

Osteopathic Manipulative Treatment for Inpatients With Pulmonary Exacerbations of Cystic Fibrosis: Effects on Spirometry Findings and Patient Assessments of Breathing, Anxiety, and Pain

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Context: Osteopathic manipulative treatment (OMT) has been studied in patients with various respiratory diseases. However, to the authors' knowledge, no studies have assessed the efficacy of OMT in patients with cystic fibrosis (CF).

Objective: To evaluate pulmonary function and perceptions of breathing, anxiety, and pain of CF patients who receive OMT in addition to standard inpatient management of pulmonary exacerbation.

Methods: In a single-blind randomized controlled trial, we assessed adult patients with a history of CF who were admitted to the hospital because of pulmonary exacerbation. Participants were randomly assigned to receive a daily standardized protocol of OMT or sham therapy. Both groups also received standard treatment for CF. Spirometry and questionnaire data (self-assessment of breathing, pain, and anxiety level) were collected before the first OMT or sham therapy session and after the final session.

Results: A total of 33 patients were included in the study: 16 in the OMT group and 17 in the sham therapy group. Improvements in spirometric parameters were observed in both the OMT and the sham therapy groups, with no statistically significant differences found between the groups. More patients in the OMT group than in the sham therapy group had questionnaire response patterns that indicated their breathing had improved during the study period (15 of 16 vs 8 of 16, respectively). No differences were found between groups for perceived improvement of pain and anxiety.

Conclusion: In the current study, CF patients who received OMT did not demonstrate statistically significant differences in pre- and posttreatment spirometry findings compared with CF patients who received sham therapy. Questionnaire findings suggest that OMT may affect CF patients' perception of overall quality of breathing. Additional studies are needed to assess the clinical use of OMT in patients with CF.

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Cystic fibrosis (CF) is a multisystem disease of the gastrointestinal, pulmonary, and endocrine systems that affects approximately 30,000 children and adults in the United States.¹ The airways of CF patients are characterized by thick mucus secretions, chronic inflammatory responses, and poor ciliary function.² One study³ estimated the annual, direct medical cost per patient for CF at \$40,000. Management of acute pulmonary symptoms, which often requires hospitalization, is a large component of these costs. Pulmonary exacerbations are characterized by myriad signs and symptoms that may include increased cough, sputum, dyspnea, and decreased forced expiratory volume in the first second of expiration (FEV_1).² Management of exacerbations includes antibiotics tailored to sputum culture findings and aggressive pulmonary clearance.

The theoretical applications of osteopathic manipulative treatment (OMT) in the pulmonary system have been well described,⁴ but to our knowledge OMT has not been studied as treatment for patients with CF. Studies investigating the use of OMT in other pulmonary diseases, such as chronic obstructive pulmonary disease (COPD), pneumonia, and asthma, have been published, with varying results. For example, a study⁵ published in 2008 revealed that an OMT protocol led to a decrease in forced expiratory flow at 25% to 75% of vital capacity effort ($FEF_{25\%-75\%}$), expiratory reserve volume, and airway resistance in a group of 35 elderly patients with COPD. The authors also found an increase in residual volume and total lung capacity in the treatment group, suggesting air trapping. Another study⁶ of 20 patients with severe, stable COPD demonstrated improved exercise capacity (measured using a 6-minute walking test) in patients who received OMT compared with that of patients who received standard pulmonary rehabilitation only. Noll et al⁷ reported shorter duration of intravenous antibiotics and hospital stays among elderly patients hospitalized with pneumonia who received OMT ($n=28$) compared with those who received sham therapy ($n=30$). The Multicenter Osteopathic Pneumonia Study

in the Elderly⁸ revealed shorter duration of intravenous antibiotics, shorter length of stay, and fewer deaths and respiratory failures in patients who received OMT compared with those who received conventional inpatient treatment only. Finally, a recent systematic review⁹ of the literature revealed that there was a lack of rigorous, well-designed reported trials on OMT for pediatric conditions (including asthma, bronchiolitis, and sleep apnea).

Given this lack of research, we sought to evaluate whether OMT would be beneficial in patients with CF. In the present study, we evaluated the effect of OMT in patients with CF who were admitted to the hospital for pulmonary exacerbations. We hypothesized that OMT combined with standard therapy would be more effective than standard therapy alone in improving the pulmonary function and patient perceptions of breathing in CF inpatients with pulmonary exacerbations.

