CAN VITAL CAPACITY BE IMPROVED BY OSTEOPATHIC TREATMENT OF THE MEDIASTINUM?

Master thesis

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CONTENT

Personal Foreword

Listening to the signals of the body – an important capability of osteopaths – was not new for me when I started with osteopathy. Cross country skiing and long distance running, the competitive sports I practised for many years, made me sensitive for the interplay of different structures and functions of the body.

During my initial studies of medicine the holistic view of the human body was not established in school medical concepts. For me, the best way to work in a medical profession was becoming a physiotherapist. This profession enabled me to get into direct contact with the patients. Many techniques applied involve manual contact with them. To expand my professional skills I specialized in manual medicine. In addition I was interested in alternative approaches like acupuncture and homeopathy.

Later on, I came in touch with physioenergetics. This engagement led me to my studies of osteopathy at the WSO ("Wiener Schule für Osteopathie").

Today I frequently use visceral osteopathic techniques for diagnosis and treatment of patients that attend our hospital due to internal diseases. Since I experienced the efficiency of many osteopathic techniques in combination with school medical treatment I would like to contribute to general acceptance of osteopathy. Thus I decided to investigate the effects of an osteopathic treatment on a clinical gold standard parameter, the vital capacity. I discussed my ideas with our teacher Franz Buset D. O. and he recommended me the treatment of the pericardial ligaments for that purpose.

ABSTRACT

Currently only few researchers have investigated the influence of osteopathic treatment on lung function. For optimal perspiration free mobility of the thorax is essential. Since it is assumed that the mobility of the thorax is limited by the tension of fascia and ligaments, the relaxation of the pericardial ligaments might improve lung function. To investigate whether the treatment of the mediastinum can improve vital capacity of persons with palpable restrictions of fascia 60 adult persons were randomly divided into Test (n=30) and Control (n=30) groups. The osteopathic treatment consisted of a recoil technique to the sternopericardial ligaments and a stretch technique to the vertebropericardial ligaments. Lung function was assessed before and after the treatment using a forced expiration test. The treatment did not result in a significantly increased vital capacity (t-test confirmed zero hypothesis - no difference between both groups).

Key-words*: vital capacity; lung function, ligamentum sternopericardium superior; ligamentum sterno-pericardium inferior; ligamentum vertebropericardium, sternum, recoil technique, stretch technique*

1 INTRODUCTION

1.1 General considerations

In western medicine treatment of most diseases was dominated by pharmaceutical interventions for the last decades. Currently, not only the patients, but also an increasing number of medical professionals try to substitute pharmaceutical treatment by alternative procedures. One important argument for alternative procedures is the fact that less side effects are expected. Furthermore alternative methods might be more cost effective. Osteopathic treatments have the potential to fulfil both demands.

Patients suffering from respiratory diseases might profit from osteopathic treatment since ligamental restrictions might be involved. Such restrictions are a typical target of osteopathic mobilisation techniques.

For that the current study tried to evaluate the potential of mobilisation of the pericardial ligaments on lung function.

1.2 Principles of Osteopathy

Osteopathic medicine is based on the philosophy that all body systems are interrelated and dependent upon one another for good health. *Dr.Still*, the main founder of osteopathy believed that the body`s ability to function and its ability to heal is greatly improved by manipulative treatment correcting problems in the body´s structure (*Still, 1902, 1910, 1946*).

The basic principles of osteopathy will therefore be cited as they were originally expressed (list taken from *Frymann, 2006, p.2*)

- The interdependance of structure and function.

  Disease is the result of anatomical abnormalities followed by physiological discord.

- The unity function.

  The human body does not function in separate units but only as a harmonic whole.

- The body produces all substances for functioning in health.

  The body constitutes the shop in which all substances pertaining to the physical makeup are manufactured.

- The body has the power to overcome disease.

  To make the sick well is no duty of the operator, but to adjust a part or whole of the system that the rivers of life may flow in and irrigate the famishing fields.

- Circulation of healthy blood is fundamental to well-being.

  The artery and its nerves must deliver constantly on time and in quantity sufficient: the venous system and its nerves must perform their function and allow no accumulations. These two demands are absolute.

- The potency of the cerebrospinal fluid.

  The cerebrospinal fluid is the highest known element that is contained in the human body and unless the brain furnishes this fluid in abundance, a disabled condition of the body will remain.

- The law of cause and effect.

  As the beautiful works of nature stand today, and in all times past, fully able by the evidence it holds before the eye and mind of reason, that all beings great and small come by the law of cause and effect, are we not bound to work by the laws of cause, if we wish an effect?

These principles are still fundamental for modern osteopathy. The following study considers these principles. Furthermore it combines osteopathic treatment with measurements typically used in school medicine.

1.3 The Human Hand in Diagnosis and Therapy

The best comprehension has been formulated by *Magoun, 1976, p.81-83:*
"The human hand has been called the greatest single diagnostic instrument known to man. Marvelous as the advances of objective science may be, nothing takes the place of a searching analysis of the tissues with a well trained palpatory sense, to determine not only the condition present but also the best procedure to modify or remedy it. This is a study from the aspect of function, not stasis; living physiology, not cadaveric anatomy. The x-ray may show gross changes in pathology; the laboratory alterations in chemistry; but neither can possibly reveal the fine shades of tissue tone and tension, mobility, elasticity, resiliency, flexibility, extensibility, reaction to stimuli and all the other things so essential to adequate diagnosis. In the art and science of osteopathy, structural change has been found to be an essential corollary to functional disturbance."

1.4 Anatomical Basics

In the following chapter the anatomic basics necessary to understand the rationale of this study are summarized. For more detailed information refer to standard anatomical textbooks like *Drenckhahn, Zenker* (*1994*) and *Standring (2005)*.

1.4.1 Anatomical and Histological Structure of the Fascia and Ligaments

Fascia and ligaments originate from the mesoderm like all other connective tissues, bone, cartilage, muscles, the pericardium, pleura, peritoneum, blood- and lymphatic vessels, the spleen and the kidneys. Fascia and ligaments belong to the taut connective tissue consisting of fibrocytes that deposit collagen and elastic fibres to the extracellular space. These fibres form the so called extracellular matrix. In fascias the fibres are wavy and intersected, in tendons and ligaments fibres are oriented parallel (Fig. 1).

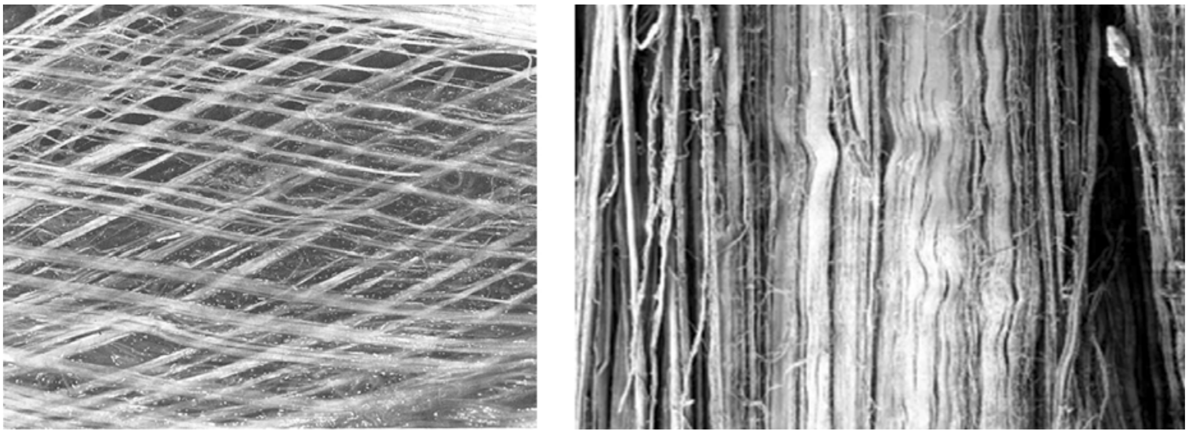

Figure 1 Collagen texture in fascia (left) and ligaments (right)
Figures taken from Rohen, 1990, p.121 (fascia) and from http://silver.neep.wisc.edu/~lakes/slideTissue.dir/LigFig4A.jpg , September 28th,9:50am (ligament)

Beside cells and fibres the extracellular matrix also contains extracellular fluid. This fluid is generated by ultrafiltration of the blood and nourishes the cells. It is also the vehicle for removal of metabolic end products. The flow of extracellular fluid is stimulated by mobility processes generated by muscle contractions. Fibres play a role in transmitting the movements.

A correlation between age and connective tissue morphology has been described by Ishihara et al, 1980. Histological and ultrastructural investigations of normal human pericard showed that the waviness of collagen is maximal in young adulthood and decreases thereafter. As collagen becomes less wavy in older persons, elastic fibers do not decrease in number but the structure of pericardial connective tissue becomes progressively less organized. The study shows that strips of pericardium from young subjects are more extensible than those from older subjects. It also suggests that the waviness of collagen is a major determinant of pericardial distensibility.

Fascias are continuous from the head to foot and from the outside to the inner body. Fascia support posture and cover the organs. They also act as shock absorbers. Lesions can spread along fascial chains to far distant regions of the body. Such lesions can be generated by altered organ function. For instance, a change in liver function can result in hypertrophy of the organ. As a consequence the fascia are overstreched leading to restriction of the mobility of the diaphragm. This reduced mobility is transmitted via the fascials system to other parts of the thoracial region and thus negatively affects the breathing movements. Recent results point to the involvement of interfascial mechanoreceptors and of the autonomous nerve system resulting in a loss of elasticity of the fascial connections *(Schwind 2004).* Upon repeated strain biochemical alterations take place: flexible elastin fibres are displaced by collagen fibres resulting in a loss of elasticity.

Thus, the interchange of fluids gets worse. *(Schwind, 2004, Paoletti, 2001).*

1.4.2 The Thorax

The thorax protects the organs enclosed, particularly the lungs and the heart (as you can see in Fig. 1). It is not a rigid, but a highly flexible structure due to approximately 150 articulations. This flexibility allows movements including those necessary for respiration - during respiration the thoracic articulations of the ribs and spinal column undergo more than three million movements a day.

