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Enhanced Respiratory Muscular Function in Normal Adults after Lessons in Proprioceptive Musculoskeletal Education without Exercises*

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A subjective sense of enhanced ease of breathing has been described after instruction in the Alexander technique of proprioceptive musculoskeletal education (awareness and voluntary inhibition of personal habitual patterns of rigid musculoskeletal constriction). We investigated the effects of AT instruction on respiratory function in healthy adult volunteers (group 1, ten subjects), who received 20 private AT lessons at weekly intervals. Spirometric tests, including maximum static mouth pressures, were assessed before and after each course of lessons. Healthy control subjects, matched for age, gender, height, and weight (group 2, ten subjects), without instruction, were tested over a similar interval. Group 1 showed significant increases in PEF (9 percent, $p<.05$), MVV (6 percent, $p<.05$), MIP (12 percent, $p<.02$), and MEP (9 percent, $p<.005$) (paired Student's *t* testing). Group 2 showed no significant changes. Possible mechanisms for the changes in group 1 include increased length and decreased resting tension of muscles of the torso, which in turn may increase their strength, increase thoracic compliance, and/or enhance coordination. We conclude that AT musculoskeletal education may enhance respiratory muscular function in normal adult subjects.

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AT = Alexander technique; FRC = functional residual capacity; MEP = maximal expiratory mouth pressure; MIP = maximal inspiratory mouth pressure; MVV = maximal voluntary ventilation; PEF = peak expiratory flow; PIF = peak inspiratory flow; RV = residual volume

Individual habitual patterns of musculoskeletal constriction are common after early childhood.[1-4] An educational method which teaches awareness and voluntary inhibition of these patterns is the Alexander technique.[3-5] In the past two decades, teachers of performing artists have been increasingly sending their students to the teachers of AT_2 in order to help resolve fatiguability-associated muscular tensions during performance.[6-8] Although photographic, electromyographic, and mechanical studies have shown enhanced muscular performance during AT-guided movements,[1,4,9] this approach to musculoskeletal problems currently, is not widely appreciated among physicians.

Because a subjective sense of increased ease of breathing has been described in healthy young adults as associated with instruction in the AT,[10] we assessed the effects on respiratory function of a course of AT instruction in a series of healthy adult subjects and compared the findings with those of a control group who did not undergo instruction.

Methods

We invited 15 certified teachers of the AT to recruit their private students as volunteers for study of possible effects of lessons on respiratory function. Entry criteria for the study included age >18 years, excellent general health, no history of respiratory disease, and ability to cooperate with testing.

Smoking, scoliotic, or obese (weight greater than 15 percent above ideal body weight) volunteers were not accepted. Wind instrumentalists were excluded from study because no change was noted in respiratory function after AT instruction in these subjects,[11] who were already "respiratory athletes." Swimmers and runners of more than ten miles per week, singers, and dancers were similarly excluded. Normal volunteers fulfilling the same criteria were recruited as control subjects. The study was approved by the institutional committee on human research. Informed consent was obtained from each subject.

Each volunteer underwent standard spirometric testing in the sitting position using a 13.5-L spirometer on each of two days approximately seven months (mean 6.8 ± 3.3 months) apart. The same time of day was used for each set of tests. Each test was performed by an experienced technologist blinded to the individual subject's membership in the experimental or control group. Women were not tested during menses or late in the luteal phase. The tests included FVC, FRC, RV, TLC, FEV_1, PEF, PIF, forced expiratory flow rates at quarterly percentiles of FVC, and 12-s MVV. The best value was selected for each of these tests from among a minimum of three reproducible efforts.[12]

Maximal static mouth pressures were measured by the technique of Black and Hyatt,[13] using an aneroid pressure gauge. The MIP was measured as the most negative pressure sustained for at least one second during a maximal inspiratory effort from residual volume. The MEP was measured as the most positive pressure sustained for at least 1 s during a maximal expiratory effort from TLC. For each of these tests, the value selected for analysis was the best of a minimum of five trials. The second and third best trials also were required to be no greater than 5 cm H_2O different from the best value. This process required a maximum of ten trials in this series.

Ten volunteer normal subjects (six men, four women, ages 23 to 48, mean 33 ± 7 years) comprised group 1. Mean height of the six men was 173.2 ± 8.9 cm. Mean height of the four women was

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FIGURE 1. Habitual patterns of lordotic ("slumped") posture are common (*left*).[1-4] Proprioceptive musculoskeletal education, as described by Alexander[5] and others[3,4] teaches voluntary elongated posture (*right*). (By permission, Alfred A. Knopf, Inc)

164.0±6.0 cm. Mean height of the ten subjects was 169.5±8.9 cm. Each subject completed a course of at least 20 private lessons in the AT and returned for follow-up testing (mean interval 6.8±4.6, range 2.7-18.4 months). Eight of the ten subjects in group 1 received lessons at approximately weekly intervals; two received lessons two or three times weekly. Two of the courses of lessons contained substantial time gaps without instruction because of scheduling problems. A total of eight teachers provided lessons for the ten subjects in group 1 (seven taught one subject each, one taught three subjects).

