaluated using the same protocol used before intervention. Three of the subjects showed improvement in flexibility. All of them improved their chest expansion (two in both levels and two in only one of then). Three of the subjects improved their inspirato-

ry muscle strength. All of them experienced reduction in their expiratory muscle strength. Only one experienced improvement in the inspiratory muscle strength, chest expansion and flexibility of the studied subjects. It can be stated that this improvement is due to the effects of the exercise in warm water. Controlled studies with bigger sample and control group must be realized to get to definitive conclusions.

KEY WORDS: physical therapy; ankylosing spondylitis; aquatic exercises hydrotherapy; respiratory muscle strength; thoracic mobility; flexibility

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INTRODUCTION

Ankylosing spondylitis (AS) is a rheumatic condition characterized by ligament insertion and joint inflammation. It results in immobility and stiffness, mainly in spine (FISHER et al., 1989; AGGARWAL et al., 2001; VIITANEN, 2000). It involves spinal chest joints and ligaments, but also affects extra-spinal structures (VIITANEN, 2000).

AS is a systemic condition, with many extra-joint manifestations (AGGARWAL et al., 2001). Pulmonary involvement was initially described in 1941, but only from 1965 was it considered an extra-joint manifestation (SAMPAIO et al., 1999). Bone ankylosis occurs in a lot of chest joints, resulting in limitation of chest wall and lung movement (FISHER et al., 1989).

Costochondral joint troubles culminate in loss of joint mobility. It frequently leads to a measurable reduction in normal chest expansion (FISHER et al., 1990). The reduction of 2 to 5 cm in the pulmonary expansion is AS diagnosis criteria (FISHER et al., 1989). Associated to chest expansion reduction, there is restrictive ventilatory damage, characterized by reduction in forced vital capacity. These alterations occur because of the increase of chest wall resistance and complacence reduction (SALTER, 2001). Generally, chest expansion deteriorates during the illness's evolution and also with age (BARROS et al., 1999).

Viitanen et al., (1995) analyzed chest mobility of subjects with AS. Seventy-three men, with average of age 45,8 years had their chest mobility measured at forth-intercostal space level. They concluded that chest mobility had low correlation with other subjects characteristics, as age and radiological profile.

Vanderschueren et al., (1989) saw a relation between chest expansion and vital capacity in 30 subjects with AS. They observed that subjects with chest expansion reduction presented only 62% of

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the vital capacity predicted. Feltelius and collaborators (1986) also observed correlation between pulmonary volume and chest mobility in 32 subjects with AS. Authors said that these damages were related to inflammatory process, lung fibrosis and pathology evolution time. They also believe that costochondral and costosternal joint inflammation reduces chest mobility and increases pain and stiffness, reducing pulmonary volumes and chest expansion.

For above-mentioned factors, flexibility is also widely affected by AS. Flexibility is the maximum physiological passive range of motion of a joint. It tends to be specific to a movement or joint (ARAÚJO, 2000). It is considered by Araújo (2000) as relevant to simple and complex movements, sporting performance, health and quality of life maintenance.

Lung involvement with reduction of pulmonary volumes is a well-known manifestation of this illness, which has been attributed to reduced chest mobility (VANDERSCHUEREN et al., 1989). It is recognized that respiratory muscle weakness is a common complication of many clinical conditions (ROCHESTER, 1988). Respiratory muscle strength is surely affected in AS (VANDERSCHUEREN et al., 1989; CARTER et al., 1999; SAHIN et al., 2004). However, no data is available on the behavior of respiratory muscle strength of subjects submitted to physical therapy interventions. Faus et al., (1991) suggests that muscles in general are affected in AS as a consequence of pain inhibition, caused by intense inflammatory activity and general movement reduction.

This study intends to evaluate spine and pelvis flexibility, chest mobility and respiratory muscle strength of subjects with ankylosing spondylitis submitted to a physical therapy aquatic exercise program.

METHODS

Sample

Four subjects with AS clinical diagnosis were selected, one female and the others male. All of them had rheumatological accompaniment and received medication based on non-hormonal and hormonal anti-inflammatory drugs. This medication was not modified during interventions.

Smokers and/or those who presented signals or symptoms that hinder the accomplishment of proposed activities were excluded from this study. Other exclusion criteria was the time and means of transportation, availability and acceptance of routine training.