During inspiration all diameters of the thorax enlarge. *(Michallet, 1995)*

Any restriction of the bones can affect the function of the organs inside, and vice versa *(Barral, 1997).*

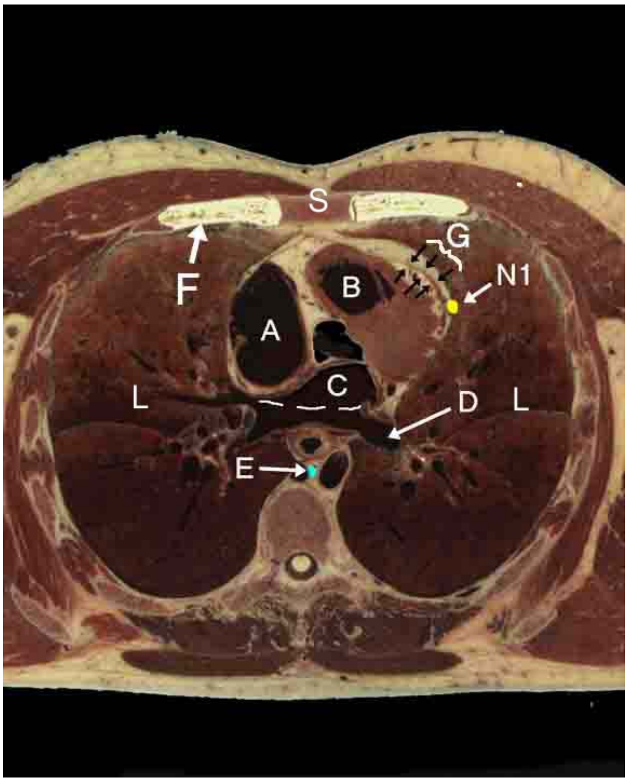

Figure 2 T7 / Mediastinum and Thorax
Figure taken from http://iris3.med.tufts.edu/ (April 8th 2006, 8pm)
A.: R. Atrium; B.: R. Ventricular Outflow; C.: L. Atrium; D.: L. Pulmonary v. ;E.: Thoracic Duct; F.: costal Cartilage; G.: Pericardium; N1.: Phrenic n; S.: Sternum; L.: Lungs

1.4.2.1 The Sternum

The sternum, a strong and flat bone in the middle of the thorax articulates with the ribs and the clavicles. The bone moves anterior and superior and becomes more vertical in the inhalation phase, it performs a translation. The amplitude of motion at the angulus sterni is 5° with 80% of persons *(Klein, 1996).*

The sternal region reacts very sensible to all kinds of stress, irritations of the fascia and ligaments are frequent. Motor vehicle accidents with the seat belt fastened often cause oblique strain to the thorax *(Paoletti, 2001).*

The sternum receives all mechanical tensions of the thorax and is the first to be affected by physical trauma. Restrictions limit deep inhalation and cause pain. *(Barral, 1997)*

1.4.2.2 The Mediastinum

The mediastinum lies in the midline between the two pleural cavities. It extends from the thoracic vertebra to the sternum, lateral it is limited from the lobes of the lungs with their parietal pleura, caudal it ends at the diaphragm, cranial it continues the connective tissues of the throat (as you can see in Fig. 2).

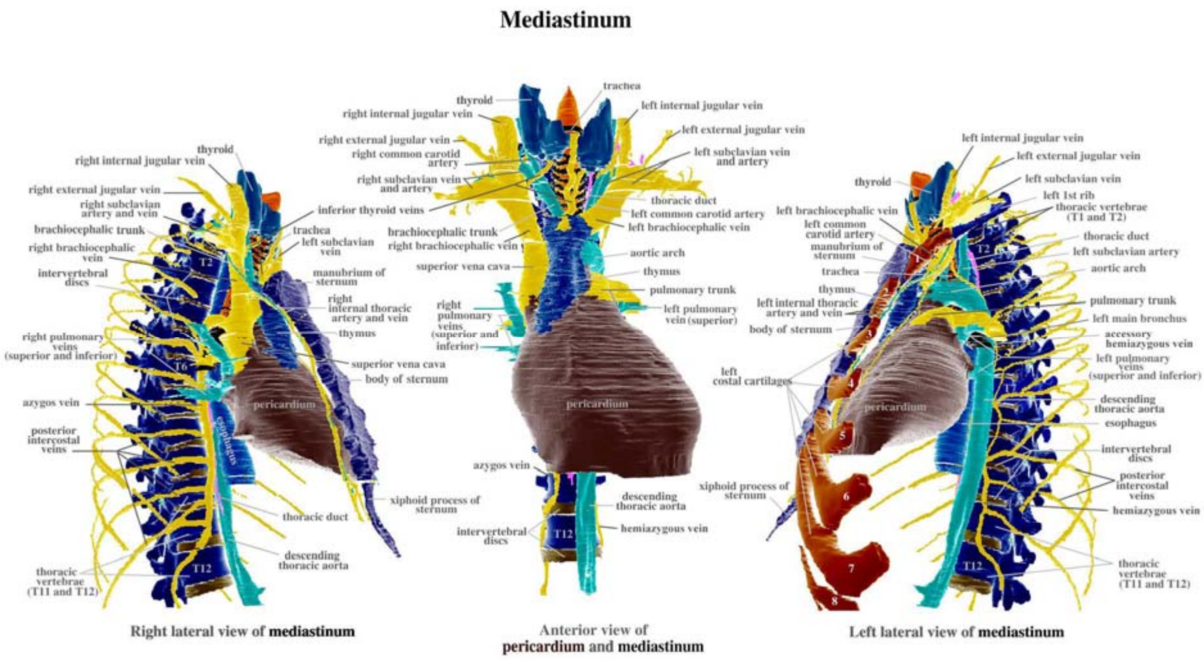

Figure 3 Overview of the Mediastinum
Figure taken from http://anatquest.nlm.nih.gov (April 8th 2006, 8pm)

The position of the mediastinum depends on the relative pressures in the two pleural cavities. The mediastinum is divided into superior, anterior, middle and posterior compartments. The thymus gland lies in the thin anterior mediastinum. The heart covered by the pericardium takes place in the middle mediastinum together with the phrenic nerves, the arcus of the aorta, the pulmonal arteries, and the vena cava superior.

The pericardium as a very tough fibrous and serous sack is part of a homogenous fascial connection between the cranium, the vertebral column, the sternum and the diaphragmn. The pericardium is attached to the sternum, the diaphragm and the spinal column by various ligaments.

The posterior mediastinum is continuous with the superior mediastinum and contains the oesophagus and the vagus nerv, the trachea and the main bronchia, the descending Aorta and other arterial, venous, nerval and lymphatic pathways.

1.4.2.3 Pericard and Pericardial Ligaments

The pericardium consists of three principal layers: the serosa, the fibrosa and the epipericaridal connective tissue layer *(Ishihara, 1980; Paoletti, 2001)*. The latter is formed by large bundles of collagen forming the pericardiosternal ligaments (as can be seen in Fig. 3). These ligaments are part of a larger network of loose connective tissue fibres separating the pericard from the sternum, which condenses at the top and bottom to form the superior and inferior sternopericardial ligaments.

The Superior Sternopericardial Ligaments

As the thymus degenerates, these ligaments seems to replace it, running from cranial to caudal *(Barral, 1997).* They suspend the pericard in vertical and supine positions. A single ligament originating from the pericard divides at its cranial end: one group of fibres connects the pericard with the manubrium and the first sternocostal joint, another fixes the pericard to the middle cervical aponeurosis.

The Inferior Sternopericardial Ligament

It originates at the bottom of the xyphoid process and exchanges several fibres with the diaphragm, running horizontally to the epipericardial connective tissue layer (Ishihara et al, 1980). It also helps to suspend the heart in supine position.

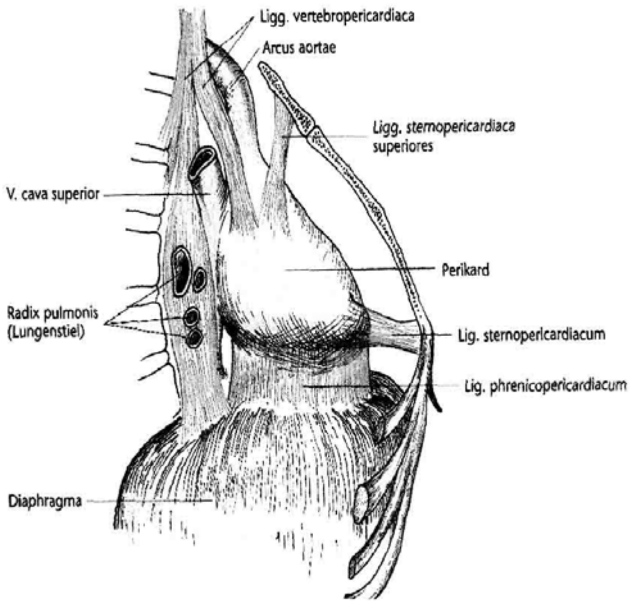

Figure 4 Pericardial ligaments
Figure taken from Paoletti, 2001, p.80

The Vertebropericardial Ligaments

These ligaments connect the pericard with the spinal cord between the 4th cervical vertebra and the 4th thoracical vertebra. There they are inserted into a thickened portion of the deep cervical aponeurosis.

The vertebropericardial ligaments are better developed on the left side of the body forming sheaths for the aorta and large vessels of the neck.

Seidler (2004) described In his diploma-thesis at the “Akademie für Osteopathie” in Germany that these „ligaments“ are no ligaments in the classical sense where collagen fibres are orientated in a parallel manner. In the far majority of the corps investigated the “ligaments” appeared as a fascious smooth and flexible structure where the collagen fibres are intercrossed and wavy. True ligaments were only visible after preceding fibrosis. This status correlated with anatomical alterations due to general pathologies of the thorax. Seidler proposed that strain and tractive force caused fibrosis. The same is true for the sternopericardial ligaments.

The Phrenopericardial Ligaments

The phrenicopericardial ligaments connect the pericard with the centrum tendineum, the tendinous region in the middle of the diaphragm.

1.4.2.4 The Thoracolumbal Diaphragm

The thoracolumbal diaphragm is continuous with the connective tissues in cranial and caudal direction. Fixation to the mediastinal region is accomplished by the phrenicopericardial ligaments mentioned above (Liem, 2005, p.536).

Besides the tentorium cerebelli, the cervicothoracal diaphragm and the diaphragma pelvis, the thoracolumbal diaphragm belongs to the important horizontal fascia layers of the body. The thoracolumbal diaphragm is the most important respiratory muscle. It contracts more than 20 000 times a day. Since the diaphragm is connected to the organs below and above the movements of the diaphragm is transmitted to these organs (Barral, 1994).

