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ORIGINAL CONTRIBUTION

Immediate Effects of Osteopathic Manipulative Treatment in Elderly Patients With Chronic Obstructive Pulmonary Disease

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Context: Osteopathic manipulative treatment (OMT) has long been advocated for patients with respiratory disorders, but little definitive evidence exists to support its use in this population.

Objective: To investigate the immediate effect of OMT on pulmonary function parameters in elderly subjects with chronic obstructive pulmonary disease.

Methods: Subjects aged 65 years or older with a forced expiratory volume in 1 second to forced vital capacity ratio of less than 70% were recruited and randomly assigned to receive either OMT or sham therapy. The OMT protocol consisted of seven standardized osteopathic manipulative techniques, while the sham therapy protocol comprised light touch applied to the same anatomic regions and for the same duration (20 min). All subjects received baseline and posttreatment pulmonary function testing. A telephone survey was conducted 1 day after the intervention to collect subjective feedback and assess the success of blinding protocols.

Results: Of the 35 study participants, 18 were randomly assigned to the OMT group and 17 to the sham group. Compared with the sham group, the OMT group showed a statistically significant decrease in the forced expiratory flow at 25% and 50% of vital capacity and at the midexpiratory phase; the expiratory reserve volume; and airway resistance. The OMT group also had a statistically significant increase in the residual volume, total lung capacity, and the ratio of those values compared with the sham group. Most subjects (82%, OMT group; 65%, sham group) reported breathing better after receiving their treatment. Only 53% of subjects in the OMT group and 41% in the sham group correctly guessed their group assignment.

Conclusion: Results suggest an overall worsening of air trapping during the 30 minutes immediately following one multitechnique OMT session relative to the sham group.

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Chronic obstructive pulmonary disease (COPD) is a syndrome of progressive airflow limitation caused by chronic inflammation of the airways and lung parenchyma.[1] Conventional management of COPD includes smoking cessation, pharmacologic therapy, long-term oxygen therapy, and pulmonary rehabilitation.[2] Bronchitis and emphysema have been shown to decrease compliance of the chest wall.[3] Likewise, with advancing age, chest wall compliance decreases, the force-generating capacity of the diaphragm diminishes, residual volume (RV) increases, and forced vital capacity (FVC) lessens.[4] Therefore, the chest wall and related structures are potential targets for therapeutic intervention. For example, respiratory muscle stretch gymnastics—stretching exercises designed to improve chest wall compliance—have been reported to improve chest wall mobility, improve vital capacity, and decrease dyspnea.[5]

The osteopathic medical profession has developed a variety of techniques for the specific purpose of improving pulmonary function.[6,7] These techniques are well described and target various aspects of the musculoskeletal, neuronal, and lymphatic components of the pulmonary system.[6-9] The efficacy of osteopathic manipulative treatment (OMT) is thought to be enhanced by using techniques in combination, where one technique works synergistically with another to achieve an overall therapeutic effect.[6] Such techniques are used for specific individual musculoskeletal structural findings and with the overall treatment dosed to fit the individual.

However, few clinical trials have tested the effects of OMT on pulmonary function. In one small clinical trial,[10] the thoracic lymphatic pump technique showed an improvement in FVC in hospitalized patients who had lower respiratory infection. However, in another study,[11] no change in pulmonary function parameters were reported among healthy medical students

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who received thoracic spinal manipulation. Likewise, subjects with mild COPD who were treated with OMT had no change in pulmonary function parameters.[12] In yet another study,[13] patients who received the thoracic lymphatic pump technique in the hospital after having a cholecystectomy had a more rapid improvement in FVC and forced expiratory volume in one second (FEV_1) than those who received conventional incentive spirometry. Among 17 subjects with COPD who were treated with OMT targeting the mobility of the thoracic cage during a 1-year period, illness severity, total lung capacity (TLC), and RV showed modest improvements.[14]

Despite these studies, the immediate effect of an OMT protocol on pulmonary function parameters in patients with COPD has—to our knowledge—never been reported. If OMT does cause measurable changes, then pulmonary function measures could be used to develop more effective manual treatment protocols and to better understand the underlying mechanisms of such therapies for respiratory disorders.

Therefore, we conducted a double-blind, randomized controlled clinical trial measuring the immediate effect of one OMT session on pulmonary function measures in elderly subjects with COPD. The primary objective of this study was to determine if a standardized OMT protocol could produce immediate changes in pulmonary function parameters in this population. We hypothesized that a single multitechnique OMT session would produce measurable changes in pulmonary function parameters while the light-touch sham control treatment would not. Our secondary hypotheses were that (1) the control strategy would at least partially blind participants, (2) the subjects would perceive the interventions as beneficial, and (3) the adverse effects would be minimal.