Methods

Participants

The present single-blind randomized controlled trial was conducted at Nationwide Children's Hospital in Columbus, Ohio. Included in the study were patients aged 18 to 50 years admitted to the hospital with a primary diagnosis of pulmonary exacerbation of CF from August 2009 to February 2011. Other inclusion criteria included FEV_1 greater than or equal to 30% predicted determined with spirometry performed within 24 hours of admission and the presence of symptoms of exacerbation. Enrollment in the study was initiated within 24 to 48 hours of admission to the hospital. Exclusion criteria were substantial (>5 mL) hemoptysis at the time of admission, diagnosis of allergic bronchopulmonary aspergillosis, severe pulmonary disease (defined as $FEV_1 < 30\%$ predicted), baseline oxygen requirement or persisting requirement 24 hours after admission, pediatric intensive care unit admission, intubation during the current hospitalization, and severe spinal or musculoskeletal deformity or injury. Informed consent was obtained from patients before they were enrolled in

the study. Approval for the study was obtained by the Nationwide Children's Hospital institutional review board (approval number IRB08-00331).

Procedures

At enrollment, participants were randomly assigned to an OMT group or a sham therapy group using a random numbers generator. Assignments were clustered in blocks of 10 to ensure even distribution between the 2 groups over time. Demographic data including sex, age, and ethnicity were collected. At the time of enrollment, each participant was given a written questionnaire to complete before the first treatment session. Participants in both the OMT and sham therapy groups received 1 treatment or sham therapy session lasting approximately 15 minutes daily for a minimum of 4 days and a maximum of 7 days, depending on hospital length of stay. After the last OMT or sham therapy session, patients' breathing was measured again using spirometry and patients completed the written questionnaire a second time. During the hospital stay, the inpatient physician service dictated all other standard treatments including antibiotic treatment, pulmonary physiotherapy, massage therapy, and recreational therapy, as well as hospital length of stay. All physicians caring for the patients were blinded to the patients' group assignment. Trained respiratory technicians who were blinded to the participants' group assignment performed spirometry using a Collins CPL-Raptor spirometer (nSpire Health, Inc).

OMT

Three osteopathic physicians (D.A.S., G.T., and K.A.) administered a set of 5 standard OMT techniques, described previously by Noll et al.¹⁰ Patients remained in the supine position during all treatments. The OMT techniques were as follows:

- **Rib raising:** The physician stands to the side of the patient and places his or her hands under the patient's thoracic spine. Using the pads of his or her

fingers, the physician applies gentle anterolateral pressure along the angles of the ribs and holds the pressure until soft tissue release is palpated. This procedure is repeated along the entire thoracic spine.

- **Abdominal diaphragm release:** The physician places the thenar eminence of his or her hands parallel to the costal margin of the patient's abdomen and positions his or her thumbs pointed to midline. Beginning laterally, the physician gently applies medial and lateral traction to the border of the patient's diaphragm, testing for direction of greatest ease. In concert with patient inspiration, the physician applies cephalad and medial or lateral traction against the direction that is the most restricted. The physician repeats this maneuver for both sides of the patient's diaphragm and along the costal margin until he or she palpates tissue release and determines that mobility of the diaphragm is equal bilaterally.

- **Thoracic inlet myofascial release:** The physician stands at the head of the table and places his or her hands on the patient's thoracic inlet, with the physician's thumbs positioned posteriorly along the angle of the first rib and his or her fingers positioned anteriorly over the clavicle. The physician uses passive motion testing to determine the directions of ease and restriction. He or she then takes the tissues to the direction of least ease, holds them there, and instructs the patient to inhale and exhale. While the patient is exhaling, the physician takes the soft tissues further in the direction of restriction. The physician repeats this maneuver until he or she palpates tissue release and left-right symmetry.

- **Thoracic lymphatic pump:** The physician stands at the head of the bed and places his or her thenar eminences just below the patient's clavicle and over the pectoralis muscle, with the physician's

fingers directed laterally. Using a rhythmic pumping motion (approximately 45 repetitions per minute), the physician introduces motion into the thoracic cavity for approximately 2 minutes. The force is gentle but sufficient to force expiration and inspiration.

- **Suboccipital decompression:** The physician stands at the head of the bed and places the tips of his or her fingers along the occipital condyles on the base of the patient's head. Using gentle pressure, the physician releases the occipital joint with outward and cephalad traction. The physician applies the technique to both sides of the patient's head until he or she palpates symmetry of restriction.