During the inhalation phase the centrum tendineum descents and thus the vertical diameter of the thorax enlarges (Fig. 5). This lowering is immediately limited by the increasing tension of the ligamentous connections of the mediastinum and by the increasing pressure of the viscera of the abdomen (Kapandji, 1992). Afterwards further thorax expansion takes place increasing the horizontal and lateral diameter of the thorax.

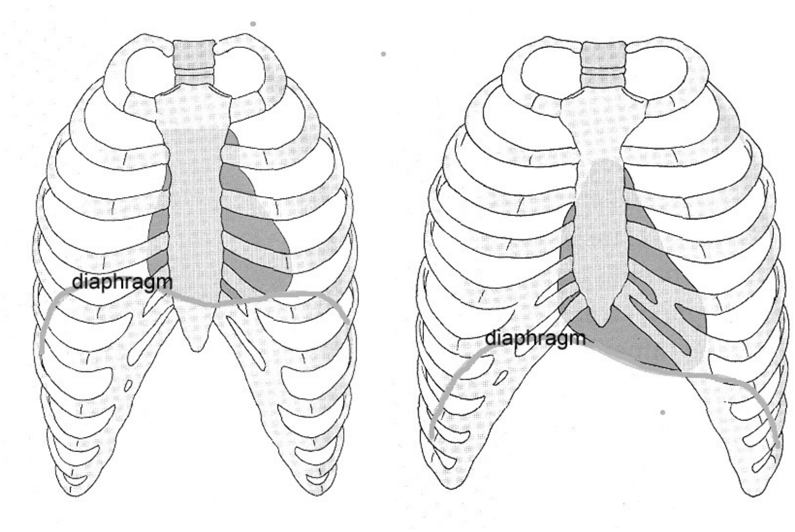

Figure 5 Position of diaphragm and heart.
The Figure shows the change in shape of the thorax and the position of the heart caused by the movements of the diaphragm during expiration and inspiration.
Figure taken from Schwind, 2003, p.32

Malfunction of the viscera, vertebral or costal lesions as well as metabolic or psychological disorders can cause restrictions of the diaphragm. Symptoms are shallow breathing and difficulty with inhalation. *(Barral, 1997).*

1.4.2.5 The Lung and Lung Volumes

The largest organs above the diaphragm are the lobes of the lungs. These are covered by the pleura consisting of two distinct layers, the visceral and the parietal layer. A fluidal film between the visceral and parietal layer of the pleura enables the lungs to follow the movements of the diaphragm and the thorax. The capillary effect of this fluidal film is also responsible for the fact that the lobes of the lung occupy the greatest possible volume inside the thorax. The mediastinum containing the heart is hold in place by the equivalent pressure in both lobes of the lung. The parietal layer of the pleura lines the entire thoracic cavity and adheres to the diaphragm (Barral, 1997).

During inspiration the muscles of the thorax generate negative pressure in the pleural space, directing flow of air into the lungs. The lobes of the lungs expand until the pressure equilibrates. When the muscles relax the pressure in the lungs increases and thus forces air out of the lungs -.expiration (Standring, 2005).

Pulmonal diseases causing a reduction of tissue-flexibility are called “restrictive”. One cause for such diseases are adhesions of the two layers of the pleura. As a result, the lungs or even the ribcage loose flexibility. Normal lung function is impaired (Alexander, 1999). A similar effect can be expected when the intrathoracical ligaments exert a reduced elasticity (Buset, 2000).

Lung function parameters – vital capacity

Restrictive pulmonal deseases result in reduced “vital capacity”. (VC). VC is defined as the maximum volume that an individual can expire after a single maximal inspiration *(Haber, 2004).* VC is one of the parameters that can be measured by spirometry (an overview of relevant parameters can be seen in Fig. 6).

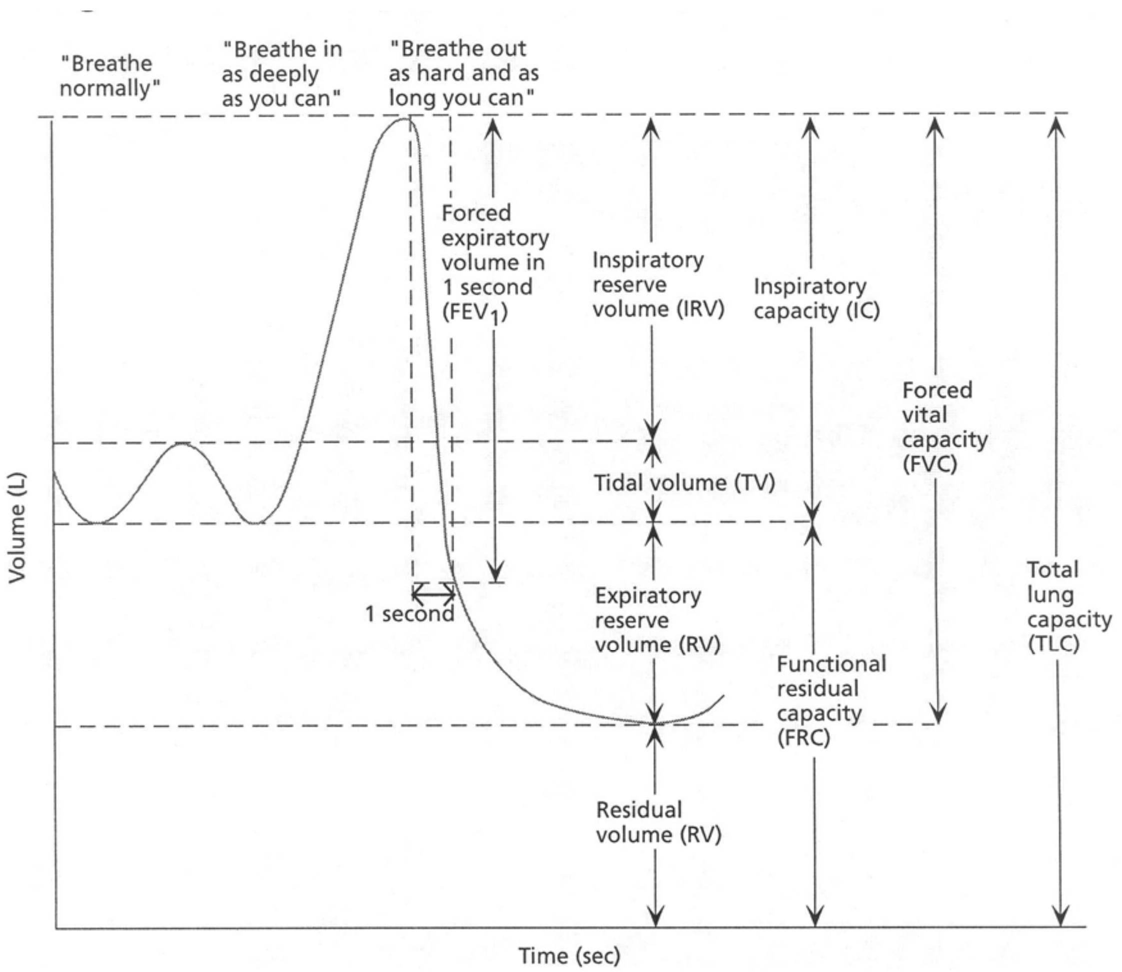

Figure 6 Lung function parameters that can be measured by spirometry
Figure taken from Cleveland Clinic Journal of Medicine, Volume 70, Number 10, 2003, p.871

These parameters can be either measured directly or can be calculated from spirometric measurements. Spirometry is the most commonly used examination method for lung function (Gold-Standard).

The measurement can be performed in a forceful manner to generate a “forced vital capacity” (FVC) or in a more relaxed manner to generate a “slow vital capacity” (SVC). In normal individuals, the inspiratory vital capacity, the expiratory SVC, and expiratory FVC are more or less equal. Measurement of FVC requires a voluntary manoeuvre in which a seated or standing patient inhales maximally from tidal respiration to total lung capacity (TLC) and then rapidly exhales to the fullest extent until no further volume is exhaled at residual volume (RV). The measurement is so simple that it can be administered in an ambulatory setting (Gildea, 2003).

Relevant information can be obtained when the measured values of an individual patient are compared with standard values. The deviation from the standard value is used to define normal and abnormal. The extent of the deviation is a measure of the severity of the abnormality. Alternatively, intraindividual alternations can be monitored. According to *Baur et al, 1996*, the interpretation of individual lung function measurements should primarily be based on the intraindividual alterations instead of comparison with standard values.

All pulmonary volumes and capacities are about 20 to 25 per cent less in woman than in men, and they are obviously greater in large and athletic persons than in small and asthenic persons. Typical values for male are > 4l, typical value for female >3l, but standard values are highly variable in the literature (Röcker, 2001).

2 AIM OF THE STUDY

The aim of the present study was to investigate whether the treatment of the pericardial ligaments can increase vital capacity in persons with restricted mediastinal mobility.

For that, recoil and stretch techniques to the sternopericardial and vertebropericardial ligaments were applied. Since the autonomous nerve system might be involved in the loss of elasticity of affected ligaments a single stretch event should result in a partially restored elasticity of the respective ligament.

The hypothesis was that the treatment results in an in an increase of vital capacity of at least 5%.

3 METHODS

3.1 Methodological Design

Type of Study

A quasiexperimental matched controlled study was chosen: the data obtained with the experimental group (with treatment) were compared with those of a control group without any therapy. The independent variable was the specific osteopathic treatment, the dependent variable investigated was the vital capacity measured by spirometry (unifactorial design).

Overview of the Methodology employed

The numbers in parenthesis are the numbers of the following chapters

Interview part I - exclusion criteria fulfilled? (3.2.1)

⇓

Inclusion Criteria - Sternovertebral test (3.2.2)

⇓

Interview - further exclusion criteria not fulfilled? (3.2.1)

⇓

Assignment of individual probands to either treatment or control group (3.3)

⇓

Initial measurement of vital capacity (3.4)

⇓

Osteopathic treatment (control group: no treatment) – (3.5)

⇓

Measurement of vital capacity

⇓

Data analysis – (3.7)

3.2 Probands

Persons visiting the physiotherapeutic/osteopathic ambulance at the public hospital of the Austrian town Klosterneuburg were chosen as probands (nonprobability sampling). The participation was voluntarily. Every person was informed about the rationale and the procedure in advance. A total of 65 probands were selected by application of the exclusion and inclusion criteria described below.

