Prevalence of somatic dysfunctions in adult patients with cystic fibrosis- a pilot study

Lucile Soubeiran\textsuperscript{a},* Dominique Hubert\textsuperscript{b}, Raphael Serreau\textsuperscript{c}, Nadine Desmazes-Dufeu\textsuperscript{d}, Rafael Zegarra-Parodi\textsuperscript{a}.

**INTRODUCTION**

Cystic fibrosis (CF) is the most frequent serious genetic disease in Caucasian populations, (1 in 3 500 live births)\textsuperscript{1}. The prognosis has improved considerably over the past decades. Median survival age is now over 38 years in most European and North American countries, where more than 40% of patients with CF are adults\textsuperscript{2}. The disease manifests in many organs, but mainly in the upper and lower airways, pancreas, bowel and reproductive tract\textsuperscript{3}. For most patients, lung disease is the most important problem in terms of symptoms and treatment required and it is the most likely cause of death. There is no available therapy to correct the underlying genetic defect or reverse the ion transport abnormalities associated with dysfunctional Cystic Fibrosis Transmembrane Conductance Regulator (CFTR). The therapy is directed toward slowing the progression of secondary organ dysfunction and its sequelae such as pancreatic insufficiency and chronic endobronchial infection. This treatment approach has been improved by the establishment of dedicated multidisciplinary CF care centers\textsuperscript{4}.

**ABSTRACT**

**Background:** Cystic fibrosis (CF) is the most frequent genetic disease in France. To relieve pain and improve quality of life, patients with CF often use alternative medicine.

**Purpose of study:** To assess the somatic dysfunctions in patients with CF through osteopathic manipulative examination.

**Materials & methods:** This study was conducted on 14 patients with CF (study group) and 14 patients without chronic musculoskeletal pain or respiratory insufficiency (control group), from October 1 2007 to January 31 2008 in the adult CF center at Cochin Hospital and in the clinical department of the European Center for Higher Education in Osteopathy (CEESO), Paris, France. We used common clinical procedures for an osteopathic protocol test of each subject. Tests were divided into three main categories: cranial, neuro-musculo-skeletal and visceral. Qualitative data were exposed and analyzed using the Fisher’s exact test with α risk set at 5%.

**Results:** As compared with a population carrying no chronic musculoskeletal pain and without respiratory insufficiency, this study reveals frequent somatic dysfunction in patients with CF, mainly in the thoraco-pulmonary region and respiratory muscles, which can be associated mostly with postural changes and physiological consequences of respiratory insufficiency.

**Conclusion:** The study findings are important for professionals involved in pulmonary rehabilitation of patients with CF.

**Key words:** Cystic fibrosis, osteopathic treatment, adult, somatic dysfunction.

**Authors’ information:**

- Centre Européen d’Enseignement Supérieur de l’Ostéopathie (CEESO), Paris and Lyon, France – 175 boulevard Anatole France – 93200 Saint-Denis – France
- CRCM – Service de Pneumologie – Hôpital Cochin APHP – 27 rue du faubourg Saint-Jacques – 75679 Paris Cedex 14 – France
- Unité de Recherche Clinique Cochin-Necker – Hôpital Tarnier – 89 rue d’Assas – 75006 Paris – France
- Service de Pneumologie du Pr Reynaud-Gaubert – CRCM, CdC HTAP – Maladies rares pulmonaires – Hôpital Nord – CHU de Marseille – Chemin des Bourrellys – 13915 Marseille Cedex 20 - France

*- Corresponding author- Lucile SOUBEIRAN. Centre Européen d’Enseignement Supérieur de l’Ostéopathie (CEESO), Paris and Lyon, France – 175 Boulevard Anatole France – 93200 Saint-Denis – France. Phone: 00 33 6 50 01 97 62.