Methods

The study was conducted in an outpatient office setting and was a collaborative effort between the Department of Internal Medicine and the Department of Osteopathic Manipulative Medicine at the Kirksville (Mo) College of Osteopathic Medicine-A.T. Still University (KCOM-ATSU). Informed consent was obtained from each subject, and all procedures were approved by the institutional review board at KCOM-ATSU.

Potential subjects were identified by a known history of COPD and office pulmonary function screening. Subjects were eligible to participate if they were aged 65 years or older and had airflow obstruction (ie, FEV_1/FVC ratio $<70\%$). An elderly population was chosen for this study for sample convenience and because the increased chest wall stiffness associated with the aging process could result in a more responsive population.

Subjects were excluded if they had an unstable medical condition, acute bronchitis, pneumonia, or an exacerbation of COPD. Subjects were also excluded if they were unable to perform the pulmonary function testing because of cognitive or physical impairments, if they had received osteopathic or chiropractic manipulation in the 4 weeks before the study, or if they had thoracic spinal scoliosis greater than 25 degrees, substantial chest wall deformity, or acute rib or vertebral fracture.

Subjects were randomly assigned to either the OMT or sham protocol group using stratification by the severity of airflow obstruction. The following three strata were used for the randomization of subjects to ensure similar degrees of airway obstruction between study groups:

- mild (FEV_1 $<100\%$ and $\geq 60\%$)
- moderate to moderately severe (FEV_1 $<60\%$ and $\geq 50\%$)
- severe (FEV_1 $<50\%$)

All subjects had baseline pulmonary function testing (spirometry, lung volume by plethysmography, and airway resistance), one protocol intervention (administered by D.R.N. or B.F.D.), and follow-up testing completed within 30 minutes of the protocol treatment. All subjects continued their medications for COPD the day of their participation in the study but not between testing sessions.

Certified respiratory therapists who conducted the pulmonary function tests were blinded to group assignment and used the American Thoracic Society criteria for test reproducibility.[15] The spirometry, lung volumes, and airway resistance were all measured using a MedGraphics 1085 Series apparatus (Medical Graphics, St Paul, Minn). The 21 pulmonary function parameters measured are listed in the tables that appear in the "Results" section.

Osteopathic Manipulative Treatment Protocol

The OMT group received treatment of specific somatic dysfunction found during a structural examination, if applicable, followed by seven standardized osteopathic manipulative techniques commonly used for respiratory disorders. The duration of the entire OMT protocol session was approximately 20 minutes for each subject. For treating specific somatic dysfunction, the operator used indirect myofascial release; high-velocity, low-amplitude; or muscle-energy techniques. The seven standardized techniques as used in the present study are briefly described in *Figure 1* and are defined elsewhere in greater detail.[8,16] The subjects were in a supine position for all osteopathic manipulative techniques.

Sham Therapy Protocol

The total duration of the sham protocol was also approximately 20 minutes, with light touch applied to the same anatomic regions as in the OMT group. Sham group subjects received a structural examination but no treatment of specific somatic dysfunction. Subjects were in a supine position for the standardized portion of the sham protocol session. The operator lightly placed his hands on the rib cage in a systematic and deliberate manner and palpated for preferred rib motion and observation of respiratory motion.

Next, the operator placed his hands under the subject and lightly palpated the paraspinal muscles, observing seg-

■ **Soft Tissue**
□ Operator kneaded (massaged) the subject's paraspinal muscles.

■ **Rib Raising**
□ Operator stood or sat at the subject's side and placed his hands under the subject's thorax, contacting the rib angles with the pads of the fingers. With his fingers flexed, the operator applied traction to the rib angle. While maintaining traction, the operator used his arm as a fulcrum with the wrists straight to raise the subject's rib angle anteriorly (upward). This motion was repeated several times until improved rib function was obtained.

■ **"Redoming" the Abdominal Diaphragm (Indirect Myofascial Release)**
□ One of the operator's hands was placed under the subject where the diaphragmatic muscles attach to the lower ribs and vertebrae (thoracolumbar junction). The other hand was placed on the abdominal epigastric area. The operator rotated his hands in opposite directions to determine the direction of greatest freedom of movement. Then, tissues were moved in the direction of greatest freedom to a point of "balance" and held there until a release of tissue tension or restriction was palpated.