Ten volunteer normal control subjects (six men, four women, ages 23 to 51, mean 34±8 years) were each matched to individual group 1 subjects for gender, age (within five years), height (within 10 cm), and weight (within 7 kg), and comprised group 2. These subjects underwent no AT instruction and were tested at entry and after a mean interval of 6.8±1.5 months (range 5.1 to 10.1 months). The subjects in each group entered the study concurrently. None of the subjects engaged in any intertest program of muscular strengthening.

In each AT lesson (usual duration, 35 to 45 min), the teacher employed verbal, hands-on, and mirror instruction to develop the subject's proprioceptive awareness of personally contracted and elongated patterns of musculoskeletal positioning, especially of the spine (Fig 1).[3-5] While the subject performed ordinary muscular actions, such as rising from sitting to standing, the teacher demonstrated the subject's habitual contractions unrelated to the immediate act, *eg*, anterior thrusting of the neck or lumbar spine. Each lesson usually included placing the subject supine on a table (for 10 to 20 minutes) and the teacher elongating gently but firmly various articulations of the subject, specifically including spine, ribs, shoulders, and legs. When the teacher felt muscular resistance to passive motion, the teacher usually remarked on the presence of the resistance, a process which frequently led the subject to realize that previously unappreciated contraction not only had been present but was also capable of immediate release.[4-10] Exercise training is not part of the AT.

The teacher's touch also concentrated on the relative distances between anatomic points (*eg*, midthoracic and midlumbar spinous processes), as well as on palpable tensions in the fleshy portions of contracting muscles. The common pattern of shortening the anterior torso by slumping was especially noted and the student encouraged to lengthen the torso by balancing anterior vs posterior lengthening and right vs left side lengthening. Each lesson also addressed each subject's patterns of chronic contraction of the trapezii, rhomboids, pectorals, and extensor muscles of the cervical and lumbar spine. Flexible elongation of the neck was especially encouraged. The instruction encouraged both voluntary inhibition of rigid bodyholding and also awareness of the kinesthetic ease of balanced, flexible, and elongated articular use.

Statistical comparisons were made using the paired Student's *t*-test for intragroup comparisons and the unpaired Student's *t*-test for comparisons between groups 1 and 2. A probability value of <0.05 was considered statistically significant.

RESULTS

Table 1 summarizes the data. Group 1 (AT lesions) showed significant increases in PEF (9 percent), MVV (6 percent), and MIP (12 percent) and MEP (9 percent) (Fig 2) (paired Student's *t*-testing). No other test of respiratory function in group 1 showed significant change. Group 2 (control subjects) showed no significant changes; changes for the above four tests were 0, +1, +3, and −1 percent, respectively (paired Student's *t*-testing). Unpaired Student's *t*-testing showed no significantly different changes in respiratory function between groups 1 and 2.

DISCUSSION

The major finding of the present study is a strong association between a course of AT instruction in

Table 1—*Respiratory Function in Subjects With and Without a Course of Lessons in Proproprioceptive Musculoskeletal Education*

	AT Lessons (n = 10)				Control Subjects (n = 10)			
	Pre*	Post*	% Change	P†	Pre*	Post*	% Change	P†
FVC, L	4.47 (0.87)	4.56 (0.88)	2.0	0.16	4.22 (0.91)	4.19 (0.88)	−0.7	0.4
FEV_1, L	3.66 (0.68)	3.66 (0.70)	0	0.90	3.59 (0.80)	3.55 (0.79)	−1.1	0.9
PIF, L/s	4.68 (1.59)	5.33 (1.84)	13.9	0.13	5.70 (1.41)	6.02 (1.28)	5.7	0.4
PEF, L/s	8.47 (1.92)	9.22 (1.84)	8.8	0.029	9.42 (2.02)	9.46 (2.14)	0.4	0.8
MVV, L/min	150 (28)	159 (29)	5.6	0.034	155 (34)	156 (36)	0.6	0.9
MIP, cm H_2O	−102 (23)	−114 (27)	11.8	0.0195	−115 (23)	−119 (24)	3.4	0.3
MEP, cm H_2O	190 (48)	215 (59)	9.4	0.0045	196 (52)	194 (52)	−1.2	0.2

*Test values expressed as mean (SD).
†Paired Student's *t*-test.