3.2.1 Exclusion Criteria

First, probands were asked whether they have an acute illness, whether they passed surgical interventions in the thorax like the implantation of a pacemaker. They were also asked if they suffer from thoracical disease in combination with a higher risk of bone fracture. If they agreed they were excluded from participation.

If the probands fulfilled the inclusion criteria (see 3.2.2.), the homogeneity of the group was considered. For that, probands were interviewed according to a guideline that named further exclusion criteria: pulmonary and/or internal diseases (including asthma, pneumonia, COPD and emphysema in progressed stage), osteoporosis, cancer, the consumption of corticosteroids or blood-diluting agents, neurological disorders of the cervical or thoracical spinal column, pregnancy (questionnaire see appendix).

In addition, probands with abnormal thoracocervical posture and vulnerability of the skin in the thoracical region were excluded after visual inspection.

3.2.2 Inclusion Criteria

In order to identify persons with a reduced mobility of the mediastinum (inclusion criterium) the remaining probands were subjected to the following **sternovertebral test:**

The sternovertebral test is a test for the elasticity of the soft tissues localized between the sternum and the vertebral column *(Barral, 1997).*

The test was performed with the patient in seated position. One palm was placed against the spinous processes of the thoracical vertebra 4 and 5 and the other was placed on the sternum. To test the resistance of the tissues beyond the sternum the anterior palm applied a slight posterior pressure to the sternum. The palm at the vertebral column acted as a stabilizer on the backside of the body. Next, the anterior palm exerted slight pressure in several directions. The palm placed on the vertebral column helped focussing the pressure to the respective direction.

The amount of force and the amplitude of motion tested was between listening and mobility testing. When the compression was easy but the return was slow mediastinal or pericardial tensions were present (Barral, 1997, Buset, 2000, Ligner, 1999) and the proband included into the study.

3.3 Assignment of Individual Probands to the Treatment or Control Group

Whether a proband was assigned to the treatment group or to the control group was decided by lot. Probands of the control group were subjected to the same procedure besides the fact that they rested 20 minutes in a sitting position instead of receiving a treatment.

3.4 Measurement of Vital Capacity

The vital capacity as the dependent variable was measured with a spirometer (Vicatest P1/Hellige) with following specifications: volume accumulation for more than 30 s, acomodation of volumes of up to 7 litres, accuracy within 3% or 50 ml of a "test" volume. To enable the calculation of the vital capacity expressed as the percentage of standard value age, height and sex were typed into the device.

The measurements of forced expiratory vital capacity were performed in upright standing position while the nose was closed with a noseclamp. The patients were instructed to inhale as much as possible outside air and to exhale into the mouthpiece as much as they could.

Since probands are not always able to completely fulfil the instructions, individual measurements can fail to reach the correct value of the forced vital capacity. Thus, measurements were repeated two or three times in succession, the highest value was considered to be the correct value (*Haber 2004*).

3.5 The Treatment of the Pericardial Ligaments

Recoil techniques were chosen for the treatment of the sternopericardial ligaments, a stretch technique for the vertebropericardial ligaments (*Barral, 1997, 2004* and personal instructions at the Wiener Schule für Osteopathie by *Buset 2000*, *Ligner 1999* and *Rommeveaux 1998*).

Recoil techniques with respiratory assistance applied on the sternum are known to restore function of the pericardium and the mediastinum (*Barral, 1997*). Recoil techniques use high velocity and small amplitude with minimal force. The practitioner puts away his hands immediately after the correcting force to use the tissues rebound for correction (*Ligner, Assche, 1993*).

Stretch techniques are treatments for ligaments, fascias and muscles using long leverarms and slow extension movements focussing the shortened tissue (*Ligner, Assche 1993*).

For both types of treatment the hands contact the skin first in the sternal area. The “listening” hands then explore resistance and flexibility of the subcutaneuous layers followed by the periost and the bone. “Listening” continues until the respective ligaments can be sensed *(Schwind, 2004)*. Thus, for successful treatment the hand has to be active and perceptiv at the same time to be able to harmonize the treatment with the responses of the three dimensional network of the tissues.

All treatments were performed in supine position. The directions of stretching or recoiling, respectively depended on the results of “listening”. Each treatment was performed three times with the stretching in the direction indicated by testing. The overall time needed for one proband was about 20 minutes.

The mobilisation was performed in the following order:

3.5.1 Treatment of the Ligamentum Vertebropericardium

Treatment was performed in sitting position from the head end. Probands were lying supine and were instructed to breath deep. During inspiration the upper, flat hand exerted progressive pressure to the sternum into dorsal-caudal direction. At the same time the other hand exerted traction to the cervicothoracal junction in cranial-ventral direction, resulting in stretch and hyperextension of the spinal column.

3.5.2 Treatment of the Ligamentum Sternopericardium Superior

For treatment the osteopath was standing at the head end. Probands were told to breath deeply also in supine position. During inspiration both thumbs applied pressure at the level of the second rib to the manubrium sterni in dorsal-caudal direction (Fig. 7). Immediately before inspiration ceased the thumbs were removed quickly (recoil technique).

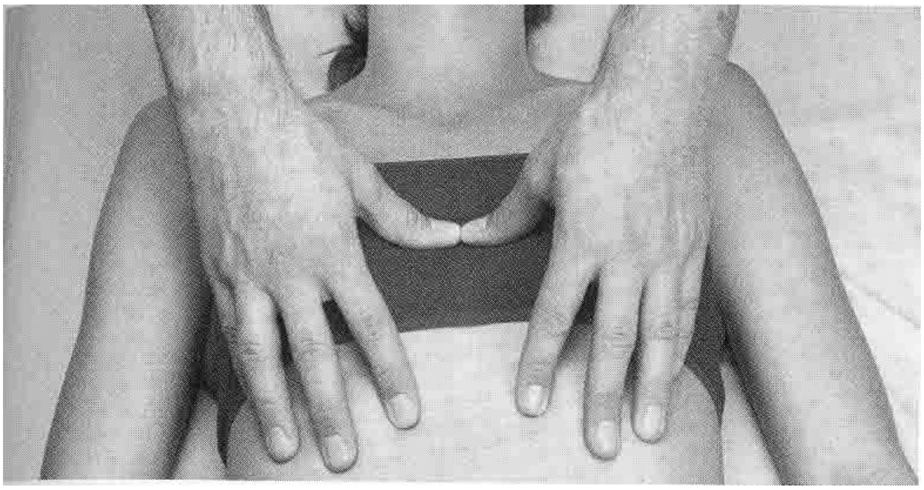

Figure 7 Treatment of the ligamentum sternopericardium superior
Figure taken from Liem, 2005, p.625

3.5.3 Treatment of the Ligamentum Sternopericardium Inferior

The technique closely resembles that of the treatment of the ligamentum sternopericardium superior. The only differences: Pressure is applied to the sternum at the level of the sixth rib (instead of the second rib) and the direction of the pressure is exerted in anterior-posterior direction.

3.5.4 Sternovertebral Technique

The treatment was performed from the head end in upright position, patient supine. One flat hand contacted the thoracical spine. The second hand was localized at the sternum at the level of the sternal angle. The patient´s head leaned against the abdomen of the osteopath resulting in flexion of the cervical spine. The lower hand focussed to the thoracical vertebra four applied pressure into cranial-ventral direction. At the same time the upper hand built up tension in the mediastinum by extending the elbow in caudal-dorsal direction. When maximal tension was reached the hands detached suddenly (recoil) – Fig. 8.

Afterwards, the treatment was repeated with the following alteration: the hand contacting the sternum exerted tension in craniodorsal direction, the lower hand applied pressure into caudal-ventral-direction.

Figure 8 Sternovertebral technique
Figure taken from Barral 1997, p.148

3.6 Treatment of the Diaphragm

This treatment is recommended for vertical shortenings and fixations of the mediastinum, which affect the heart as well as the breathing function (*Barral, 1994*).

For treatment, the patient was sitting with flexed spine leaning towards the standing osteopath (Fig. 9 left). Flexion of the spine was essential, since relaxation of the mediastinum and the abdominal muscles is a prerequisite for the treatment. For mobilisation, the ulnar sides of both hands contacted the costal insertions of the diaphragm. Mobilization was performed by rhythmical rotatory movements in close contact with the proband´s thorax. Traction was applied during backward rotation. After each cycle the hands slid to more lateral parts of the costal arch. Finally the patient had to breath in deeply three times while traction of the costal arch was maintained, fixing the thorax in inspiration position.

Afterwards the proband changed to supine position with the osteopath standing at one side (Fig. 9 right). One hand contacted the costal arch and exerted tension as described above. The other hand rotated the flexed legs of the patient. The same was repeated on the other side.

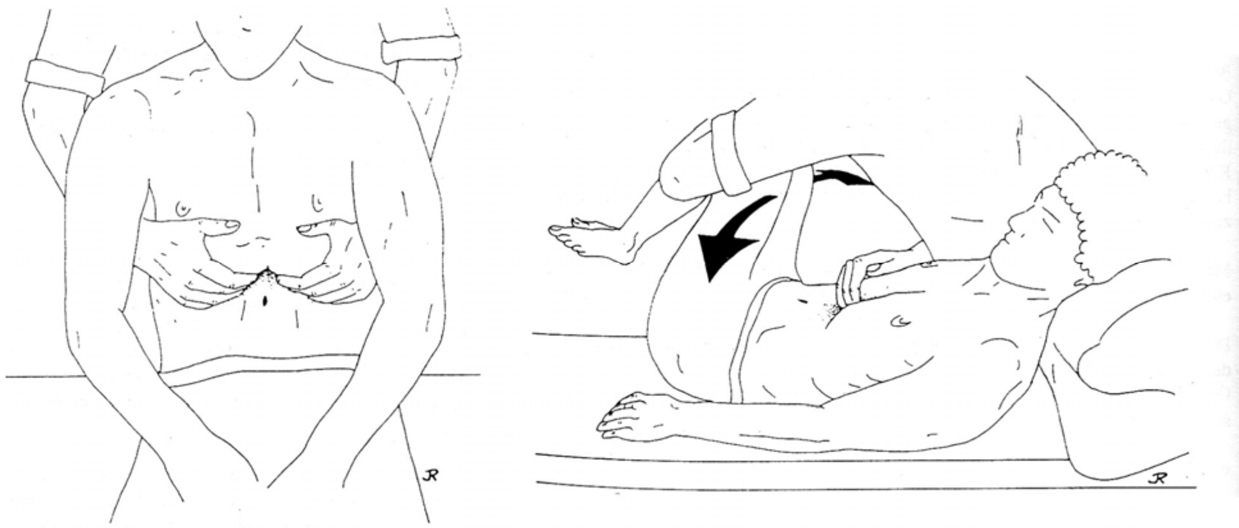

Figure 9 Treatment of the diaphragm
Figures taken from Barral, 1994, p.98

3.7 Data Analysis

The spirometer yielded the following data for each measurement: vital capacity in litre, relative percentage of the measured value in comparison to the standard value (depending on the age, height, and sex of the proband). All data obtained were analysed with MS Excel.