■ **Suboccipital Decompression**
□ The operator stood or sat at the head of the table. The tips of the fingers were placed on the occipital condyles at the base of the head. Outward and cephalad traction was applied to decompress the occipital joint.

■ **Thoracic Inlet Myofascial Release**
□ The operator sat or stood at the head of the table and placed his hands over the thoracic inlet, thumbs posteriorly over the angle of the first ribs and fingers anteriorly over the clavicle. Passive motion testing determined the direction in which the tissues moved most freely, and then those tissues were held in that position until a relaxation or "release" of the tissues was palpated. If still restricted, the tissues were taken in the direction of least motion to relieve the restriction.

■ **Pectoral Traction**
□ The operator stood at the head of the table. The inferior border of the pectoralis muscle was grasped and cephalad traction applied, aided by respiration. Gentle traction was maintained until release of upper respiratory muscle tension was palpated.

■ **Thoracic Lymphatic Pump With Activation**
□ Operator's hands were placed on the thoracic wall with the thenar eminence of each hand over the pectoralis muscles just below the clavicle; fingers were spread and angled toward the sides of the subject's body. The subject took a deep breath in and then exhaled. During exhalation, the operator induced rhythmic pumping action by alternating pressure on the chest wall. At the end of exhalation, some pressure was maintained on the chest wall, and the subject was told to take another deep breath. This procedure was repeated several times, each time building more pressure on the thoracic wall. On the fourth or fifth inhalation and during the first one-third of the inhalation, the hands were quickly removed from the chest wall, creating a sudden increase in negative intrathoracic pressure and causing air to rush into the subject's lungs. This cycle was repeated three times in the study protocol.

Figure 1. *The seven standardized osteopathic manipulative techniques used during each osteopathic manipulative treatment protocol session, which lasted approximately 20 minutes. Subjects were in a supine position for all manual intervention protocols, which are described in greater detail elsewhere.*[8,16]

mental restrictions but not engaging the tissues for myofascial release. The operator slowly worked his way up the thoracic spine in a manner similar to that done for the rib-raising technique, taking care not to articulate the ribs.

Next, one hand was lightly placed posterior on the thoracic-lumbar junction and the other in the epigastric region in the same position and duration as for the redoming of the abdominal diaphragm technique. Tissue direction preference was tested, but no myofascial release was attempted.

Then, light touch to the skin only was applied to the cervical spine, followed by lightly placing the hands on the thoracic inlet. Light motion testing was used for tissue direction preference but without using myofascial release.

Finally, the subject was moved to a lateral recumbent position, and very light open-handed "clopping" with no postural drainage was systematically administered to the thoracic rib cage.

Survey and Statistical Analysis

A nonvalidated survey was used to collect information on blinding success, subjective perceptions of the intervention used, and adverse effects. This questionnaire was conducted over the telephone 1 day postintervention, and survey administrators were blinded to each subject's group assignment.

The study groups were compared on demographic and pretreatment measures using the χ^2 (chi-square) and Mann-Whitney *U* tests to determine the adequacy of the randomization. The two groups were compared on each of the follow-up pulmonary function measurements using nonparametric analysis of covariance (ANCOVA). The covariate for each of these tests was the corresponding pretreatment measurement. The OMT and sham groups were compared on the percent change from baseline pulmonary function levels using the Mann-Whitney *U* test. To compare the study groups on the results of the poststudy survey, the chi-square test was used.