healthy young and middle-aged adults and an increase in measures of respiratory muscular strength (MIP, MEP, PEF) and endurance (MVV).[13-16] Other than an uncontrolled pilot series of eight subjects,[17] no previous study, to our knowledge, has demonstrated quantitative improvement in respiratory function after an instructional course which emphasizes proprioceptive education and specifically does not include regular performance of respiratory exercises.[18]

A potential limitation of the present study is the "learning effect" (*ie*, a second test of respiratory function appears to improve compared to a first, as the subject becomes familiar with performance of the test).[14,19] However, no such effect was evident in group

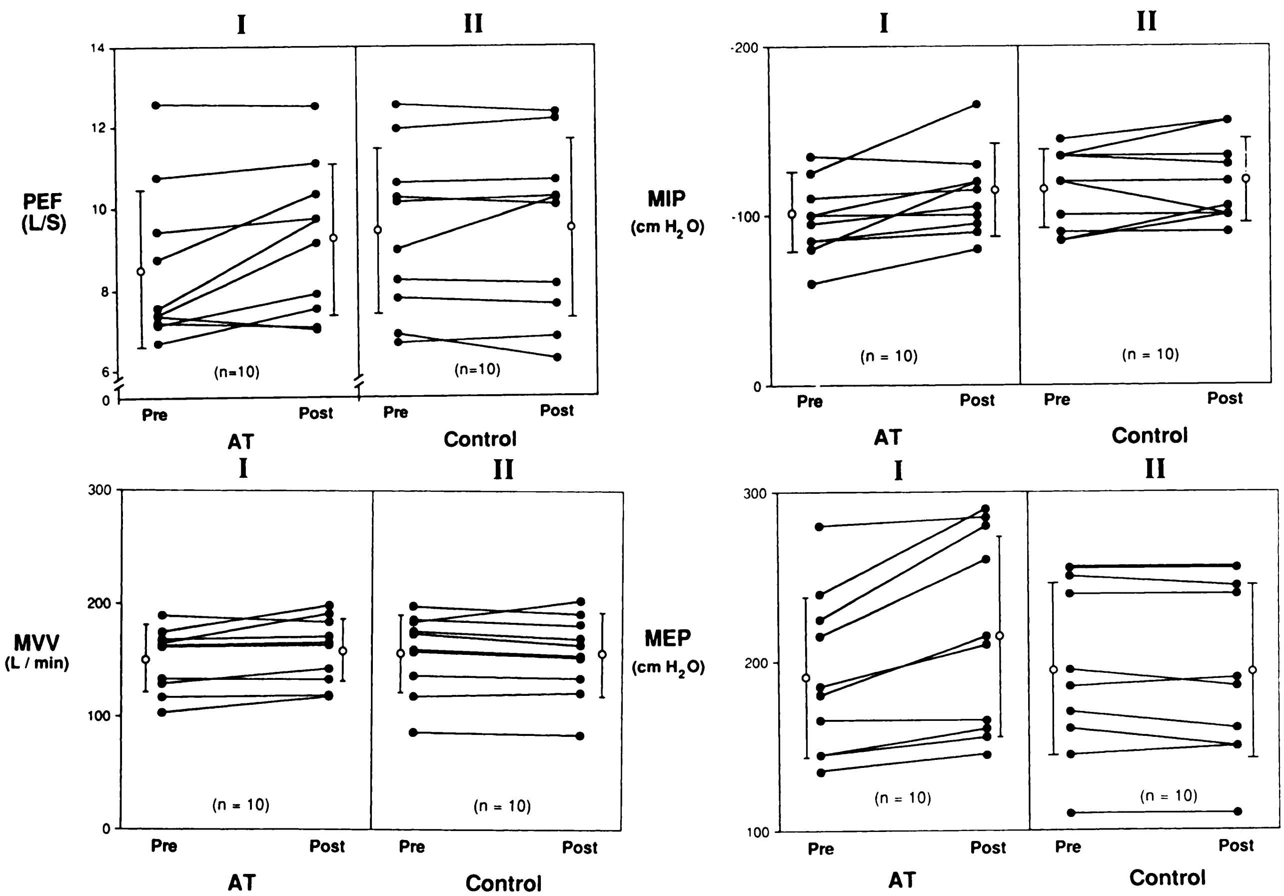

FIGURE 2. Results of respiratory muscle tests, mean ± SD and individual values, before and after a course of 20 lessons in proprioceptive musculoskeletal education (Alexander technique) in ten subjects (group 1). Ten control subjects (group 2) underwent no course of instruction. A *(upper left)*, PEF. Mean follow-up values increased significantly in group 1 ($p<0.05$, paired Student's *t*-test). B *(lower left)*, MVV. Mean follow-up values increased significantly in group 1 ($p<0.05$, paired Student's *t*-test). C *(upper right)*, MIP. Mean follow-up values increased significantly in group 1 ($p<0.02$, paired Student's *t*-test). D *(lower right)*, MEP. Mean follow-up values increased significantly in group 1 ($p<0.005$, paired Student's *t*-test).