The initial measurement of vital capacity was performed more than once in most of the cases (see 3.4., p 20). For calculation of the correct initial value the highest value was chosen. To find out, whether the osteopathic treatment altered the vital capacity the individual differences of vital capacity before and after treatment were calculated and plotted (Fig. 10, p 28). To study the overall effect of the treatment the mean value of this alteration was also determined. To test whether the alterations in vital capacity differed from treatment to control group a t-test was performed. For that, the standard deviation of both groups was calculated, followed by a one-sided f-test. For determination of the t-value a two-sided t-test was chosen (5% level).

All these calculations were made independently for the treatment and the control group.

To find out whether the magnitude of the relative vital capacity of the individual proband had an influence on the effect of the treatment, the respective values were plotted (Fig. 11, p.29). Furthermore, the influence of the age of the patient on the effect was also determined (Fig. 12, p.30).

4 RESULTS

4.1 Compliance of the Probands

All 65 persons that were included exhibited strong interest in the study. Special interest was directed to the fact that the osteopathic treatment was monitored with a traditional school medical measurement. Some probands characterized the combination of these two methodologies as a positive indicator of quality. Many of them proposed a similar procedure for future osteopathic treatments. Thus, it was clear that every single person tried hard to reach full vital capacity at the spirometric measurements, the probands fulfilled an essential criterium for a correct measurement. The high quality of the data obtained is obvious when single measurements of the individuals were compared *(Haber, 2004):* consecutive measurements yielded values that differed less than 5% or 100 ml from each other most cases (see table 3 and 4, appendix)

All patients of the treatment-group declared to feel more free in the thoracical region, to move and to breath easier.

4.2 Effect of the Osteopathic Treatment on Vital Capacity

As can be seen in *table 1* the 30 probands of the treatment group had an average age of 62 years (control group 67), and consisted mainly of females. The initial relative vital capacity (percentage of normal value for the respective age; displayed by the spirometer) of the probands varied from 17% to 126% (control group 57% to 122%). At the initial measurement only 13 persons of the treatment group (7 control group) obtained 100% or more percent of normal value. The latter fact confirms the assumption that the sternovertebral test was effective for selection of persons with reduced vital capacity.

Treatment group									Control group								
			Vital capacity									Vital capacity					
			before treatment		after treat-ment		difference					1st value		2nd value		difference	
No of proband	**age**	**sex**	**in L**	**% of standard value**	**in L**	**% of standard value**	**in L**	**in % of initial value**	**No of proband**	**age**	**sex**	**In L**	**% of standard value**	**in L**	**% of standard value**	**in L**	**in %**
1	46	f	**3,64**	122	**3,87**	130	**0,23**	6,6	31	50	f	**3,38**	115	**3,4**	116	**0,02**	0,9
2	47	f	**2,71**	76	**3,25**	91	**0,54**	19,7	32	59	f	**2,89**	89	**2,83**	88	**-0,06**	-1,1
3	81	m	**2,89**	116	**2,81**	107	**-0,08**	-7,8	33	38	f	**2,75**	79	**2,76**	79	**0,01**	0,0
4	39	f	**3,79**	100	**3,98**	105	**0,19**	5,0	34	50	f	**3,4**	91	**3,44**	92	**0,04**	1,1
5	80	f	**1,87**	90	**1,89**	91	**0,02**	1,1	35	46	f	**2,92**	92	**2,9**	91	**-0,02**	-1,1
6	49	f	**1,96**	79	**1,66**	67	**-0,30**	-15,2	36	63	f	**2,52**	87	**2,5**	86	**-0,02**	-1,1
7	77	f	**2,08**	98	**1,74**	82	**-0,34**	-16,3	37	59	f	**2,66**	90	**2,85**	97	**0,19**	7,8
8	84	f	**0,39**	17	**0,47**	21	**0,08**	23,5	38	62	m	**3,44**	79	**3,85**	89	**0,41**	12,
9	69	f	**2,99**	108	**2,79**	101	**-0,20**	-6,5	39	76	f	**2,14**	83	**2,23**	86	**0,09**	3,6
10	45	f	**2,64**	79	**2,64**	79	**0,00**	0,0	40	88	f	**2,27**	118	**2,08**	108	**-0,19**	-8,5
11	52	f	**2,87**	92	**2,85**	91	**-0,02**	-1,1	41	65	f	**3,06**	107	**2,96**	104	**-0,10**	-2,8
12	76	f	**1,96**	92	**1,89**	89	**-0,07**	-3,3	42	91	f	**1,66**	88	**1,46**	77	**-0,20**	-
13	78	f	**2,16**	112	**1,93**	100	**-0,23**	-10,7	43	70	f	**2,37**	98	**2,27**	94	**-0,10**	-4,1
14	76	f	**2,39**	126	**2,29**	121	**-0,10**	-4,0	44	73	f	**1,41**	58	**1,56**	64	**0,15**	10,
15	65	f	**2,67**	97	**2,79**	101	**0,12**	4,1	45	73	f	**1,87**	77	**1,96**	81	**0,09**	5,2
16	64	f	**3,31**	117	**3,27**	116	**-0,04**	-0,9	46	85	f	**1,79**	76	**1,6**	68	**-0,19**	-
17	62	f	**2,67**	115	**2,71**	117	**0,04**	1,7	47	56	f	**1,97**	83	**1,7**	72	**-0,27**	-
18	41	f	**2,67**	80	**2,66**	80	**-0,01**	0,0	48	79	f	**1,7**	83	**1,66**	81	**-0,04**	-2,4
19	35	f	**3,02**	86	**3,23**	92	**0,21**	7,0	49	70	m	**2,27**	66	**2,16**	62	**-0,11**	-6,1
20	85	f	**1,35**	54	**1,32**	53	**-0,03**	-1,9	50	83	f	**2,04**	94	**2,12**	98	**0,08**	4,3
21	48	f	**3,81**	109	**4,15**	119	**0,34**	9,2	51	70	m	**3,44**	77	**2,92**	65	**-0,52**	-
22	55	m	**4,34**	101	**4,69**	109	**0,35**	7,9	52	77	f	**2,19**	72	**2,5**	83	**0,31**	15,3
23	63	f	**2,60**	76	**2,55**	75	**-0,05**	-1,3	53	39	f	**3,94**	104	**3,83**	101	**-0,11**	-2,9
24	64	f	**2,90**	104	**2,83**	102	**-0,07**	-1,9	54	47	f	**3,62**	122	**3,82**	129	**0,20**	5,7
25	58	f	**2,37**	78	**2,71**	90	**0,34**	15,4	55	82	m	**2,29**	57	**2,54**	61	**0,25**	7,0
26	70	m	**2,48**	72	**2,44**	71	**-0,04**	-1,4	56	64	f	**2,81**	96	**2,83**	97	**0,02**	1,0
27	69	f	**2,33**	84	**2,35**	85	**0,02**	1,2	57	81	f	**1,91**	94	**1,97**	97	**0,06**	3,2
28	62	m	**4,02**	98	**4,11**	91	**0,09**	-7,1	58	82	m	**2,9**	113	**2,71**	105	**-0,19**	-7,1
29	57	m	**4,46**	105	**4,19**	99	**-0,27**	-5,7	59	71	f	**2,58**	115	**2,66**	119	**0,08**	3,5
30	54	f	**3,04**	101	**2,79**	92	**-0,25**	-8,9	60	71	m	**3,02**	88	**3,04**	89	**0,02**	1,1
∅	62		**2,746**		**2,762**		**0,016**	0,3		67		**2,574**		**2,570**		**-0,003**	-0,2
SD							**0,20923**		SD							**0,18591**	

f-value: 1,2667 (critical value: 2,1; p<0,05); t-value: 0,371812 (critical value 2,00172; p<0,05)

Table 1 Measurements of vital capacity of the probands and control group

For calculation of the difference in % the first value was set 100%. ∅...mean value

The individual alterations of vital capacity are visible in the following diagram (Fig. 10).

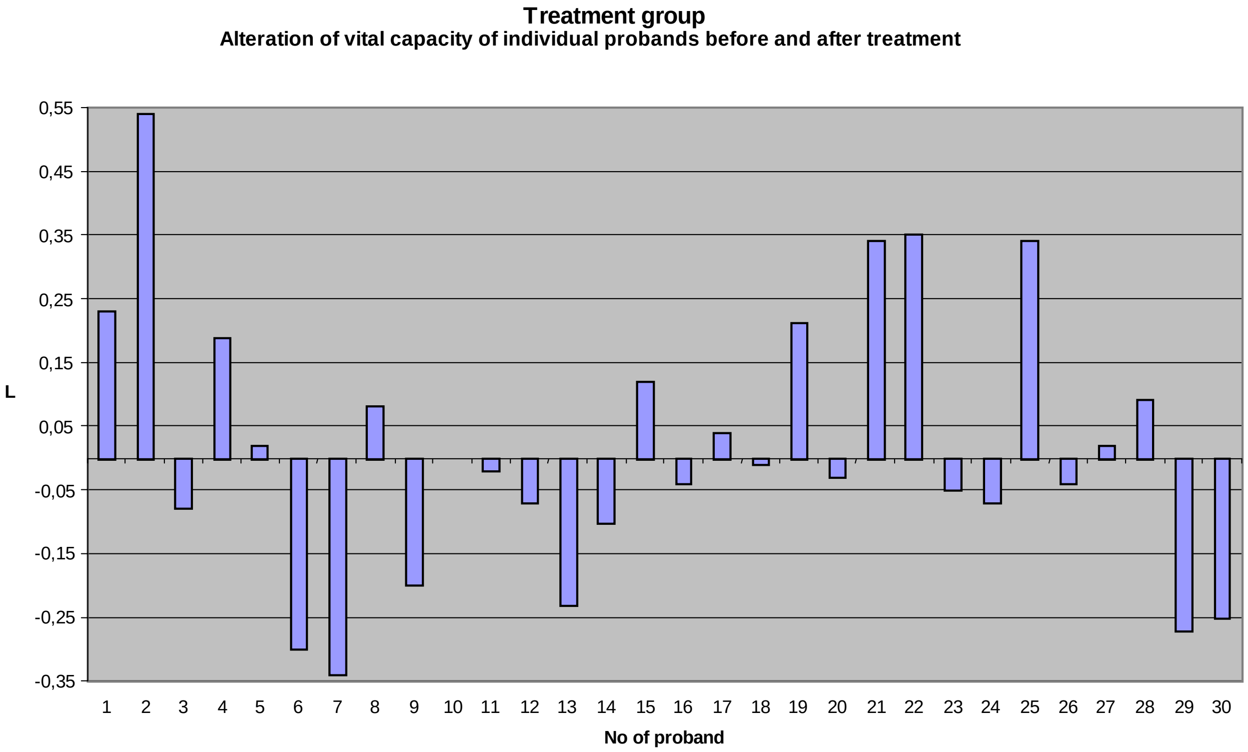

Figure 10 Individual differences of vital capacity before and after treatment
The initial value before treatment was set zero.