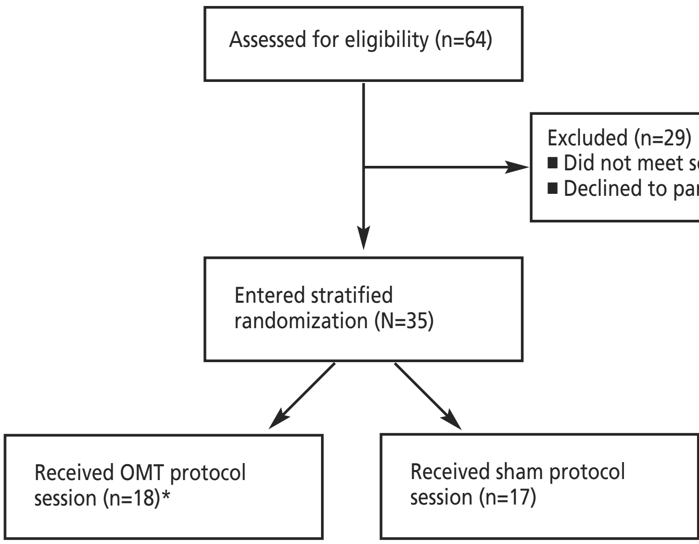

Figure 2. *Flowchart overview of subject enrollment and group assignment. The protocol session for both the osteopathic manipulative treatment (OMT) and sham therapy groups included measurement of pre- and post-treatment pulmonary function parameters. *Subjects in both study groups were surveyed 1 day posttreatment; however, 1 subject in the OMT group was lost to survey follow-up and therefore was not included in the analysis of survey responses.*

Results were considered statistically significant at $P \leq .05$.

Results

Sixty-four potential subjects were assessed for eligibility in the study (*Figure 2*). Twenty-eight were excluded because they did not meet inclusion criteria. One subject met criteria but declined to participate. Of the 35 subjects entered in the study, 18 were randomized to the OMT group and 17 to the sham group. All 35 subjects completed the treatment protocol; however, 1 subject in the OMT group could not be reached for survey completion. Thus, all subjects were included in the treatment analyses, but only 17 of the OMT subjects were included in the survey analysis.

The mean (SD) age for the treatment group was 69.6 (6.6) years and for the sham group, 72.2 (7.1) years. All subjects were white. Other characteristics are summarized in *Table 1*. Three subjects in the OMT group and 1 in the sham group were active cigarette smokers. There was no statistically significant difference between study groups for use of home oxygen, inhaled or nebulized bronchodilators, inhaled or nebulized ipratropium bromide, inhaled or oral steroids, or theophylline. There was no statistically significant difference between study groups for a past medical history of congestive heart failure, coronary artery disease, diabetes mellitus, or thromboembolic stroke. In addition, 15 subjects in the OMT group and 10 in the sham group reported previous experience with OMT. Twelve subjects in each study group reported previous experience with chiropractic manipulation. Only 3 subjects in the OMT group and 2 in the sham group reported ever having received manual therapy for a respiratory problem. Thirteen subjects in the OMT group and 14 in the sham group reported receiving manual treatment less than once per year.

The mean absolute pulmonary function parameters pre- and posttreatment are shown in *Table 2*. Nonparametric ANCOVA showed statistically significant differences between the study groups for eight of the 21 pulmonary function parameters. Of these eight parameters, the forced expiratory flow after 25% and 50% of the FVC had been exhaled ($FEF_{25\%}$, $FEF_{50\%}$), FEF at the midexpiratory phase ($FEF_{25\%\text{-}75\%}$), and expiratory reserve volume (ERV) were significantly lower in the OMT group compared with the sham group. Corresponding to the lower expiratory flow volumes was a general increase in lung volume parameters in the OMT group relative to the sham group (differences in RV and TLC were statistically significant). The RV/TLC ratio increased in the OMT group compared with the sham group. Airway resistance decreased in the OMT group compared with the sham group.

Table 3 displays the mean pre- and posttreatment percent predicted values for each study group. Nonparametric ANCOVA found that the OMT group had a statistically significant decrease in both $FEF_{50\%}$ and $FEF_{25\%\text{-}75\%}$ relative to the sham group. Likewise, the OMT group showed a relative posttreatment increase in both the mean RV and TLC.

The results of the percent change from baseline to posttreatment in the pulmonary function parameters for the OMT group were compared with those of the sham group (*Table 4*). Six of the 21 measured parameters showed statistically significant changes in the OMT group relative to the sham control group. The mean $FEF_{50\%}$ and $FEF_{25\%\text{-}75\%}$ decreased while the inspiratory capacity (IC), RV, TLC, and the RV/TLC ratio increased.

The results from the telephone survey conducted the day after the subject's treatment session are presented in *Table 5*. As previously indicated, 1 subject in the OMT group was lost to survey follow-up. Chi-square analysis showed no statistically significant difference between study groups for any of the questions. Only 9 subjects (53%) in the OMT group and 7 (41%) in the sham group correctly guessed their group assign-

Table 1
Chronic Obstructive Pulmonary Disease: Characteristics of Study Subjects* (N=35)