EVALUATION

After complete physical therapy evaluation, subjects had their chest mobility, flexibility of spine and pelvis and respiratory muscle strength evaluated.

To chest mobility evaluation, subjects were seated without dorsal support and with feet in the floor. A measuring tape was connected to thorax in the height of the arm pits. Three forced inspirations were requested, each one followed by a forced expiration, with interval of fifteen seconds between each breath (forced inspiration and expiration). Procedure was repeated in xiphoid process level. For the study, it was selected the biggest difference of chest range of motion, for each level. Flexibility evaluation was carried through by standardized photographic study of subjects in the simple fingertip-to-floor test (modified for hand-to-floor) in seated position. This test has its validity proved by Perret et al (2001).

Subjects were located seated in a rigid stretcher, with the knees, elbows and digits totally extended. Ankles were kept in neutral position, by a rigid device in the distal extremity of the stretcher. All of them had marked its right styloid ulna processes, with a circular white adhesive. Laterally to subject, a 30 cm baton was located. It was requested to the subject to realize anterior spine flexion, leading average digit to the distal device top, when they were photographed. Using the software "Corel Draw", one measured the photographic distance between white adhesive and stretcher device. It was also measured the length that 30 cm baton acquired in the photo. Through three-rule, it was measured the real distance between the subject fist and the device. Taking into consideration that in the literature the results of the test consider the distance o the third finger to the ground, which normally is zero, i.e., the finger touches the ground- and that the hand has average 20 cm in length, the results of the present study will be inaccurate in circa 20 cm.

Maximum respiratory pressures (IPmax and EPmax) were measured using a manovacuometer calibrated before the procedures. Participants were located seated erect, without leaning themselves against the chair, with the feet on the floor and using a nasal clip. One registered the measures of IPmax and EPmax, after a normal expiration and inspiration respectively, as suggested by Sorlie et al (1989). Maneuvers were repeated three times, with interval of two minutes between each one. To the study, it was considered the best try. The body index composition was also measured. It was done because weight alterations may affect the respiratory function and hinder the real effects of the exercises.

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In the program ending, subjects were reevaluated with the same procedures. Results were later compared with the subject own result and between the groups.

Interventions

After initial evaluation, subjects were submitted to an aquatic physical therapy program, as described below:

- Gait heating, in different directions, per five minutes
- Anterior, posterior and lateral trunk, upper and lower limbs chain stretching
- Passive trunk mobilization
- Lateral flexion and trunk rotation. Flexion, extension, adduction and abduction of the shoulders with shoulders subjects covered by water
- Exercises in all shoulder range of motion, in high speed, aiming to improve cardiorespiratory conditioning
- Walk in moderate speed, inspiring and expiring slowly, to get cooler
- Superficial landslide in supine position, for relaxation

All procedures were realized in the Physical Therapy Clinic of this institution. Aquatic physical therapy sessions took place in a 32 ± 2°C warm swimming pool, with 11.8 x 7.75 m and 1.05 m deep. The program was applied for 10 weeks, three times a week with one hour each session.

RESULTS

Results are described in TABLE 1 and FIGURE 1 about spine and pelvis flexibility. It is observed that most subjects worsened, because of the direct increase in the hand-to-floor distance. Only one subject improved, while the remain of the sample (from 9.25 to 30.16%) worsened.

TABLE 1 – Spine and pelvis flexibility before and after intervention.

Subject	Flexibility (cm)		Before-after difference	Change percentage (%)
	Before	After		
A	33.08	28	-5.8	-17.53
V	30.73	40	+9.27	+30.16
E	21.51	23.50	+1.99	+9.25
S	22.09	24.15	+2.06	+9.32

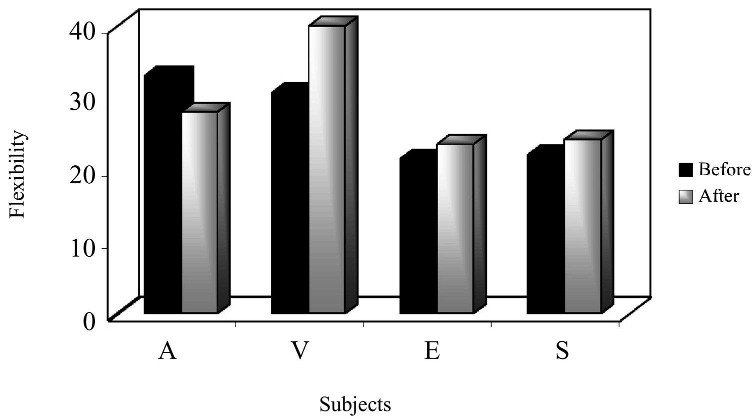

FIGURE 1 – Flexibility scores before and after intervention.