The vital capacity before and after the osteopathic treatment differed only by 0,016L (mean value). Though this alteration was very low, a statistical analysis was performed. However, a t-test demonstrated that there was no significant difference between treatment and control group (Table 1). Thus the vital capacity was hardly influenced by the treatment of the pericardial ligaments.

To analyse whether the effect of osteopathic treatment is influenced by the magnitude of the initial vital capacity, the difference of vital capacity before and after treatment was plotted against the relative vital capacity in % of every individual proband. Figure 11 demonstrates that there was no correlation between these two values (the dots are randomly distributed).

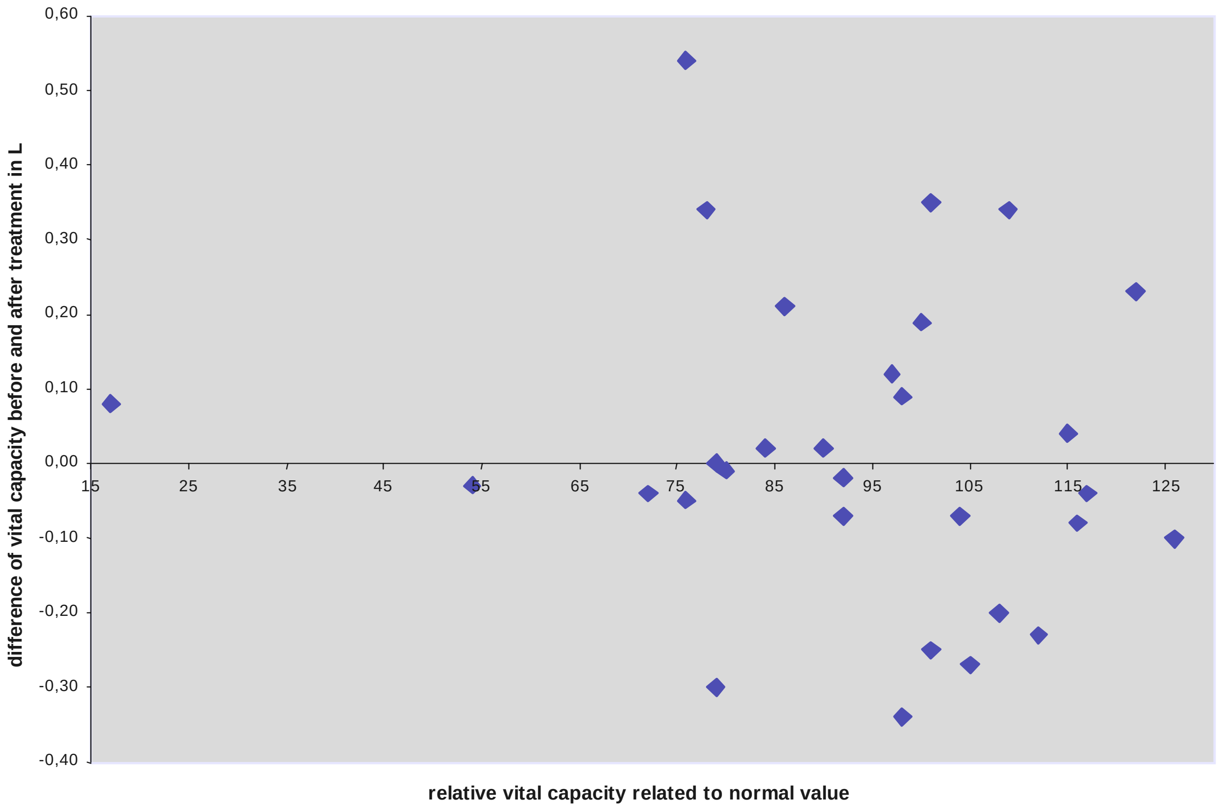

Figure 11 Correlation between the relative vital capacity and the difference of vital capacity before and after treatment

In order to find out, whether the effect of osteopathic treatment is influenced by the age of the individual proband, the age was plotted against the difference in vital capacity for every proband. Since these dots are also randomly distributed, no correlation could be detected (Fig. 12).

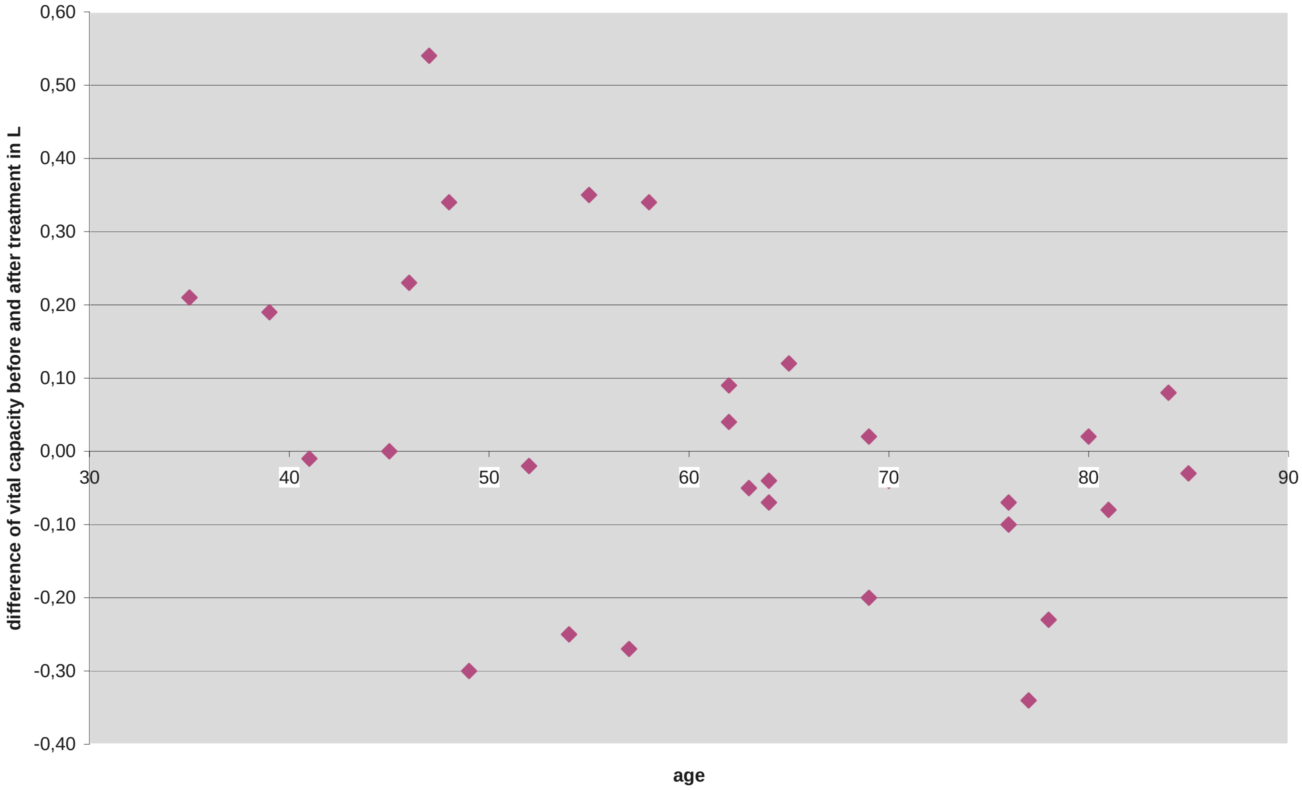

Figure 12 **Correlation between the age of the proband and the difference of vital capacity before and after treatment**

Alternative Strategy

Since treating of the pericardial ligaments and the mediastinum did not result in a significant improvement of vital capacity, an alternative strategy was tested briefly. It should be mentioned that it was not possible to study the effects of this alternative technique thoroughly.

The mobilisation of the diapraghm is described as a method suitable for relaxation of the mediastinum resulting in a better perspiration.

As can bee seen in table 2, five female patients joined this group (average age 57), initial relative vital capacity varied from 67% to 111%. Only one proband obtained more than 100% of normal value.

Vital capacity								
before treatment					after treatment			
No of pro-band	age	sex	higher value	% of standard value	in L	% of standard value	Deviatation L	Devbiatation %
1	65	f	3,17	111	2,96	104	-0,21	-6,3
2	63	f	2,79	96	2,90	100	0,11	4,2
3	60	f	2,79	87	2,50	78	-0,29	-10,3
4	33	f	2,41	67	2,64	73	0,23	9,0
5	65	f	2,69	96	2,79	99	0,10	3,1
∅	**57**		**2,770**		**2,758**		**-0,012**	**-0,1**

Table 2 Measurements of vital capacity of the probands /alternative strategy

For calculation of the difference in % the first value was set 100%. ∅...mean value

The values of vital capacity before and after treatment were graphically represented alterations of vital capacity are visible in the following diagram (Fig. 13).