E-mail for correspondence: lso@ceeso.com
Pain is a potential complication of CF\(^5\) and, in addition to medical care, patients with CF are regularly using non-drug treatments or alternative medicine\(^6,7\), mainly to reduce thoraco-abdominal and thoraco-lumbar pain, and improve their quality of life\(^8\). Osteopathy is the most often used the alternative medicine\(^9\), although little information is, as yet, available about the effect of this technic on symptoms of patients suffering from chronic diseases, such as cystic fibrosis. Osteopathic treatment for patients with CF are mainly based on individual will to use it although there is a lack of clinical data on this topic. Treatments provided are claimed as specific for each patient's recognised somatic dysfunctions observed by the practitioner. Their correction should consider three main issues: body unity, homeostatic mechanisms, and structure-function interrelationships\(^10\). Somatic dysfunction is a pathologic condition referenced in the « International Classification of Diseases » which is defined as « diminished or impaired function of the somatic components of the system (skeleton, joints and myofascial structures) and the vascular, nodes and neurological elements »\(^11\), and is treated with osteopathic manipulative techniques (OMT)\(^12\). Somatic dysfunction is a clinical concept described by osteopathic practitioners that is characterized by the presence of several clinical signs using the TART acronym: Tenderness, Asymmetry, Restriction of mobility and Tissue texture.

Changes\(^13\). Kuchera\(^10\) has described several causes of appearance of somatic dysfunction which include a prolonged inflammatory response, a chronic change in posture, a personal or professional environmental change, a modification of the organic physiology and the facilitation segmental nervous system.

Several studies mention the benefits of osteopathy on the treatment of chronic pain mainly due to an hypoalgesic action attributed to spinal manipulations\(^9,14,15\). A descriptive study of patients with chronic low back pain revealed that they had more frequently somatic dysfunctions that could be associated with their symptoms\(^16\). To our knowledge, no study assessing the somatic dysfunctions in patients with CF has been published.

The aim of this paper is to compare, through a clinical examination, somatic dysfunctions in patients with CF and in a control group without chronic musculoskeletal pain or respiratory insufficiency. These informations could help in finding an appropriate osteopathic treatment for these patients. Comparing the presence of somatic dysfunctions between these two groups could allow us to discuss possible associations between somatic dysfunctions found in patients of the study group and their pathology or side effects of their treatments.

**MATERIALS & METHODS:**

**Study design**
We designed an observational study in patients with CF (study group) and patients without chronic musculoskeletal pain or respiratory insufficiency (control group).

The study was conducted from October 1 2007 through January 31 2008 in the adult CF center at Cochin Hospital Paris, France, which cares for 320 adults with CF, and in the clinical department of the European Center for Higher Education in Osteopathy, Paris (CEESO), France, for the control group. The study was submitted to the local ethics committee and written consent was obtained from all patients. It was conducted in accordance with the Declaration of Helsinki and French laws.

**Subjects**
The study group included 14 patients with CF among the 320 CF patients cared at our CF centre. They were selected and informed by their CF physician, during a routine visit at the CF center. Patients in the control group were recruited at CEESO during an initial consultation and before any treatment. Subjects from the two populations were matched according to age and sex.

Inclusion criteria for patients of the study group were cystic fibrosis diagnosed by a positive sweat test and/or the presence of two mutations in the CFTR gene in adult patients, and the absence of chronic musculoskeletal pain and no respiratory insufficiency for the control.
group.

Non-inclusion criteria for the study group were: acute respiratory exacerbation, history of lung transplantation and for both groups, pregnancy and patients who had received osteopathic care in the previous six months. We have not used any exit criteria for the study since the osteopathic protocol test was performed only once on all patients at the time of their inclusion.

Osteopathic test protocol

Subjects in both groups were evaluated by the same practitioner (LS). The examination was performed by one examiner for osteopathic clinical data gathered through the « Outpatient Osteopathic SOAP Note Form » a standardized file giving good intra- and inter-examiner reliability. LS was supervised by an osteopath with 10 years clinical experience (JL). The practitioner was not blinded since patients and controls were seen in two different places.

The clinical procedures used in this study are commonly described, taught and practiced in osteopathy: inspection, palpation and testing of all anatomical regions of each subject. They were divided into three main categories: cranial18, neuromusculo-skeletal19 and visceral20. The chronology for all tests was chosen in view of favouring the comfort and needs of each subject during the examination. The osteopathic protocol test evaluated the occurrence of major clinical elements that were associated with the presence of somatic dysfunction. Practitioner have tested all SOAP anatomical areas and listed the clinical signs (TART) to determine the severity of the somatic dysfunctions. The criteria for clinical decision on the presence or absence of somatic dysfunction used in this study are listed in Table I.