Sham Therapy

Five sham therapy techniques were provided to participants in the control group. These techniques were administered with the physician and participant in the same positions as those used for the OMT techniques, with the physician using the following modifications:

- avoiding prolonged contact of any 1 body area
- using minimal pressure and body surface contact and attempting to direct most of the force of contact into adjacent bedding
- avoiding body areas involved in OMT (eg, the spine) and instead applying light touch to adjacent structures when possible
- avoiding focal areas of pressure by using flat, soft hand contact

Before the study, all 3 osteopathic physicians participated in a session to standardize the OMT techniques. The session lasted approximately 15 minutes per physician, during which each physician performed the techniques on an osteopathic physician who specializes in OMT. The osteopathic physician specialist (the same for all operators) provided feedback when he detected sub-

stantial variations in operator technique. No further standardization of OMT technique was carried out during the study.

Participant Questionnaires

Participants were asked to complete the same questionnaire before their first OMT or sham therapy session and after their last session (*Figure 1*). Questions asked patients to rate their quality of breathing, level of anxiety, and level of pain, as well as describe any adverse effects from the therapy.

1. Please rate how you are breathing TODAY:
 - worse than usual
 - about the same as usual
 - better than usual
2. Compared to 1 week ago, would you say your breathing TODAY is:
 - worse than 1 week ago
 - the same as 1 week ago
 - better than 1 week ago
3. Rate your level of anxiety TODAY:
 - very relaxed
 - less anxious than usual
 - as anxious as I usually am
 - more anxious than usual
 - very anxious
4. On a scale of 0 to 10, rate the level of physical pain that you are experiencing TODAY (0=no pain, 1=very little pain, 5=moderate pain, 10=worst pain of your life): _____
5. Did you have any adverse effects from any of the therapies you received while in the hospital? If yes, please identify the therapy and describe the side effect, briefly: _____

Figure 1.

Questionnaire completed by inpatients with pulmonary exacerbations of cystic fibrosis before and after receiving osteopathic manipulative treatment or sham therapy (N=33).

Outcome Measures

The primary outcome measure was change in FEV₁% predicted, (FEV₁% predicted on the final day of intervention – FEV₁% predicted on day 1). Percent predictions were based on standards from the Third National Health and Nutrition Examination.¹¹ Secondary outcome measures included changes from day 1 to the last day of intervention in other spirometry measures, weight, mean temperature, mean heart rate, mean pulse oximetry, blood pressure, and mean respiratory rate. Other secondary outcomes included questionnaire assessments of change in overall breathing quality, pain level, and anxiety level.

Statistical Analysis

Changes in mean vital signs were calculated by adding all recorded vital signs from day 1 and the final day of intervention individually, calculating the arithmetic

mean for each day, and then subtracting the mean for the final day of intervention from the mean for the first day. Group demographics were compared using χ^2 analysis. Changes in pulmonary function parameters (forced vital capacity [FVC], FEV₁% predicted, FEV₁/FVC, and FEF_{25%-75%}) were calculated for each participant, and the mean change for each group was calculated; independent sample *t* tests were performed to compare the 2 means. A *P* value less than .05 was considered statistically significant. Statistical analyses were performed using SPSS statistical software, version 15.0 (SPSS Inc).

Results

A total of 36 patients were enrolled in the study. Two patients (1 from each study group) declined to continue the study after 2 days, and 1 patient from the OMT group

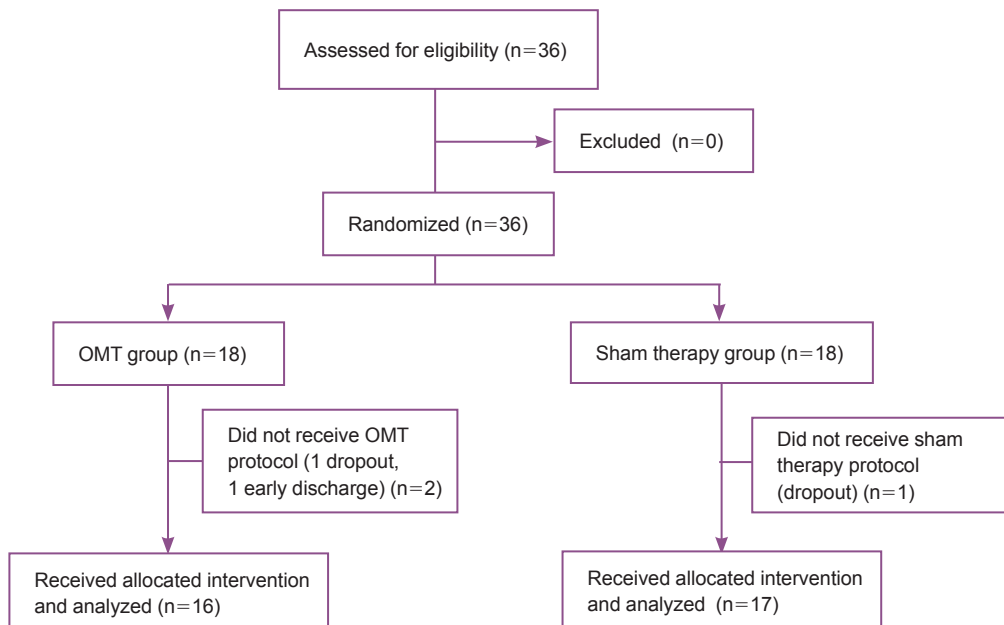


Figure 2.