In relation to chest expansion, most the subjects improved, as observed in TABLE 2 and FIGURE 2. Two subjects didn't improve in the axillary level (average increase of 30.42 ± 70.80 %). At xiphoid level, all subjects increased their scores, from 20 to 700%.

TABLE 2 – Chest expansion at axillar and xiphoid levels before and after intervention.

Subject	Level	Chest expansion (cm)		Before-after difference	Change percentage (%)
		Before	After		
A	Axillar	3	6.5	+3.5	+116.67
	Xiphoid	4	8	+4	+100
E	Axillar	10	7	-3	-30
	Xiphoid	5	6	+1	+20
S	Axillar	2.5	4	+1.5	+60
	Xiphoid	3.5	5.5	+2	+57.14
V	Axillar	4	3	-1	-25
	Xiphoid	0.5	4	+3.5	+700

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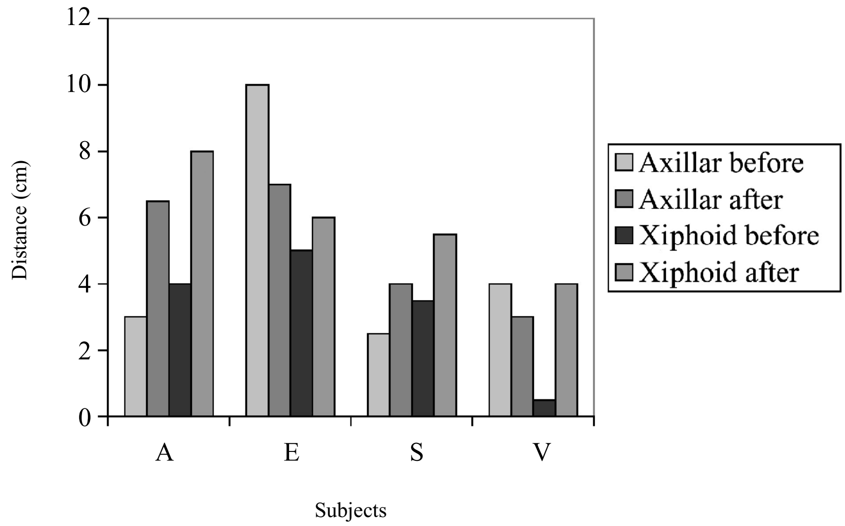

FIGURE 2 – Chest expansion at axillar and xiphoid levels before and after intervention.

As observed in TABLE 3 and FIGURE 3, only one subject did not improve in the IPmax after-intervention (average increase of 26.77 ± 25.66 %). In relation to EPmax, all subjects decreased their scores after intervention, varying from 5.26% to 18.75%.

TABLE 3 – Respiratory maximum pressures before and after intervention.

Subject	Respiratory maximum pressures			Before-after difference	Change percentage (%)
A	IPmax	75	120	+45	+60
	EPmax	190	180	-10	-5.26
V	IPmax	140	190	+50	+35.71
	EPmax	130	120	-10	-7.69
E	IPmax	170	170	0	0
	EPmax	160	130	-30	-18.75
S	IPmax	130	150	+20	+15.38
	EPmax	175	150	-25	-14.28