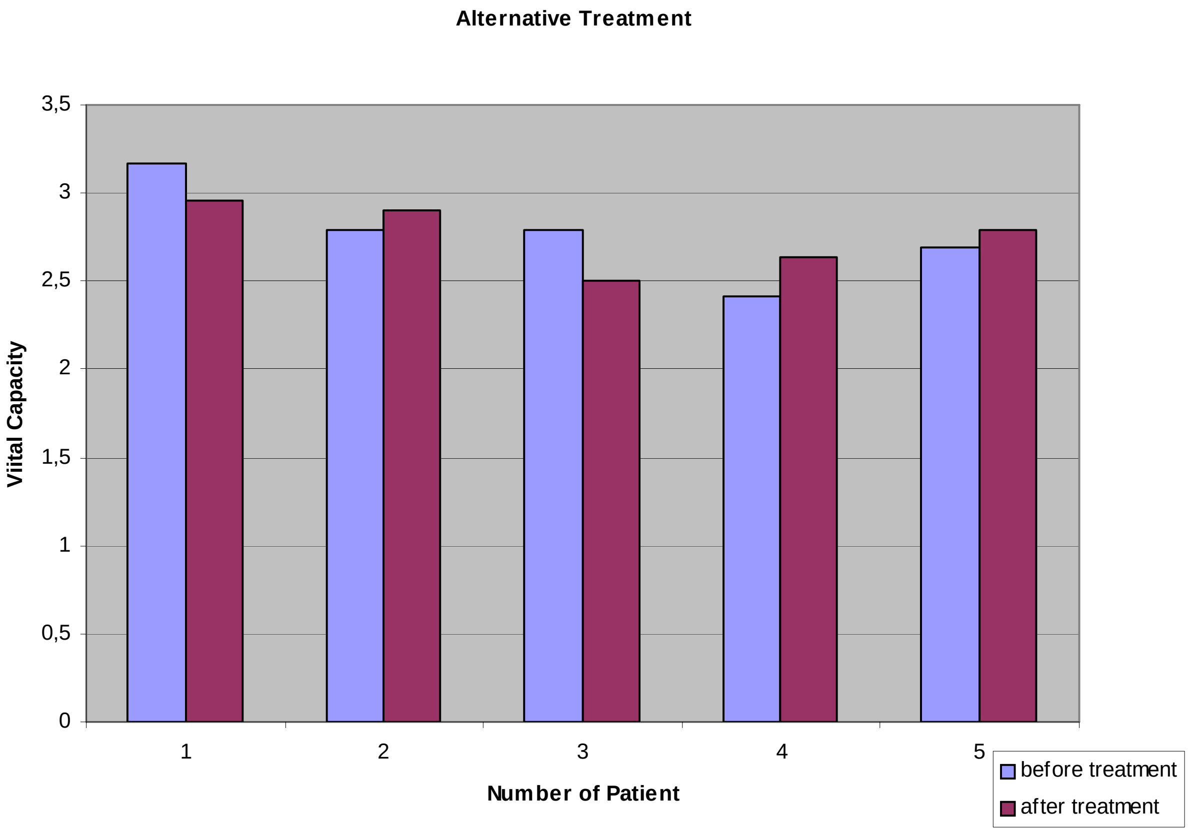

Figure13 Vital capacity before and after treatment (alternative strategy)

Figure 13 demonstrates that the vital capacity increased in three of five probands, it was reduced in the other two. Calculation of mean values (table 2) point to the fact, that the mobilisation of the diaphragm is also inefficient in improving vital capacity.

5 DISCUSSION

5.1 Discussion of Methodology chosen for this Study

Methodological Design

In the current study a quasiexperimental design was chosen, since a true experimental design would require more personal and temporal resources. Since I worked alone the coordination of the study and the therapy was performed by the same person reducing the internal validity. For the same reason, it was not possible to make the study blinded.

The present study worked intentionally with probands, and not with patients. Treatment of patients might have resulted in stronger effects on vital capacity, since certain thoracical pathologies reduce vital capacity. The treatment chosen for this study is associated with certain risks (see below) when applied to patients, thus an official permission and the involvement of a team of specialists would be necessary.

For instance, patients suffering from pulmonal diseases might be asthmatic. These patients are often treated with corticosteroids that increase the risk of bone fracture. Recoil techniques like those used in the present study have the potential to induce bone fracture in such patients. Other patients might suffer from cancer, the osteopathic treatment could aggravate the condition.

To select a subgroup of probands in which the treatment might be effective and to guarantee homogeneity of the group, persons with restrictions of the mediastinum should be selected. School medicine has no suitable test. Thus a manual test, the sternovertebral test (*Barral, 1997*) was chosen, though the validity of such a manual tests is limited (*Sommerfeld 2004*).To optimize the reliability of the test the author was supervised by professors of the WSO (*Franz Buset D.O. and Bernard Ligner D.O*.). The procedure was standardized.

The treatment was based on the idea that mobilisation of a single structure, in this case the pericardial ligaments, can restore the function of the whole system. *Barall 1994* describes this effect as “restoration of harmony” that recovers the interaction between contents and covering).

The measurement of forced vital capacity was chosen as the dependent variable because of its practicability. The measurement is a non invasive procedure, easily to explain and lasts only few minutes. This method is the gold-standard in lung function testing. Whether this method is the best to examine the effectiveness of a treatment can be discussed.

5.2 Discussion of the Results of the Study - Efficiency of Osteopathic Treatments on Vital Capacity

In the present study, a single osteopathic treatment of the pericardial ligaments did not alter vital capacity.

For that, different reasons can be responsible.

Since organs might cause restrictions of the pericardial ligaments it might be necessary to treat not only the ligaments, but also the organs. This assumption correlates well with the usual treatment procedure of osteopaths that do not treat single structures but whole functional systems.

The mobilization might be inefficient, since it was only performed once. Furthermore, there might be no short-time effect: regain of plasticity of ligaments might require a longer period, since the fibres need to be restructured. The treatment might also causa microtraumata in fascia and ligaments that need to heal up for fully restored function of these connective structures. Biochemical alterations require altered protein expression that does not take place in minutes. It is thinkable that the body needs a certain period for adaptation and that counterregulatory effects mask positive effects of the treatment.

It should be mentioned that lung parameters can be be altered within very short periods of time on principal. Significant effects on forced vital capacity (∅ 173 ml increase) were observed in pharmacological studies with different broncho-dilatators in COPD therapy *(Rabe et al, 2005*). However such effects are not mediated by ligamental relaxation.

Repeated treatments and measurements after a longer period might yield better results.

The argument that the sternovertebral pretest did not select appropriate probands: manual tests have a limited reliability and validity. It can not be excluded that only a subpopulation of the probands selected by the sternovertebral test can profit from the treatment. Restriction of the mediastinum can not only be caused by restricted pericardial ligaments, but also by other lesions inside the thorax like inflammations of the oesophagus, adhesions of the pleura.

However, it was obvious that the test selected persons with a lung function below normal values: The vital capacity of most of them was below standard values. An effect could also be expected since the proband chosen had a mean age of 62. Elder persons are known to posses more fibrotic and thus more restricted fascia than younger ones (*Ishihara 1980*).

Another cause for the fact that no detectable success of osteopathic treatment could be observed is that vital capacity is only one of a larger number of lung function parameters. In internal medicine usually several spirometric parameters are registered. Relevant information often depends on the relationship of different parameters (*Al-Ashkar 2003*). Unfortunately measurements of more parameters were not possible in the present study.

5.3 Effects of Different Treatments on Lung Function Parameters in the Osteopathic Literature

The effects of osteopathic treatment on fascial structure and function of the connective tissues of the mediastinum have not been elucidated in detail up to know.

Though the present study was not effective to improve an important lung parameter by an osteopathic treatment, this does not mean that osteopathic treatments are ineffective in modulation of lung function parameters.

Unfortunately, only few osteopathic studies investigating the correlation between an osteopathic treatment and vital capacity are available. The hitherto existing studies give no uniform results. The reasons for that might vary from the different treatment methods to the heterogeneity of the persons included.

No Effect to the Vital Capacity

The fact that the vital capacity could not be influenced significantly by osteopathic treatments correlates well with the results of *Gibb, 2002*, who applied a cervical high velocity technique. In addition, neither the posture (May, 2000) nor an inspiratory muscle training (Henderson, 2000) were able to increase lung function parameters (forced vital capacity and others).

Positive Efects to the Vital Capacity

In contrast *Gimborn, 2001* found positive and negative effects on lung function parameters after a fluid technique on the fourth ventricle in a subgroup of probands.

Astonishing results were published from several researchers of “The International Academy of Osteopathy” in Germany. *Schröder, 2003* described that the stretch of thoracical fascia improved the vital capacity significantly (11%). *Fischer, 2003* was able to improve the vital capacity by manipulation of the thoracical spine (Th1-Th5) depending on the level of the vertebra manipulated from 1,71% to 4,75%. These small alterations seem to be without medical significance.

Zielinski, 2005 treated 15 adults with chronic bronchial asthma in an osteopathic individualised manner for five times. In comparison to the control group, patients in the treatment group showed remarkable improvements in pulmonary function parameters and quality of life. The improvements amounted to 21% for FVC, 19% for FEV_1, and 26% for PEF. Even at the time of follow-up after six weeks these improvements were still evident at almost the same magnitude.

In spite of strong efforts it was impossible to get full text versions of all of the above cited studies. One academy even answered that diploma works are not available for inspection that complicated the comparison of scientific studies of this subject.

5.4 Ideas for Further Studies/ Perspectives

Further studies investigating the effects of osteopathic treatments on lung function parameters could focus on patients suffering from certain diseases.

For instance, persons suffering from whiplash injuries ore seatbelt traumas after car accidents could be investigated. Such patients exhibit strong restrictions in the fascial system that can appear even years later *(Barall 1997*).

Though the present study was not able to prove the efficiency of a certain osteopathic technique on a well accepted school medical parameters, I believe that such a type of study design should be model for further osteopathic studies. Osteopathy will be more accepted in central Europe, if measureable effects on well accepted parameters can be found.