Clinical data were collected on the « Outpatient Osteopathic SOAP Note Form », subjective and objective assessment form designed by the American Academy of Osteopathy (AAO)12,17,21, which divides the clinical evaluation of a subject in 14 anatomical areas. This file was designed, published and distributed by the AAO, to allow osteopathic physicians to record data on a standard osteopathic musculoskeletal examination, enumerate any somatic dysfunctions found and observe the patient’s response to OMT17. We detailed this general osteopathic protocol test by evaluating the anatomical regions which are the most frequently found as dysfunctions by practitioners who regularly treat patients with CF. This allowed us to use an assessment tool which seemed most appropriate for patients in the study group (Table II).

Statistical analysis

Qualitative data were exposed and analyzed using the software Graphpad Prism 5 (Graphpad Software Inc, CA). We used Fisher’s exact test with an α risk set at 5%.

RESULTS

Population:

The characteristics of patients and controls are reported in Table III.

Prevalence of somatic dysfunction:

We report our results of the prevalence of somatic dysfunctions in our 2 populations in Table IV and Table V.

DISCUSSION

Insofar as the osteopathic management of patients with CF is mainly based on description of their pain and on the somatic dysfunctions found by the practitioner, this descriptive study is likely to provide additional clinical information to improve efficiency of treatment. Numerous physiological models have been proposed to describe development, maintenance and correction of somatic dysfunction, but the neurological one based on the functioning of nociceptors is the most commonly described in the scientific literature22. Alteration of somatic or visceral structures produces a flood of conflicting afferent influx to the dorsal horn of the spinal cord. Hypothetically, the spinal inter-neuron threshold depolarization could be lowered, allowing an exaggerated response of the different neurological
Table I – Criteria for clinical decision on the presence or absence of somatic dysfunction: Tenderness, Asymmetry, Restriction of mobility, Tissue Texture Changes

<table>
<thead>
<tr>
<th>Osteopathic tests</th>
<th>Criteria of presence</th>
<th>Criteria of absence</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranial</td>
<td>3 - 4 clinical manifestations found</td>
<td>0 - 2 clinical manifestations found</td>
<td>Magoun\textsuperscript{18} Error! Bookmark not defined.</td>
</tr>
<tr>
<td>Neuro-musculo-skeletal</td>
<td>3 - 4 clinical manifestations found</td>
<td>0 - 2 clinical manifestations found</td>
<td>Hartmann\textsuperscript{19} Error! Bookmark not defined.</td>
</tr>
<tr>
<td>Visceral</td>
<td>3 - 4 clinical manifestations found</td>
<td>0 - 2 clinical manifestations found</td>
<td>Barra\textsuperscript{20} Error! Bookmark not defined.</td>
</tr>
</tbody>
</table>

Table II – Specific evaluated anatomical regions

<table>
<thead>
<tr>
<th>Anatomical Regions</th>
<th>Osteopathic tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspiratory Muscles (diaphragm, accessory muscle)</td>
<td>Neuro-musculo-skeletal</td>
</tr>
<tr>
<td>Thorax (bone sphere)</td>
<td>Neuro-musculo-skeletal</td>
</tr>
<tr>
<td>Thorax (visceral sphere)</td>
<td>Visceral</td>
</tr>
<tr>
<td>Organs affected (pancreas, liver, small intestine et colon)</td>
<td>Visceral</td>
</tr>
</tbody>
</table>

Table III – Characteristics of the subjects

<table>
<thead>
<tr>
<th></th>
<th>Study group</th>
<th>Control group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Mean age (min - max)</td>
<td>32.0 (18 - 53)</td>
<td>31.6 (19 - 54)</td>
</tr>
<tr>
<td>Gender (Male-Female)</td>
<td>8 / 6</td>
<td>8 / 6</td>
</tr>
</tbody>
</table>