2, whereas four tests in group 1 improved (Table 1). To our knowledge, a learning effect has not been reported for MVV. A slight learning effect over a short-term (few hours to five days) interval has been reported for maximal respiratory pressures,[13,14,20] although this was not confirmed in one recent study which did not state its intertest intervals.[21] No longer term study on MIP or MEP, to which our data could be compared, has been reported. The only test in the present study which suggests any tendency toward a possible learning effect for both groups 1 and 2 was PIF, for which each group showed a nonsignificant (group 1, $p=0.13$; group 2, $p=0.42$) increase of approximately 10 percent (Table 1). We conclude that a learning effect is unlikely to explain the differences between groups 1 and 2.

Another potential limitation of the present study is the placebo effect. Each subject in group 1 was aware that the study was assessing the hypothesis that AT instruction might improve respiratory function. However, we are unable to explain the specific results as changes which any subject anticipated. Support for the positive value of AT instruction also derives from the remarkable uniformity with which artistic performers, including singers and wind instrumentalists, describe AT instruction as directly aiding their ability to perform.[4,6-8,11]

A further potential limitation of the present study derives from the point of view of the AT: are 20 lessons sufficient to cause significant changes in habitual patterns of musculoskeletal use? Most AT teachers and students agree that 20 lessons, comparable to lessons in playing golf[5] or a musical instrument,[7,8,11] represent a satisfactory beginning, but altering habits of a lifetime is an enduring process which of necessity must extend beyond 20 lessons.[3-5] Most serious students of the AT undertake at least a one- to two-year course of instruction, comprising on the order of 40 to 100 lessons. A longitudinal study of the respiratory effects of lessons in the AT over a course of instruction greater than 20 lessons would be of interest.

Mechanisms to explain enhanced respiratory muscular function in the present study must necessarily be speculative, but four possible mechanisms can be considered as follow:

First, increased length of muscles of the torso: the AT strongly encourages voluntary inhibition of slumping patterns.[3-5,8] Habitual or prolonged cervical lordosis is common and can be unlearned by AT instruction.[1,3,4,7,9] Also, AT instruction has been shown to lengthen the rectus abdominis,[1] which is a deflationary muscle.[22] Insofar as AT instruction lengthens this muscle, it follows that increased force will be generated, due to its length-tension relationship.

Second, increased strength and/or endurance of muscles of the abdominal wall: the common habit of slumped posture, especially in the sitting position, not only shortens the major muscles of the anterior abdominal wall, it also minimizes their active use. By encouraging vertical elongation of the anterior abdomen and lumbar spine, the AT promotes active use of the abdominal and lumbar paraspinous muscles in ordinary daily activities. Thus, regular use of these new patterns for these muscles may increase their strength and tone. These considerations may explain the particularly strong association between AT instruction and improvements in expiratory muscle function.

Third, decreased resting tensions of chest wall muscles: rapid respiratory maneuvers in the upright position, as in the determination of maximal static mouth pressures, have been described as accomplished by "overwhelming dominance of rib cage motion."[23] Teachers of the AT report that over the course of a series of lessons, the student's thoracic muscles usually become palpably less tight, *ie*, their resting tensions are reduced.[4] This effect has been shown electromyographically for the sternocleidomastoid muscle during AT instruction.[4,9] Habitual thoracic muscular tensions may act as a muscular corset to restrict movements of the chest cage, analagous to an external thoracic corset in causing decreased thoracic compliance.[24] Abdominal posture also affects movement of ribs. Slumping restricts motion of the anterior ribs of the lower thorax. Arching the low back ("military posture") restricts motion of the posterior ribs of the lower thorax. Thus, lessons in the AT may decrease the resting tensions of thoracic muscles and increase the compliance of the thoracic cage.

Fourth, enhanced coordination of the respiratory muscles: learning new habitual patterns of increased length and decreased resting tension of various chest and abdominal muscles may decrease musculoskeletal interference in coordination of respiratory movements.[1,4,9,25,26] The AT emphasizes the subject's developing particular appreciation of head-neck elongation and poise.[3-7] The extraordinary density of muscle spindles in the neck[27] may favor improved coordination, insofar as AT instruction promotes enhanced cervical length, balance, and flexibility.[28]

In summary, the results show that a course of instruction in proprioceptive musculoskeletal education (AT), without exercises, was associated with increased PEF, MVV, MIP, and MEP in healthy adults. Possible clinical applications and clarification of mechanisms await future study.

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