	No. (%)	
Characteristic	OMT Group (n=18)	Sham Group (n=17)
■ **Sex**		
□ Men	8 (44)	10 (59)
□ Women	10 (56)	7 (41)
■ **Current Cigarette Smoker**	3 (17)	1 (6)
■ **Current Home Oxygen Use**	10 (56)	10 (59)
■ **Current Drug Therapies**		
□ Bronchodilators		
– Inhaled	13 (72)	10 (59)
– Nebulized	9 (50)	9 (53)
□ Ipratropium bromide		
– Inhaled	7 (39)	9 (53)
– Nebulized	6 (33)	4 (24)
□ Steroids		
– Inhaled	10 (59)	8 (47)
– Oral	3 (17)	2 (13)
□ Theophylline	4 (22)	2 (12)
■ **Patient History**		
□ Congestive heart failure	3 (17)	2 (12)
□ Coronary artery disease	5 (28)	4 (24)
□ Diabetes mellitus	3 (17)	2 (12)
□ Thromboembolic stroke	2 (11)	0

* The mean (SD) age of subjects in the osteopathic manipulative treatment (OMT) group was 69.6 (6.6) years. In the sham therapy group, the mean age was 72.2 (7.1) years. All subjects were white.
† Inhaled steroid use and patient history of thromboembolic stroke were unknown for 1 patient in the OMT group. For these values, percentages were calculated with n=17.
‡ Oral steroid use was unknown for 1 patient in the control group. For this value, the percentage was calculated with n=16.

ment. Most subjects in both study groups thought their health benefited from receiving manual treatment and reported subjective improvement in their breathing.

The phone survey yielded two instances of possible adverse effects occurring in the approximate 24-hour period after the treatment session in the OMT group. One subject reported generalized muscle soreness, and another reported "a little muscle soreness in the neck." The sham group reported four instances of possible adverse effect: "elevated blood pressure in the morning" (164/90 mm Hg), "mild heart palpitations," "a little [muscle] soreness," and "back was a little sore." None of the reported side effects in either study group were judged to be severe. Most subjects in both study groups said they enjoyed receiving the treatment and would recommend the treatments to others.

Comment

The results of the present study support our primary hypothesis that a single multitechnique OMT session produces measurable changes in pulmonary function parameters. However, the overall pattern suggests a worsening of airway obstruction rather than an improvement.

Certainly, an increase in RV in a patient with COPD—a disease characterized by air trapping and an already-elevated RV—is not a desirable change. Although some changes can be interpreted as beneficial, such as the increase in IC, the increase in RV is greater as evidenced by the increase in the RV/TLC ratio.

We speculate that the "activation" component of the thoracic lymphatic pump technique used in the protocol was primarily responsible for the increase in RV because the activation portion of the technique promotes a sudden rush of air into the lungs. This air rush may not be fully exhaled in the context of airway resistance. Modifying the technique to avoid activation may eliminate the problem of increased RV. In addition, the decrease in airway resistance more likely reflects the overall increase in lung volume than diminished bronchoconstriction. In other words, as lung volume increases, airways widen and the resistance lessens.[17]

Several limitations should be considered when interpreting the results of the present study. The protocol used to treat subjects in the OMT group comprised multiple techniques; therefore, it is impossible to know the contribution of each individual technique to the final outcome. For example, a technique with a beneficial effect may have been canceled out by one with an adverse effect. Likewise, as described in a 1980 study,[18] too many techniques or too long of a treatment duration may result in an overdose of OMT. In addition, though some pulmonary function parameters worsened 30 minutes posttreatment, the long-term effects were not explored. Future studies should examine the effect of individual techniques on the pulmonary system. Such techniques and protocols could then be fine-tuned for better efficacy.

One study[19] that reviewed adverse events associated with OMT observed that virtually all reports in the literature have focused on catastrophic events and noted the distinct absence of reports describing mild to moderate adverse effects. It was speculated that mild and moderate adverse effects do occur but are grossly underreported.[19] However, it is important for studies of manual therapies to report potential adverse effects so that a better understanding of the tolerability and safety

Table 2
Chronic Obstructive Pulmonary Disease:
Mean (SD) Pulmonary Function Parameters for the OMT and Sham Therapy Groups (N=35)