We used this model to describe the clinical signs diagnosed in the patients of our study. We hoped thus to discuss possible associations between the different somatic dysfunctions that could be involved through neurological reflexes: viscosa-somatic, somato-visceral, somato-somatic and viscero-visceral\textsuperscript{22}. CF is an autosomal recessive disease caused by mutations in the Cystic Fibrosis Transmembrane Conductance Regulator (CFTR) gene\textsuperscript{26}. This results in dysfunction of the apical membrane CFTR protein which regulates chloride and sodium transport in secretory epithelial cells, with abnormal ion concentrations across the apical membranes of these cells\textsuperscript{27}.
Table IV – Prevalence of somatic dysfunctions in the two groups – Anatomical regions of Outpatient Osteopathic SOAP Note Form

<table>
<thead>
<tr>
<th>Anatomic Regions</th>
<th>Study Group (n=14)</th>
<th>Control Group (n=14)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>12</td>
<td>4</td>
<td>p&lt;0.006</td>
</tr>
<tr>
<td>Neck</td>
<td>20</td>
<td>25</td>
<td>Ns</td>
</tr>
<tr>
<td>Thoracic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1-T4</td>
<td>25</td>
<td>24</td>
<td>Ns</td>
</tr>
<tr>
<td>T5-T9</td>
<td>38</td>
<td>28</td>
<td>Ns</td>
</tr>
<tr>
<td>T10-T12</td>
<td>22</td>
<td>18</td>
<td>Ns</td>
</tr>
<tr>
<td>Lumbar</td>
<td>28</td>
<td>29</td>
<td>Ns</td>
</tr>
<tr>
<td>Ribs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R1-R4</td>
<td>14</td>
<td>5</td>
<td>p&lt;0.052</td>
</tr>
<tr>
<td>R5-R9</td>
<td>9</td>
<td>4</td>
<td>Ns</td>
</tr>
<tr>
<td>R10-R12</td>
<td>1</td>
<td>0</td>
<td>Ns</td>
</tr>
<tr>
<td>Sternum</td>
<td>13</td>
<td>2</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td>Sacrum/Pelvis</td>
<td>13</td>
<td>14</td>
<td>Ns</td>
</tr>
<tr>
<td>Pelvis/innominate</td>
<td>6</td>
<td>7</td>
<td>Ns</td>
</tr>
<tr>
<td>Upper extremity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>3</td>
<td>2</td>
<td>Ns</td>
</tr>
<tr>
<td>R</td>
<td>3</td>
<td>3</td>
<td>Ns</td>
</tr>
<tr>
<td>Lower extremity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>3</td>
<td>8</td>
<td>Ns</td>
</tr>
<tr>
<td>R</td>
<td>14</td>
<td>8</td>
<td>Ns</td>
</tr>
</tbody>
</table>

Ns: Statistically insignificant

Table V – Prevalence of somatic dysfunctions in the two groups – Anatomical regions described by practitioner experts

<table>
<thead>
<tr>
<th>Anatomic Regions</th>
<th>Study group (n=14)</th>
<th>Control group (n=14)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest Superior Orifice</td>
<td>13 (93)</td>
<td>5 (36)</td>
<td>0.004</td>
</tr>
<tr>
<td>Right sub-clavicular muscle</td>
<td>9 (64)</td>
<td>2 (14)</td>
<td>0.018</td>
</tr>
<tr>
<td>Left sub-clavicular muscle</td>
<td>14 (100)</td>
<td>2 (14)</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Right pleural dome (ligament)</td>
<td>7 (50)</td>
<td>0 (0)</td>
<td>0.005</td>
</tr>
<tr>
<td>Left pleural dome (ligament)</td>
<td>13 (93)</td>
<td>0 (0)</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Mediastinum</td>
<td>11 (78)</td>
<td>4 (28)</td>
<td>0.02</td>
</tr>
<tr>
<td>Motility of the lungs</td>
<td>13 (93)</td>
<td>0 (0)</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Diaphragm (Right dome)</td>
<td>11 (78)</td>
<td>4 (28)</td>
<td>0.021</td>
</tr>
<tr>
<td>Pelvic floor (Muscles)</td>
<td>12 (85)</td>
<td>5 (36)</td>
<td>0.018</td>
</tr>
</tbody>
</table>
The practitioner contacts the patient's head by taking the cranial vault:
- the thumbs, along the sagittal suture;
- the index, next to the large wings of the sphenoid;
- the majors, in front of the ear canal;
- the ring, behind the external auditory canal;
- the atrial, in contact with the squamous occipital.