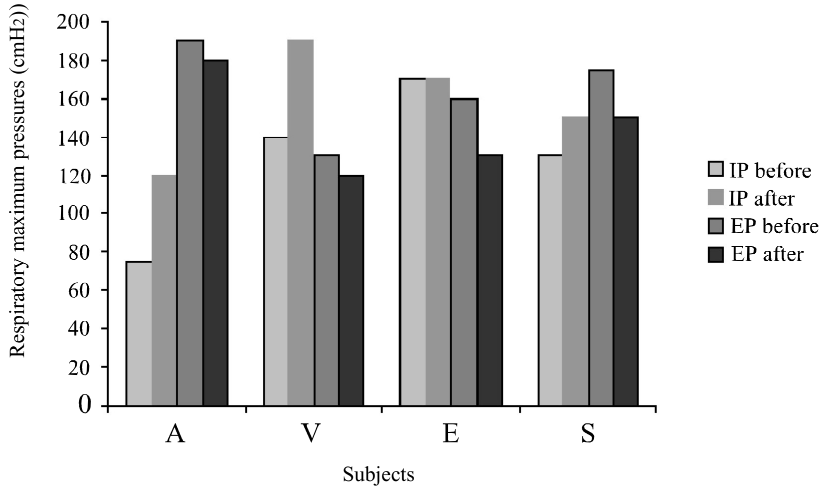

FIGURE 3 – Respiratory maximum pressures before and after intervention.

DISCUSSION

Improving spine and hip flexibility is an objective of many illnesses muscle-skeletal programs, as in AS. In the present study, the data suggested a spine and pelvic flexibility reduction after treatment.

Viitanen et al (1991) also detected worsening in finger-to-floor test scores in their study. Authors aimed to verify physical therapy effects in spine mobility of patients with AS. Study was composed by 362 men and 143 women. Rehabilitation group realized strength and flexibility training, techniques of mobilization and electrotherapy. Despite of the mobility improvement by majority of the subjects, 8% of them worsened their finger-to-floor scores. Similar results were found by Madureira and Lima (1998), who did not detect alteration in 25 women's flexibility submitted to aquatic exercises three times a week, for four months. Spine and hip flexibility did not present statistic significant improvement.

Flexibility score decrease in this study suggests that flexibility improvement requires a specific physical therapy intervention.

In relation to chest expansion, scores improvement were observed. Findings agree with those of Heikkila et al (2000) and Viitanen et al (1991). Heikkila et al (2000) submitted 112 subjects with AS to physical therapy intervention. After three weeks, one observed significant improvement in chest expansion. Viitanen et al

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(1991), after four weeks of physical therapy exercises, also observed increase in the chest expansion in 505 subjects with EA.

When observing IPmax and EPmax, presented in the TABLE 3 and FIGURE 4, three of four subjects got higher in Ipmax indexes after interventions. EPmax did not get to the same result, with worsening of all the subjects.

It is believed that IPmax improved due to bigger inspiratory resistance present in water. The 60% increase in the respiratory work occurs because of the hydrostatic pressure – which resists the chest expansion – and the increase in blood thorax volume, caused by push water effect (RUOTI et al., 2000). Moreover, one believes that water thermal effect improves chest mobility and expansion and respiratory muscle contraction quality.

In relation to EPmax worsening, it is believed that it can be justified by three factors. First, forced expiration muscles are tonic and very powerful, not exclusive of ventilation. In this way, one believes that its strengthening cannot be acquired by simple expiratory incentive. According to Azeredo (2002), in forced inspiration, the maximum flow to be reached at each volume depends on the effort undertaken by inspiratory muscles. However, forced expiration does not use the same mechanism. In the beginning, it depends on the individual effort, but after that, bigger efforts do not lead to proportional flows, and small reduction due to dynamic compression of aerial ways could follow. It favors an increased breath energy expense and may even harm ventilation. Third and last one, immersion favors expiration by the hydrostatic circular pressure. Moreover, this property helps in pelvic and abdominal contention, which is also a expiratory muscle function, by the same mechanism.

No studies about the aquatic exercises influence in the respiratory muscle strength in subjects with AS have been found. Thus, it was not possible to compare the results to verify recurrence. In this way, more studies are necessary to verify the real influence of aquatic exercise in the respiratory muscle strength.

Although a similar behavior in great majority of analyzed variable was found, study results may have been influenced by several factors. The sample was reduced, increasing the probability that subjects hold similarly due to chance, not because of therapeutic interventions.

CONCLUSIONS

The exercise program can be said to have improved inspiratory muscle strength, chest expansion and flexibility of the subjects studied although it did not change the expiratory muscle strength of people carrying ankylosing spondylitis. One believes that this improve happen because of the benefic effects of the exercise in warm water. Controlled studies with larger samples and control groups are necessary to find definitive conclusions about it.

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