Study flow diagram of inpatients with pulmonary exacerbations of cystic fibrosis assigned to receive osteopathic manipulative treatment (OMT) or sham therapy.

Table 1.
Demographic Data of Inpatients With Pulmonary Exacerbations
of Cystic Fibrosis Who Received OMT (n=16) or Sham Therapy (n=17)

Characteristic	Mean (SD) ^a		SEM	
	OMT Group	Sham Therapy Group	OMT Group	Sham Therapy Group
Age, y	26.6 (8.8)	22.5 (4.7)	2.2	1.1
Treatments, No.	5.2 (1.0)	4.8 (0.9)	0.2	0.2
Sex, male, No.	6	13	NA	NA

^a Data on sex presented as No.

Abbreviations: NA, not applicable; OMT, osteopathic manipulative treatment; SD, standard deviation; SEM, standard error of the mean.

Table 2.
Changes in Pulmonary Function Measures of Patients With
Cystic Fibrosis Who Received OMT (n=16) and Sham Therapy (n=17)

Pulmonary Function	Mean (SD) ^a		SEM	
	OMT Group	Sham Therapy Group	OMT Group	Sham Therapy Group
FVC	10.4 (11.7)	13.5 (6)	3	1.5
FEV ₁	11.8 (8.3)	11.8 (6.4)	2.1	1.5
FEV ₁ /FVC	3.3 (6.5)	2.2 (3.8)	1.6	0.9
FEF _{25%-75%}	11.3 (10.5)	8.1 (7.2)	2.6	1.8

^a Change from before first osteopathic manipulative treatment (OMT) or sham therapy session (ie, day 1) to after final OMT or sham therapy session (ie, day 4 to 7).

Abbreviations: FEF_{25%-75%}, forced expiratory flow at 25% to 75% of vital capacity effort; FEV₁, forced expiratory volume in the first second of expiration (% predicted); FVC, forced vital capacity.

was discharged before treatment day 4. Therefore, 33 patients completed the study (*Figure 2*). Patient demographic data are shown in *Table 1*. There were more men in the sham therapy group and more women in the OMT group ($\chi^2=4.05$, $P=.044$). No statistically significant differences were found between the 2 groups for age or number of treatments received. All enrolled patients were white. There were no statistically significant changes in mean vital signs (data not shown). Although

the OMT group had a larger pre- to posttreatment mean decrease in temperature than the sham therapy group, this difference was not statistically significant ($P=.084$). There were no statistically significant between-group differences in pre- to posttreatment mean changes in the other vital signs or in weight.

Participants in both the OMT and sham therapy groups exhibited improvement in pulmonary function. At baseline (day 1), no differences in spirometric mea-

asures were found between the 2 groups (data not shown). Changes in spirometry measurements in the OMT and sham therapy groups are shown in *Table 2*. The improvement in FEV₁% was not significantly different between the OMT and sham therapy groups ($t = -0.29, P = .977$). Analysis of other spirometric data similarly showed no statistically significant differences (data not shown).

Table 3 shows the patterns of responses among the OMT and sham therapy groups for questionnaire items on breathing, anxiety, and pain. For the questionnaire item “Please rate how you are breathing TODAY,” 15 of 16 participants in the OMT group and 8 of 16 participants in the sham therapy group answered in a pattern that showed improvement from day 1 to the last day of intervention. For the same questionnaire item, 1 of 16 participants in the OMT group and 6 of 16 participants in the sham therapy group indicated that their state of breathing was “about the same as usual” both at baseline and after the final intervention. The second questionnaire

item asked the participants about their breathing compared with 1 week ago. In the OMT group, 8 of 16 participants answered in a pattern that showed improvement during the study period, whereas 7 of 16 replied that their breathing had improved on both instances (ie, “better than 1 week ago”). By comparison, 6 of 16 participants in the control group answered in a pattern that showed improvement, and 6 of 16 replied that their breathing had improved in both instances (ie, “better than 1 week ago”). For the question on adverse effects, 1 participant reported intravenous catheter pain and 1 participant reported shortness of breath before receiving OMT. At the end of treatment, 1 participant from the OMT group reported feeling mildly nauseous.