**Figure II: Neck**

The practitioner’s index palpated the posterior articular process of the cervical.
The practitioner’s fingers palpate the interspinous spaces of the dorsal.

The practitioner palpates the interspinous space of the lumbar.

The practitioner feels with his thumb and index, the costochondral cartilage.

The palm of the hand contacts the manubrium. The upper hand is raised in support against.
Figure VII: Sacrum/Pelvis
The thumb palpates the sacroiliac joint.

Figure VIII: Pelvis/innominate
The fingertips of the practitioner palpate the pubic symphysis.

Figure IX: Upper extremity
The practitioner includes the glenohumeral joint, just below the acromion.

Figure X: Lower extremity
The practitioner contacts the patient’s hip.
Figure XI: « Chest Superior Orifice »
The practitioner places his hands in projection of anatomical elements of the chest superior orifice, both sides of the patient's cervical spine:
- the thumbs are facing the transverse processes of T1;
- the other fingers cover the clavicular and the upper chest.

Figure XII: Sub-clavicular muscle
The thumb palpates the sub-clavicular muscle. The patient breathes and moves his shoulder forward.
Figure XIII: « Pleural dome »
The practitioner’s fingers are positioned in the projection of the attachment of ligaments of the pleural dome on the musculoskeletal system, behind the beats of the subclavicular artery.

Figure XIV: « Mediastinum »
The posterior hand contacts the thoracic spine. The anterior hand contacts the manubrium. Both hands are projecting the anatomical area of the mediastinum.
Figure XV : « Motility of the lungs »
The palms are resting on the front of the chest. The practitioner is positioned in projection of the pulmonary lobes.

Figure XVI : « Diaphragm »
Practitioner's thumbs palpate the lower edge of the rib cage; the other fingers are spread over the lower chest. The hands are positioned on the insertion of the diaphragm on the musculoskeletal system.
The clinical consequences include multi-system disease characterized by progressive pulmonary damage leading to respiratory failure, pancreatic dysfunction, liver disease that may progress to cirrhosis, gut motility problems, and male infertility due to atresia or complete absence of the vas deferens. In the human lung, thick, tenacious secretions obstruct the distal airways and bacteria become well established within airway secretions and cannot be eradicated. Pulmonary inflammation is another major cause of the decline in respiratory function in patients with CF.

Snider et al think that subjects with chronic disease often present somatic dysfunctions probably related to their symptoms. The different phenomena observed in CF could be responsible for the somato-somatic and viscero-somatic reflexes which can be observed on the neuro-musculo-skeletal system of patients. According to Barral, the pathology of an organ could be associated with disturbances of its motion, which may account for 93% of patients with CF (p<0.0001), loss of lung expansion and decrease in pleural elasticity of the domes tissue, mostly on the left side. Cylinders lung and mediastinum are in close anatomical relationship through their cell wall tissues. The observed increase in tissue resistance to compression of the anterior-posterior mediastinum in 78% of the study group, against 28% of the control group (p=0.02), could be explained by physiologic changes of the lungs and/or the decline of their movement. A study by Licciardone et al showed statistically significant levels in evolution of the severity of vertebral somatic dysfunction due to viscera-somatic reflexes in diabetic population. The results in our study suggest that a similar mechanism could be involved in patients with CF.

Many subjects with CF have a distended chest at its base, characterised on thoracic radiography by lung distension, a kyphosis and a bulging sternum. Postural adaptation in CF patients may explain the somatic dysfunction of the sternum (chondro-costal joints) in 93% of them (p<0.0001). 12.5% of the subjects’ experienced somatic dysfunctions of the fourth ribs, which occurs during active inspiration and expiration movements, compared to 4.46% in the control group (p=0.052). The lung inflation is also causing a diaphragmatic dome flattening and a shortening of its muscle fibers. It results in a decrease in its strength of contraction that could promote the somatic dysfunction of the diaphragm found in 78% of patients, against 28% of the control group (p=0.021). In addition, postural changes and the presence of chronic cough could explain the overstressing and accessory inspiratory muscle hypertonia such as sub-clavicular muscles (100% and 64% left to right) (p<0.0001 and p=0.018 left to right). These mechanical phenomena could be responsible for somato-somatic reflexes which may increase and/or maintain the muscle imbalance that we have found. Thoracic diaphragm hypertonia in the study group could exert a great pressure on the abdominal organs, including pelvic organs and affect the pelvic floor. This mechanism could explain 85% of patient’s perineum muscles hypotonia, against 36% of the control group (p=0.018), which could simply be a physiological adaptation to the thoracic diaphragm position in patients with CF.