Pulmonary Function Parameter	OMT Group (n=18)		Sham Group (n=17)		*P* Value*
	Pretreatment	Posttreatment	Pretreatment	Posttreatment	
FEV_1, L	1.22 (0.65)	1.18 (0.62)	1.26 (0.57)	1.28 (0.63)	.06
FVC, L	2.50 (0.94)	2.36 (0.93)	2.71 (0.87)	2.66 (0.92)	.14
FEV_1/FVC, %	47.72 (13.23)	48.89 (12.88)	46.41 (13.05)	45.88 (16.66)	.83
$FEF_{25\%}$, L/sec	1.53 (1.09)	1.34 (0.91)	1.51 (1.09)	1.52 (1.13)	.04†
$FEF_{50\%}$, L/sec	0.66 (0.45)	0.59 (0.43)	0.60 (0.42)	0.65 (0.53)	.008†
$FEF_{75\%}$, L/sec	0.25 (0.22)	0.19 (0.14)	0.21 (0.13)	0.22 (0.15)	.23
$FEF_{25\%-75\%}$, L/sec	0.50 (0.33)	0.43 (0.31)	0.50 (0.34)	0.55 (0.43)	.02†
FEF_{Max}, L/sec	3.84 (1.62)	3.56 (1.75)	4.25 (1.58)	4.15 (1.95)	.72
FIVC, L	2.30 (0.79)	2.11 (0.78)	2.42 (0.79)	2.32 (0.69)	.18
$FIF_{50\%}$, L/sec	2.51 (0.96)	2.30 (0.89)	2.90 (1.23)	2.68 (1.14)	.46
FIF_{Max}, L/sec	2.61 (0.96)	2.48 (0.93)	3.06 (1.24)	2.84 (1.19)	.92
ERV, L	0.81 (0.54)	0.60 (0.43)	0.72 (0.47)	0.86 (0.44)	.02†
IC, L	1.57 (0.66)	1.62 (0.70)	1.88 (0.58)	1.63 (0.61)	.12
MVV, L/min	48.06 (25.74)	43.89 (23.64)	45.59 (17.17)	43.65 (19.07)	.27
SVC, L	2.38 (0.89)	2.22 (0.83)	2.60 (0.81)	2.50 (0.73)	.39
TGV, L	5.18 (1.97)	5.63 (3.03)	5.74 (1.79)	5.70 (2.01)	.53
RV, L	4.37 (2.09)	5.02 (3.06)	5.03 (1.68)	4.84 (1.84)	.003†
TLC, L	6.75 (2.02)	7.25 (2.91)	7.62 (2.01)	7.34 (1.98)	.02†
RV/TLC, %	63.0 (14.1)	66.2 (14.8)	65.3 (9.6)	64.8 (10.5)	.04†
Airway resistance (cm H_2O/L/s)	6.83 (6.94)	6.15 (5.22)	5.75 (3.41)	7.71 (6.09)	.04†
Airway conductance (L/s/cm H_2O)	0.25 (0.16)	0.27 (0.23)	0.27 (0.18)	0.25 (0.22)	.41

* Statistical significance was tested using the nonparametric analysis of covariance. The pretreatment value was the covariate.
† Statistically significant difference in the study groups between pre- and posttreatment ($P \leqslant .05$).

Abbreviations: ERV: expiratory reserve volume; $FEF_{25\%}$, $FEF_{50\%}$, $FEF_{75\%}$, FEF_{Max}: forced expiratory flow at 25%, 50%, 75%, and maximum of vital capacity; FEV_1: forced expiratory volume in 1 second; $FIF_{50\%}$, FIF_{Max}: forced inspiratory volume at 50% and maximum of vital capacity; FIVC: forced inspiratory vital capacity; FVC: forced vital capacity; IC: inspiratory capacity; MVV: maximum voluntary ventilation; OMT: osteopathic manipulative treatment; RV: residual volume; SVC: slow vital capacity; TGV: total gas volume; TLC: total lung capacity.

of these modalities can be developed. The present study reports several instances of mild to moderate posttreatment muscle soreness, which may have been caused by the manipulation protocol. Although the reported instance of muscle soreness was similar in both study groups, the small size of the study limits what conclusions can be drawn.

The sham protocol was successful for introducing a measure of uncertainty regarding group assignment. Only 53% of the subjects in the OMT group and 41% in the sham group correctly guessed their group assignment. Although most subjects had prior experience with manipulative treatments, few had prior experience with OMT for a respiratory problem. Most of the techniques used in the study protocol differ substantially from those used to treat patients with other conditions, such as back pain. This lack of familiarity with the protocol treatment may account for the success of the sham protocol in subject blinding. Sham protocols may also be more effective at blinding subjects than is commonly thought.

