The Lungs and the Diaphragm

Grégoire Lason & Luc Peeters
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1. Introduction

The osteopath is often confronted with patients with respiratory problems, thoracic and cervical complaints.

In many cases the lungs are in dysfunction. The first sign for the osteopath is identification of one or more somatic dysfunctions in the region T1-5. The thoracic organs must be osteopathically examined in these patients.

The complaints that can originate from lung dysfunctions are diverse, from respiratory difficulties, thoracic and cervical complaints to general complaints such as tiredness and headaches.

The osteopath does not treat lung disease but can significantly influence functional problems. Even in patients with specific lung disease the osteopath can contribute in an important way to the total therapy of this patient.

In this e-book the aim is to present the osteopathic vision of lung examination and the functional treatment of the lungs, pleura and diaphragm as a means of improving the respiration, oxygen transport and the vital capacity of the patient.

For the reader who is not familiar with the osteopathic visceral approach please consult chapter 11 at the end of this e-book.
2. Anatomy

2.1. The Lungs
The lungs are intrathoracic organs, found left and right of the mediastinum.

The upper edge reaches the height of the first rib. When inhaling deeply the apex of
the lung ascends to 1 cm above the first rib.

The lower edge of the lungs lies upon the domed diaphragm.

The lower edge projects posteriorly to the height of T_{10} with exhalation and T_{12} with
inhalation (Figure 1).

The right lung has two fissures (Figure 1):

- A horizontal fissure that runs from the spinous process T_{3} and follows the
  fourth rib.

- An oblique fissure that runs approximately from the spinous process of T_{3} to
  the sixth rib (ventral).

The right lung has three lobes: superior, middle and inferior.

The left lung has one fissure (Figure 1):

- The oblique fissure that runs identically to the right oblique fissure.

The left lung has two lobes, superior and inferior.

The position of the fissures is important because the osteopath employs them to test
the mobility. The importance of this will be explained later in this e-book.

The left lung has an impression on its caudal/medial surface for the heart,
surrounded by the pericardial space.

On the medial side of the right and left lung is the hilus, which contains the bronchi,
lymph nodes and the venous and arterial vessels.
2.2. The Bronchi

The air transport occurs in the bronchi and bronchioles.

The bifurcation is found at the height of T₄₋₅ and the ventral projection is at the sternal angle (Figure 2).

The traction of the lungs upon the bronchi is greater on the right side because the bifurcation is right of the mid-line.

Branches (Figure 2):

- left and right primary bronchi,
- secondary bronchi in the lobes (2 left and 3 right),
- tertiary bronchi (in the segments),
- fourth order,
- fifth order,
- in total there are 23 orders of branching,
- bronchioles (smaller than 1 mm diameter),
- the deeper towards the bronchioles, the higher the number of smooth muscle (less cartilage),
- the alveoli are enveloped by the blood vessels (Figure 3),
- the entire complex is surrounded by elastic fibres,

Figure 1 - Topography of the lungs and the fissures
- the most distal part of the alveoli contain no muscular fibres.

Figure 2 - Bronchial branches

Figure 3 - Bronchioli and alveoli
3. Physiology

3.1. Respiration
Calm inhalation occurs under influence of the diaphragm.

Deep inhalation occurs under influence of the diaphragm and the external intercostal muscles.

Very deep inhalation occurs under influence of the diaphragm, the external intercostal muscles, scalene muscles, pectoral muscles and sternocleidomastoid muscles.

Calm exhalation occurs due to the elastic recoil of the diaphragm and lungs and the surface tension of the alveoli. It is a passive activity.

Deep exhalation occurs under influence of the internal intercostal and abdominal muscles.

During calm respiration the diaphragm descends 1 cm and the lungs expand with 500 ml of air.

During deep respiration the diaphragm descends 10 cm and the lungs expand with 2 - 3 l of air.

Following a forced exhalation, 5 l of air can be inhaled, trained athletes even more.

There is a ‘dead space’ of 150 ml.