Two components of the primary respiratory mechanisms (PRM) could be the reciprocal tension membranes (MTR) and the sphenio-basilar joint (SSB). The presence of somatic dysfunctions of MTR and SSB which are related to postural changes of patients in the study group could explain a decrease in the rate of PRM in 86% of them, against 29% of the control group (p<0.006).

This has been observed by Rivera-Martinez in patients suffering from Parkinson's disease: somatic dysfunctions of MTR and SSB have been associated with abnormal posture of the subjects, caused by abnormally high muscle tone.

**Study limitations:**
In the osteopathic protocol test of patients with chronic disease like CF, the practitioner is likely to find areas of lower mobility and to feel tissue changes that are related to physiopathological effects of the disease during palpation. It may be difficult to differentiate clinical features attributable to somatic dysfunction, considered «..."
reversible» after osteopathic treatment, from irreversible ones due to physiopathological impairments of CF. The practitioner knew patients’ disease since they were examined in two different locations. Thus the practitioner could have been influenced in the evaluation of somatic dysfunctions. Anyhow, it would have been difficult for the practitioner to ignore the patient’s group because of the characteristic morphological changes in adult patients with CF, such as deformation of the thorax.

That is why the practitioner in this study followed the recommendations for filling «Outpatient Osteopathic SOAP Note Form», after specific training under the supervision of a professional, which allows very reliable intra-and inter-examiner results of the examination. The intra-operator reliability was not assessed (clinical evaluation of the same subjects at two different times). However, we believe that a specific assessment for the practitioner of such a study would provide additional information for better analysis of the results based on subjective interpretation after palpation. The presence or absence of somatic dysfunction was diagnosed by LS directly following the recommendations of the standardized file (SOAP Note Form) from the simultaneous presence of five associated clinical signs (Table II). An analysis in two steps would improve the interpretation of collected data, first with collection of clinical symptoms and subsequently analysis of the presence or absence of somatic dysfunctions. We observed that most somatic dysfunctions described in CF are likely to be the consequence of respiratory insufficiency and secondary postural changes. Thus, this observation may not be specific to cystic fibrosis and be made in other respiratory diseases with severe respiratory insufficiency. Nevertheless, in comparison with these diseases, patients with CF develop severe respiratory insufficiency at a younger age than most of these patients. They also have more cough as well as thicker and more abundant sputum. That is why, it would be interesting to conduct additional studies to compare somatic dysfunctions in patients with different respiratory diseases.

CONCLUSION

The aim of our study was to evaluate by clinical examination of adult patients with CF, the anatomical regions most frequently associated with clinical signs of somatic dysfunctions. To our knowledge, this study is the first one to evaluate the prevalence of somatic dysfunctions in patients with CF. We observed more somatic dysfunctions in these patients that were associated with changes in their posture and the impact of disease on the respiratory system (respiratory insufficiency), based on the neurophysiological model of somatic dysfunction. The observation of the presence of somatic dysfunctions in patients with CF could guide practitioners in their treatment of these patients to improve their pain and their quality of life.

ACKNOWLEDGMENTS

We thank Professor Daniel Dusser (Cochin Hospital - Paris) who gave us access to the pulmonary department, medical and paramedical staff of the CF Centre. We are also grateful to the patients who agreed to volunteer their time after their usual out-patient visits at the CF centre and control subjects who volunteered to have osteopathic tests. We also thank the clinical research Paris Descartes Centre, in collaboration with the CF centre, which was involved in obtaining regulatory review and provided methodological support for the research and Mr. Jean Lefeuvre, osteopath supervisor of the dissertation study of LS.

REFERENCES