Other studies of manipulative therapies have reported similar success at blinding subjects.[20,21] A study of chiropractic manipulation for childhood asthma, which used a simulated treatment protocol for their control group, reported that 63% of the subjects were uncertain about group assignment.[20] In a small study of OMT used to boost the efficacy of the influenza vaccine, a poststudy survey found that 43% of nursing home residents in the experimental group correctly guessed they had received OMT; the same percentage of the sham group incorrectly guessed they had received OMT; and the rest reported being uncertain. No one reported that they believed they had received sham treatment.[21]

The conclusions of the present study are somewhat limited to the elderly population studied. However, because the majority of patients with COPD are older than 65 years,[1,2] our findings are still applicable to the general COPD population. While the survey provides subjective information, it is not a validated assessment tool specific for COPD and so should be interpreted with some caution. Another limitation is that the long-term effects of OMT remain poorly defined. It is pos-

Table 3
Chronic Obstructive Pulmonary Disease:
Mean (SD) Percent Predicted Value of Pulmonary Function Parameters for the OMT and Sham Therapy Groups (N=35)

Pulmonary Function Parameter	OMT Group (n=18)		Sham Group (n=17)		*P* Value*
	Pretreatment	Posttreatment	Pretreatment	Posttreatment	
FEV_1	45 (23)	44 (22)	46 (20)	46 (22)	.12
FVC	73 (23)	69 (23)	77 (20)	75 (21)	.11
$FEF_{25\%}$	26 (18)	23 (15)	26 (19)	25 (20)	.06
$FEF_{50\%}$	17 (12)	16 (11)	16 (11)	17 (14)	.03†
$FEF_{75\%}$	24 (21)	17 (12)	20 (13)	21 (15)	.15
$FEF_{25\%-75\%}$	18 (11)	16 (10)	18 (12)	20 (15)	.04†
FEF_{Max}	63 (25)	57 (23)	66 (26)	64 (30)	.50
$FIF_{50\%}$	70 (30)	63 (24)	74 (32)	69 (30)	.52
ERV	85 (49)	68 (46)	70 (36)	82 (30)	.13
IC	58 (18)	59 (19)	66 (18)	58 (21)	.10
MVV	47 (24)	42 (22)	43 (17)	41 (18)	.30
SVC	65 (18)	61 (18)	67 (16)	64 (12)	.57
TGV	158 (57)	172 (87)	168 (44)	167 (48)	.39
RV	190 (88)	218 (127)	212 (67)	204 (74)	.004†
TLC	114 (28)	124 (46)	122 (22)	117 (21)	.01†
Airway resistance	394 (365)	357 (275)	361 (215)	482 (387)	.06
Airway conductance	24 (16)	26 (23)	26 (18)	24 (22)	.25

* Statistical significance was tested using the nonparametric analysis of covariance. The pretreatment value was the covariate.
† Statistically significant difference in the percent predicted values for the study groups between pre- and posttreatment ($P \leqslant .05$).

Abbreviations: ERV: expiratory reserve volume; $FEF_{25\%}$, $FEF_{50\%}$, $FEF_{75\%}$, FEF_{Max}: forced expiratory flow at 25%, 50%, 75%, and maximum of vital capacity; FEV_1: forced expiratory volume in 1 second; $FIF_{50\%}$: forced inspiratory volume at 50% of vital capacity; FVC: forced vital capacity; IC: inspiratory capacity; MVV: maximum voluntary ventilation; OMT: osteopathic manipulative treatment; RV: residual volume; SVC: slow vital capacity; TGV: total gas volume; TLC: total lung capacity.

sible that after an initial worsening, the pulmonary function parameters improved, thus accounting for the subjective improvement reported in the survey the day after treatment. A placebo effect is another explanation for reported improvements because they were recorded in both groups, and the differences between the groups were not statistically significant.

For OMT to be established as a useful modality for COPD, it will need to demonstrate beneficial and clinically relevant changes in pulmonary function that last longer than 30 minutes. If future studies confirm the results of the present study, then OMT may become contraindicated in COPD. Because there is such a great diversity in manual therapeutics, more research into different protocols and techniques are needed before firm conclusions can be drawn. However, it cannot be assumed that OMT is harmless. Just as it has been shown that percussive and vibratory chest physiotherapy can acutely worsen bronchoconstriction in patients with chronic bronchitis, providing mixed clinical benefits,[22,23] OMT may be limited by similar concerns.