Discussion

To our knowledge, the current single-blind randomized controlled trial is the first to report on the effects of OMT

Table 3.
Questionnaire Answers of Patients With Cystic Fibrosis Before and After Receiving OMT (n=16) or Sham Therapy (n=16)^a

Pre- to Postintervention ^b Response Change, No (%)	Question							
	Breathing Today		Breathing Today vs 1 Week Ago		Anxiety Today		Physical Pain Today	
	OMT Group	Sham Therapy Group	OMT Group	Sham Therapy Group	OMT ^c Group	Sham Therapy Group	OMT ^c Group	Sham ^d Therapy Group
Improved	15	8	8	6	6	5	7	4
Same Answer								
Improving ^e	0	2	7	6	5	7	7	8
Same	1	6	0	4	0	1	0	0
Worsening	0	0	0	0	0	0	0	0
Worsened	0	0	1	0	4	3	1	1

^a One participant from the sham therapy group did not complete the questionnaire.

^b Change from before first osteopathic manipulative treatment (OMT) or sham therapy session (ie, day 1) to after final OMT or sham therapy session (ie, day 4 to 7).

^c n=15. One participant in the OMT group did not complete this question on both days.

^d n=13. Three participants in the sham therapy group did not complete this question on both days.

^e For the question on physical pain, this category indicates a response of 0 (no pain) on both days.

on CF patients. In both the OMT and sham therapy groups, patients demonstrated an increase in FEV₁ from day 1 to the final day of intervention. No statistically significant differences were found between the 2 groups in the amount of improvement in FEV₁.

The current study involved a small number of patients in each group, and this sample size may have limited our ability to detect smaller differences in FEV₁ changes. In addition, the standard therapy for pulmonary exacerbation (eg, intravenous antibiotics, chest physiotherapy) given to patients in both study groups may have subsumed any benefit that OMT produced.

The lack of clinically significant improvement in spirometry observed in the current study (beyond that typically observed with standard CF therapy) could indicate a more prominent role for OMT in CF patients who have not yet reached the severity of disease as seen in the current study's population. Studies of OMT for CF patients in the outpatient setting or for patients with early exacerbations of CF disease may show more subtle, long-term benefits, such as fewer or shorter hospital stays and increased FEV₁ over time. As previously mentioned, studies^{7,8} of inpatient adults with pneumonia found shortened duration of intravenous antibiotics and length of hospital stay in individuals who received OMT. Another study¹² of an asthmatic pediatric population demonstrated statistically significant improvement in peak expiratory flow rates of patients who received OMT compared with those who received sham therapy.

Given the chronic and unremitting nature of pulmonary disease in CF, it is also possible that OMT is unable to resolve the substantial dysfunction that CF propagates in the pulmonary system, especially in the setting of an exacerbation requiring hospitalization. The study by Noll et al⁵ that showed worsening in air trapping in elderly patients with COPD immediately after they received OMT supports the notion that chronic, progressive pulmonary illnesses may not respond well to OMT.

All but 1 participant in the treatment group (15 of 16) identified their breathing as being better at the conclusion

of the study than at the beginning, compared with half of the participants in the sham therapy group (8 of 16). Although this assessment was subjective, it does support the possibility that a benefit of OMT was masked by the standard CF therapy or not measured by conventional spirometry. A sham therapy protocol similar to the one used in the present study has been reported to successfully mask OMT group assignment in at least 1 other study.¹³ On the basis of these findings, we believe that the current study's protocol was sufficient to mask group assignment from our participants, limiting any possible placebo effect in the questionnaire responses of the OMT group.

Limitations of the current study were its small sample size, its lack of blinding of physicians administering OMT, and the potentially confounding CF treatments administered to both the OMT and sham therapy groups. Osteopathic manipulative treatment is ideally administered in a nonstandardized fashion, with the physician using physical diagnosis to guide treatment techniques. Our treatment protocol may have been limited by its standardized approach. Finally, our study did not use any validated quality-of-life or disease-specific patient reporting instruments.¹⁴ Future research should examine OMT's effects on the quality of life and breathing in CF patients. Other areas of research should focus on OMT in the outpatient clinic setting, particularly in preventing and managing early CF exacerbations.

Conclusion

Although the benefit of OMT in other pulmonary diseases has been previously demonstrated, the current study did not show a benefit of OMT in CF patients, as measured using spirometry. Additional studies are needed to examine the potential benefit of OMT in the long-term outcomes of patients with CF, as well as in the quality of life for these patients. Given the substantial costs and morbidity associated with CF, uncovering tools that can prevent morbidity for these patients is an important task for researchers in this field.

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