3.2. Respiratory Control

**SENSORS:**
- Chemoreceptors
  - Central (brain stem)
  - Peripheral (carotid sinus and arch of aorta)
- Mechanoreceptors
  - Lungs and airways (Vagus n.)
    - Slow reaction (sensitive to held stretch)
    - Fast reaction (sensitive for irritants such as smoke,...)
  - C-fibers (sensitive for inflammation and congestion)

**CENTRAL CONTROL:**
- Brain stem (automatic)
- Medulla spinalis (information transfer)
- Cortex (voluntary respiration and non-respiratory activities)

**EFFECTORS:**
- Respiratory muscles (diaphragm, intercostal muscles, sternocleidomastoideus, scalene muscles)
3.3. Factors that can alter the Respiration

(Figure 19)

- Pain and emotions.
- Irritating physical and chemical substances.
- Stretch of the lungs: this activates stretch receptors that afferent to the brain stem. From the brain stem the inhalation is inhibited (Hering-Breur reflex).
- Blood pressure alterations, detected by baroreceptors in the arch of the aorta and in the carotid artery. A decrease in the blood pressure will increase the respiratory rate and depth.
- Changes in the plasma (pH,…).
- Temperature: temperature increase of the air expands it. The air will move more within the alveoli (kinetic energy) and more gaseous exchange occurs. Temperature decrease will result in the opposite.

Figure 19 - Factors that can alter the respiration
3.4. Lung Volume
(Figure 20)

Vital capacity (VC):
This is the maximum volume of exhaled air following a maximum inhalation.
This is a measure for the elasticity of the lungs and the thorax as well as the force of
the respiratory musculature.
This value is reduced in cases of different conditions.

Functional residual capacity (FRC):
This is the volume that remains in the lungs after a normal exhalation.
This is a measure of gaseous exchange in the alveoli.
This is increased in conditions such as asthma.

Peak flow:
This is the maximum exhalation speed.

Forced expiration volume (FEV) (Schapira et al 1993):
Normal value = FEV1.0 sec = approximately 80% of the forced vital capacity.
Indicates the quantity of air that can be exhaled in 1 second.

Figure 20 - The lung volume
4. Mobility

4.1. The Lungs

The lungs are constantly in motion due to the respiration.

The lungs follow the movements of the thorax. Lung expansion follows the biomechanical expansion of the thorax (Figure 21).

![Figure 21 - The motions of the ribs and diaphragm](image)

Below is an explanation of what occurs during deep inhalation:

- Each hemithorax increases in volume, followed by the pleura and lung.
- The diaphragm and the diaphragmal pleura descend.
- The ribs move anteriorly and laterally, followed by the costal pleura.
- The pleuromediastinal wall remains fixed.
- The upper lung diaphragm (pleural dome) remains relatively fixed.
- These fixation points are required so that the other part of the lung and pleura can stretch.
- The lung becomes tensed due to opposing forces. On one hand there is the traction (T) from the fixed structures and on the other hand a counter-force from the stretch (K) (Figure 22).
- The lateral balancing force is controlled by the interpleural ligament.
- The craniocaudal balancing force is controlled by the suspensory ligament and by the pulmonary ligament.
• The motion of the thorax is the sum of the movements of each costovertebral unit. The importance of good thoracic and rib mobility for good respiration is therefore obvious.

• During inhalation the rib rotates around different axes that run through the costovertebral and costotransverse joints. These axes change from a frontal plane in the upper ribs to a sagittal plane for the lower ribs.

• The upper ribs move in a type of pump handle motion whereby the sternum and the anterior part of the ribs move cranially and anteriorly.

• The lower ribs move more in a bucket handle motion whereby they go from lateral to cranial.

• A rib movement that clearly occurs during deep inhalation and that remains latently present during normal respiration is a rotation around a craniocaudal axis.

Every rib makes an oval-shaped motion around two axes (Figure 23).

Each thorax half has a common anterior axis and a separate posterior axis (Figure 23).

During inhalation the ribs expand their hemithorax in all diameters.

The pleura and the lungs follow this expansion.

The lung, fixed to the mediastinum, is stretched laterally around the posterior axis.

The centre of this posterior rotation is formed by the apical bronchi.

The position of these bronchi is logical as the lungs cannot move to and fro within the thorax but will expand.
**Figure 22** - Fixating traction (T) and lateral force (F)

**Figure 23** - Horizontal rib rotation during inhalation
5. Patient History and Physical Examination (Corrin 2005, Houser et al 2005)

5.1. Inspection
Four important inspections:

- Is cyanosis present? Blue, grey or purple colouring means oxygen deprivation.
- Form and size of the thorax.
- Evaluation of respiration (frequency, rhythm, symmetry and quality of the respiratory mechanism).
- Mental status: agitation or confusion are often signs of hypoxaemia.