Conclusion

Pulmonary function testing can be used to evaluate the effects of one multitechnique OMT session on the respiratory system. However, the results suggest an overall worsening of air trapping during the 30 minutes immediately after one multitechnique OMT session relative to a sham control group. Future studies should evaluate the effects of individual techniques on the respiratory system because each individual technique may have separate beneficial or harmful effects. Some caution should be used when using OMT in elderly patients with COPD, especially the protocol used in the present study, because pulmonary function may worsen initially after treatment.

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(continued)

Table 4
Chronic Obstructive Pulmonary Disease: Mean (SD) Percent Change From Baseline Pulmonary Function Parameters in Subjects Who Received OMT or Sham Therapy Protocol Intervention (N=35)

Pulmonary Function Parameter	OMT Group (n=18)	Sham Group (n=17)	*P* Value*
FEV_1	−2.3 (8.4)	−0.2 (9.2)	.18
FVC	−5.5 (7.3)	−2.9 (8.9)	.16
FEV_1/FVC	3.4 (8.8)	−2.6 (23.8)	.77
$FEF_{25\%}$	−8.3 (18.2)	1.3 (26.2)	.17
$FEF_{50\%}$	−10.5 (16.8)	6.3 (27.6)	.02†
$FEF_{75\%}$	−15.5 (37.1)	−0.5 (25.2)	.16
$FEF_{25\%-75\%}$	−12.0 (20.6)	3.2 (23.5)	.04†
FEF_{Max}	−8.3 (13.9)	−5.4 (15.2)	.53
FIVC	−8.0 (12.3)	−2.0 (25.0)	.31
$FIF_{50\%}$	−5.1 (28.1)	−1.9 (34.7)	.99
FIF_{Max}	−1.5 (28.4)	−3.3 (27.0)	.77
ERV	−3.9 (85.8)	93.5 (187.2)	.07
IC	5.6 (23.0)	−13.1 (21.2)	.01†
MVV	−9.1 (10.2)	−5.6 (10.7)	.30
SVC	−5.2 (12.1)	−2.5 (10.9)	.37
TGV	5.6 (17.7)	0.3 (15.7)	.97
RV	11.8 (18.6)	−2.7 (15.4)	.01†
TLC	5.9 (13.5)	−2.8 (11.5)	.03†
RV/TLC	5.2 (6.9)	−0.7 (7.6)	.05†
Airway resistance	−0.1 (34.8)	31.8 (65.1)	.25
Airway conductance	9.0 (35.5)	−10.9 (30.8)	.28

* Statistically significant change in the osteopathic manipulative treatment group (OMT) relative to the sham group ($P \leqslant .05$).
† Differences were tested for statistical significance using the Mann-Whitney *U* test.

Abbreviations: ERV: expiratory reserve volume; $FEF_{25\%}$, $FEF_{50\%}$, $FEF_{75\%}$, FEF_{Max}: forced expiratory flow at 25%, 50%, 75%, and maximum of vital capacity; FEV_1: forced expiratory volume in 1 second; $FIF_{50\%}$: forced inspiratory volume at 50% of vital capacity; FVC: forced vital capacity; IC: inspiratory capacity; MVV: maximum voluntary ventilation; RV: residual volume; SVC: slow vital capacity; TGV: total gas volume; TLC: total lung capacity.

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Table 5
Chronic Obstructive Pulmonary Disease:
No. (%) Subject Responses to the Posttreatment Telephone Survey

	OMT Group (n=17)*			Sham Group (n=17)		
Question	**Yes**	**No**	**Uncertain**	**Yes**	**No**	**Uncertain**
■ Did your health benefit from receiving the manipulation treatment?	12 (71)	3 (18)	2 (12)	10 (59)	4 (24)	3 (18)
■ Do you feel that you breathed better after receiving the manipulation treatment?	14 (82)	3 (18)	0	11 (65)	5 (29)	1 (6)
■ Did you have any adverse side effects from the treatment?†	2 (12)	15 (88)	0	4 (24)	13 (77)	0
■ Did you enjoy receiving the manipulation treatments?	16 (94)	1 (6)	0	14 (82)	1 (6)	2 (12)
■ Would you recommend the treatments you received to others?	15 (88)	1 (6)	1 (6)	12 (71)	4 (24)	1 (6)

* One subject from the osteopathic manipulative treament (OMT) group was lost to survey follow-up.
† The reported adverse effects in the OMT group were "generalized muscle soreness" and "a little muscle soreness in the neck." Adverse effects noted by the sham therapy group were "elevated blood pressure in the morning," "mild heart palpitations," "a little [muscle] soreness," and "back was a little sore."

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