6 LITERATURE

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Figures

Tables

7 APPENDIX

Treatment Group

Vital capacity

No of proband	age	sex	1. value in L	% of standard value	2.value in L	% of standard value	3.value in L	% of stadard value	higher value	% of standard value	in L	% of standard value	Deviation L	Deviation %
			before treatment						after treatment					
1	46	f	3,60	121	3,64	122	3,62	122	**3,64**	122	**3,87**	130	**0,23**	6,6
2	47	f	2,58	72	2,71	76	2,67	75	**2,71**	76	**3,25**	91	**0,54**	19,7
3	81	m	2,89	116	2,67	102	2,89	116	**2,89**	116	**2,81**	107	**-0,08**	-7,8
4	39	f	3,33	88	3,79	100	3,75	99	**3,79**	100	**3,98**	105	**0,19**	5,0
5	80	f	1,77	86	1,87	90	1,81	89	**1,87**	90	**1,89**	91	**0,02**	1,1
6	49	f	1,96	79	x	x	x	x	**1,96**	79	**1,66**	67	**-0,30**	-15,2
7	77	f	2,08	98	1,64	77	1,43	67	**2,08**	98	**1,74**	82	**-0,34**	-16,3
8	84	f	0,10	4	0,39	17	x	x	**0,39**	17	**0,47**	21	**0,08**	23,5
9	69	f	2,77	100	2,99	108	2,77	100	**2,99**	108	**2,79**	101	**-0,20**	-6,5
10	45	f	1,96	59	2,64	79	2,52	76	**2,64**	79	**2,64**	79	**0,00**	0,0
11	52	f	2,87	92	2,35	78	2,81	90	**2,87**	92	**2,85**	91	**-0,02**	-1,1
12	76	f	1,79	84	1,96	92	1,85	87	**1,96**	92	**1,89**	89	**-0,07**	-3,3
13	78	f	1,89	98	2,16	112	2,08	108	**2,16**	112	**1,93**	100	**-0,23**	-10,7
14	76	f	2,39	126	2,25	119	2,19	116	**2,39**	126	**2,29**	121	**-0,10**	-4,0
15	65	f	2,42	88	2,67	97	x	x	**2,67**	97	**2,79**	101	**0,12**	4,1
16	64	f	3,21	113	3,31	117	x	x	**3,31**	117	**3,27**	116	**-0,04**	-0,9
17	62	f	2,67	115	x	x	2,48	107	**2,67**	115	**2,71**	117	**0,04**	1,7
18	41	f	2,67	80	2,67	80	2,56	77	**2,67**	80	**2,66**	80	**-0,01**	0,0
19	35	f	2,98	84	3,02	86	2,98	84	**3,02**	86	**3,23**	92	**0,21**	7,0
20	85	f	1,23	49	1,35	54	x	x	**1,35**	54	**1,32**	53	**-0,03**	-1,9
21	48	f	3,81	109	3,56	102	x	x	**3,81**	109	**4,15**	119	**0,34**	9,2
22	55	m	4,34	101	x	x	x	x	**4,34**	101	**4,69**	109	**0,35**	7,9
23	63	f	2,60	76	x	x	2,60	76	**2,60**	76	**2,55**	75	**-0,05**	-1,3
24	64	f	2,90	104	x	x	x	x	**2,90**	104	**2,83**	102	**-0,07**	-1,9
25	58	f	2,37	78	2,19	73	2,35	78	**2,37**	78	**2,71**	90	**0,34**	15,4
26	70	m	2,42	70	2,48	72	2,27	66	**2,48**	72	**2,44**	71	**-0,04**	-1,4
27	69	f	2,16	78	2,33	84	x	x	**2,33**	84	**2,35**	85	**0,02**	1,2
28	62	m	3,96	87	4,02	98	x	x	**4,02**	98	**4,11**	91	**0,09**	-7,1
29	57	m	4,19	99	4,46	105	4,08	96	**4,46**	105	**4,19**	99	**-0,27**	-5,7
30	54	f	3,04	101	2,75	91	2,90	96	**3,04**	101	**2,79**	92	**-0,25**	-8,9
∅	**62**								**2,746**		**2,762**		**0,016**	**0,3**

Table 3 Measurements of vital capacity of the probands

x….no measurement available – repeated measurement was too exhausting for these patients

Control Group

Vital capacity														
			before rest								after rest			
No of proband	age	sex	1. value in L	% of standard value	2.value in L	% of standard value	3.value in L	% of standard value	higher value	% of standard value	in L	% of standard value	Deviation L	Deviation %
1	50	f	3,31	113	3,38	115	x	x	3,38	115	3,40	116	0,02	0,9
2	59	f	2,89	89	2,79	86	x	x	2,89	89	2,83	88	-0,06	-1,1
3	38	f	2,75	79	x	x	2,75	79	2,75	79	2,76	79	0,01	0,0
4	50	f	0,14	4	3,40	91	x	x	3,4	91	3,44	92	0,04	1,1
5	46	f	2,87	91	2,92	92	x	x	2,92	92	2,90	91	-0,02	-1,1
6	63	f	2,52	87	2,41	83	x	x	2,52	87	2,50	86	-0,02	-1,1
7	59	f	2,48	84	2,66	90	x	x	2,66	90	2,85	97	0,19	7,8
8	62	m	3,25	75	3,44	79	x	x	3,44	79	3,85	89	0,41	12,
9	76	f	2,08	80	2,14	83	x	x	2,14	83	2,23	86	0,09	3,6
10	88	f	2,27	118	1,96	102	x	x	2,27	118	2,08	108	-0,19	-8,5
11	65	f	3,06	107	x	x	x	x	3,06	107	2,96	104	-0,10	-2,8
12	91	f	1,66	88	1,48	78	x	x	1,66	88	1,46	77	-0,20	-
13	70	f	2,08	86	2,37	98	x	x	2,37	98	2,27	94	-0,10	-4,1
14	73	f	1,41	58	1,39	57	x	x	1,41	58	1,56	64	0,15	10,
15	73	f	1,85	76	1,87	77	x	x	1,87	77	1,96	81	0,09	5,2
16	85	f	1,79	76	1,64	70	1,45	62	1,79	76	1,60	68	-0,19	-
17	56	f	1,97	83	x	x	x	x	1,97	83	1,70	72	-0,27	-
18	79	f	1,70	83	x	x	x	x	1,7	83	1,66	81	-0,04	-2,4
19	70	m	2,27	66	2,10	61	2,06	60	2,27	66	2,16	62	-0,11	-6,1
20	83	f	2,00	92	2,04	94	x	x	2,04	94	2,12	98	0,08	4,3
21	70	m	3,44	77	3,37	75	x	x	3,44	77	2,92	65	-0,52	-
22	77	f	2,19	72	2,04	67	x	x	2,19	72	2,5	83	0,31	15,
23	39	f	3,94	104	3,91	103	3,75	99	3,94	104	3,83	101	-0,11	-2,9
24	47	f	3,62	122	3,60	122	x	x	3,62	122	3,82	129	0,20	5,7
25	82	m	2,16	54	2,29	57	x	x	2,29	57	2,54	61	0,25	7,0
26	64	f	2,69	92	2,58	88	2,81	96	2,81	96	2,83	97	0,02	1,0
27	81	f	1,71	84	1,91	94	1,81	89	1,91	94	1,97	97	0,06	3,2
28	82	m	2,90	113	2,89	112	2,63	102	2,9	113	2,71	105	-0,19	-7,1
29	71	f	2,48	111	2,58	115	x	x	2,58	115	2,66	119	0,08	3,5
30	71	m	3,02	88	3,02	88	x	x	3,02	88	3,04	89	0,02	1,1
∅	**67**								**2,574**		**2,570**		**-0,003**	**-0,2**

Table 4 Measurements of vital capacity of the control group

x….no measurement available – repeated measurement was too exhausting for these patients

Alternative Treatment group

Vital capacity												
			before treatment						after treatment			
No of proband	age	sex	1. value in L	% of standard value	2.value in L	% of standard value	higher value	% of standard value	in L	% of standard value	Deviatation L	Devbiatation %
1	65	f	3,10	109	3,17	111	**3,17**	**111**	**2,96**	**104**	**-0,21**	-6,3
2	63	f	2,79	96	2,54	88	**2,79**	**96**	**2,90**	**100**	**0,11**	4,2
3	60	f	2,79	87	2,66	83	**2,79**	**87**	**2,50**	**78**	**-0,29**	-10,3
4	33	f	2,02	56	2,41	67	**2,41**	**67**	**2,64**	**73**	**0,23**	9,0
5	65	f	2,69	96	2,67	95	**2,69**	**96**	**2,79**	**99**	**0,10**	3,1
∅	**57**						**2,770**		**2,758**		**-0,012**	**-0,1**

Table 5 Measurements of vital capacity of the probands/alternative strategy

8 QUESTIONAIRE FOR EXCLUSION CRITERIA

Fragebogen zur Erhebung der Einschlusskriterien

Sind Sie derzeit akut krank?

- ☐ nein
- ☐ ja
- ☐ Art der Erkrankung: ______

Haben Sie eine chronische Erkrankung?

- ☐ nein
- ☐ ja
- ☐ Art der Erkrankung: ______

Sind Sie schwanger?

◯ nein ◯ ja

Hatten oder haben Sie eine der folgenden Herz-Kreislauf- Erkrankungen?

- ☐ Herzschrittmacher
- ☐ Bypass-Operation
- ☐ Myokard-Infarkt
- ☐ Herzklappenfehler
- ☐ Pericard-Erkrankungen, z.B. Perikarditis
- ☐ Aneurysma
- ☐ Weitere Herz/Kreislauferkrankungen ______

Haben Sie eine der folgenden Erkrankungen der Atmungsorgane?

- ☐ Störung der Atmung
- ☐ Krankheiten der Trachea und Bronchien
- ☐ Neoplasmen der Lunge
- ☐ Tuberkulose
- ☐ Erkrankungen von Pleura oder Mediastenum/Zwerchfell
- ☐ Weitere Erkrankungen der Atmungsorgane

Haben Sie eine der folgenden Erkrankungen des Bewegungsapparats?

- ☐ Entzündliche Wirbelsäulen/Gelenkserkrankungen
- ☐ Osteoporose/Rippenfrakturen
- ☐ Operationen in den Bereich Thoras/Halswirbelsäule, ev. Implantatversorgung
- ☐ Wirbel-Knochenmetastasen
- ☐ Weitere Erkrankungen des Bewegungsapparats (im Thoraxbereich)

Erhalten Sie eine der folgenden Medikationen?

- ☐ Blutverdünnende Medikamente
- ☐ Corticosteroide
- ☐ Weitere Medikationen ______

9 ABBREVIATIONS

COPD ..... chronic obstructive pulmonary disease

FEV_1 .... forced expiratory volume in 1 second; volume of air forcibly expired from a maximum inspiratory effort in the first second

FVC .... forced vital capacity; the total volume that can be forcefully expired from a maximum inspiratory effort

Lx............ the x^{th} lumbar vertebra

PEF .... peak expiratory flow; the highest forced expiratory flow (L/second)

RV .... residual volume

SVC .... slow vital capacity

TLC......... total lung capacity

Tx .... the x^{th} thoracical vertebra

VC .... vital capacity

WSO....... Wiener Schule für Osteopathie