5.2. Abnormal Respiration Patterns

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tachypnoea</td>
<td>Frequency &gt; 20 per minute.</td>
</tr>
<tr>
<td>Hyperpnoea</td>
<td>Rapid and with difficulty.</td>
</tr>
<tr>
<td>• Hyperventilation</td>
<td>• mostly rapid but not deeper e.g.: lung inflammation.</td>
</tr>
<tr>
<td>• Kussmaul respiration</td>
<td>• deep and rapid, mostly in case of diabetic coma.</td>
</tr>
<tr>
<td>Bradypnoea</td>
<td>Frequency &lt; 12 per minute.</td>
</tr>
<tr>
<td>Dyspnoea</td>
<td>Difficult respiration, short of breath.</td>
</tr>
<tr>
<td>Orthopnoea</td>
<td>The patient must sit or stand to breath.</td>
</tr>
<tr>
<td>Cheyne-Stokes</td>
<td>Episodes of slow, superficial respiration which rapidly changes to deep and frequent.</td>
</tr>
<tr>
<td>Biots respiration</td>
<td>Deep respiration alternating with periods of apnoea lasting 10 to 30 seconds; indicates increased intracranial pressure (eg: meningitis).</td>
</tr>
</tbody>
</table>

5.3. Pulmonary Embolism
An embolism develops in the legs or pelvis (possibly following an operation) and causes arterial obstruction in the lung.

Without treatment 30% of patients will die. With classical treatment (blood thinners) this ratio decreases to 2 - 8%.

It presents as a sharp pain in the thorax that increases during inhalation.

Sudden onset and causes difficult respiration.

Mostly a history of swollen and painful legs, stasis in the pelvis.

Auscultation reveals a “wheeze” (whistling noise).
Associated with heightened heart rhythm, decreased blood pressure and swelling of one leg.

Osteopathy is contraindicated.

5.4. Pneumothorax
This is an accumulation of air in the pleural cavity.

A collapsed lung can press upon the heart and the blood vessels, leading to a dangerous decrease in blood pressure.

Auscultation demonstrates no sound in the collapsed lung.

Sudden onset with rapid shortness of breath, low blood pressure and increased heart rhythm.

A pneumothorax can occur spontaneously or post-traumatic and osteopathy is not indicated.

In patients that previously developed spontaneous pneumothorax great care must be taken with manipulations of the thoracic spine and ribs.

Spontaneous pneumothorax occurs more often in smokers.

Figure 27 - Pneumothorax
5.5. Asthma

*(Barnes 2000, Lemanske 2000, Maddox & Schwarz 2002)*

In cases of asthma *(Figure 28)* the bronchioles narrow.
This reduces airflow.
The gaseous exchange is limited.
In 80% of asthma cases an allergic factor is present.
Asthma is a chronic inflammatory condition of the airways.
The airways are hypersensitive and certainly hyper-reactive.
The airways can become deformed.
Asthma is more prevalent in cities than in the country (due to air pollution).
The last 20 years has seen an 80% increase in the prevalence of asthma.
The immunological reaction to certain substances has increased. This means that the segments of the organs that are implicated in immune action and excretion must be treated and that the treatment of the lungs and lung segments only is dealing with the symptoms only.
The condition is characterised by acute phases alternating with chronic phases.
The acute phase sees manifestation of bronchus spasm and oedema.
In the chronic phase chronic inflammation is present.

**The cause of asthma lies in the immune system. The origin can be:**

- Genetic factors.
- Uterine conditions before birth.
- The diet of the child.
- Respiratory infections.
- Environmental exposure to allergens, tobacco smoke.

The most recent hypothesis of the cause is that in the modern world with so few infections, frequent antibiotics and good hygiene, the immune system begins to react abnormally to stressors. This means that more and more allergies and asthma occur.

Antibiotics damage the micro flora in the digestive tract and this is responsible, in part, for good function of the immune system. Probiotics for children with asthma is advised.
6. Clinical Diagnosis


6.1. Percussion

Percussion is done in the non-coloured zones (Figure 36).

The percussion sounds over the lungs must be hollow to tympanic.

![Bimanual percussion](image)

Figure 36 - The location of the percussion

6.2. Auscultation

Auscultation is done with the patient is sitting.

The criteria for auscultation:

- Are the sounds softer, normal or louder?
- Are any abnormal sounds apparent?

Always compare bilaterally. For example the left apex with the right apex (Figure 37).

Ask the patient to breath in and out deeply via the mouth.

A minimum of six auscultation sites on the anterior and posterior thorax should be used.

If an abnormal sound is heard, the directly surrounding region should be tested and the sound should be described as best as possible.
Sounds can be described as follows:

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Vesicular</strong></td>
<td><strong>No sounds.</strong></td>
</tr>
<tr>
<td></td>
<td>This is heard over the majority of the lungs.</td>
</tr>
<tr>
<td></td>
<td>Long inhalation and short, soft exhalation.</td>
</tr>
<tr>
<td><strong>Bronchiovesicular</strong></td>
<td><strong>Reduced sounds.</strong></td>
</tr>
<tr>
<td></td>
<td>This is heard over the primary bronchi and over the right upper lung.</td>
</tr>
<tr>
<td></td>
<td>The exhalation is the same as the inhalation.</td>
</tr>
<tr>
<td><strong>Bronchial</strong></td>
<td><strong>Sounds that should not be at that site.</strong></td>
</tr>
<tr>
<td></td>
<td>This is only heard over the trachea.</td>
</tr>
<tr>
<td></td>
<td>Loud and long exhalation.</td>
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<td></td>
</tr>
</tbody>
</table>

- **No sounds.**
  - No sounds in a section or all of the lung.
  - Pneumothorax
  - Pneumectomy
  - Emphysema
  - Pleural effusion
  - Tumors
  - Massive atelectasis
  - Complete airway obstruction

- **Reduced sounds.**
  - Poor air flow to the lung or a part of the lung.
  - Emphysema
  - Pleural effusion
  - Pleuresy
  - Atelectasis
  - Pulmonary fibrosis

- **Sounds that should not be at that site.**
  - Bronchial of bronchiovesicular sounds over the lungs.
  - Atelectasis with secretion
  - Tumors with exudate
  - Pneumonia
  - Pleural effusion
  - Pulmonary oedema

- **Crackles, rattling.**
  - Short and discrete cracking, popping sound.
  - Pulmonary oedema
  - Pneumonia
  - Pulmonary fibrosis
  - Atelectasis
  - Bronchiectasis

- **Rumble.**
  - Hoarse and rumbling sound.
  - Pneumonia
  - Asthma
  - Bronchitis
  - Bronchospasm

- **Wheeze, whistling.**
  - Higher pitch, whistle exhalation.
  - Asthma
  - Bronchospasm
  - Inflammation

- **Pleural rub.**
  - Loud, dry, hoarse, leathery.
  - Pleural effusion
  - Pleuresy

- **Stridor.**
  - Narrowing.
  - Inflammation and oedema in the larynx and trachea
6.3. Observation of the Fingernails

Hourglass or “clubbing” of the nails (Figure 38) is a sign of chronic lung disease and is characterized by:

- bronchiectasis,
- bronchial carcinoma,
- idiopathic pulmonary fibrosis,
- pulmonary abscesses.

Not present in the case of COPD.

Example of:

<table>
<thead>
<tr>
<th>Normal lungs:</th>
<th>[Audio]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma sound:</td>
<td>[Audio]</td>
</tr>
<tr>
<td>Crackles, rattling sound:</td>
<td>[Audio]</td>
</tr>
<tr>
<td>Crackles, rattling sound:</td>
<td>[Audio]</td>
</tr>
<tr>
<td>Pleural rub:</td>
<td>[Audio]</td>
</tr>
<tr>
<td>Wheeze or whistling sound:</td>
<td>[Audio]</td>
</tr>
</tbody>
</table>
7. Osteopathic Techniques

7.1. General Advice

7.1.1. Brushing of Teeth
Oral hygiene is of essential importance for patients who are susceptible to lung and airway infections. Most importantly removal of plaque is important because methylicine resistant staphylococcus and pseudomonas are the most frequently occurring bacteria that cause these infections. Brush your teeth is the message.

Oral hygiene products (mouth washes) are of limited use in this case.

7.1.2. Diet
Patients with lung conditions must pay particular attention to diet:

- Insufficient intake of protein can lead to muscle weakness in the respiratory musculature.
- Over consumption of carbohydrates creates an overproduction of carbon dioxide, which requires more expulsion of carbon dioxide by the lungs via more forceful respiration.
- Poor gastro-intestinal function must also be addressed in these patients and medications such as antacids should be avoided.

Conditions that influence the diet and function of the lungs are:

- Malnourishment (alcohol abuse, anorexia, long term nausea, confusion and poor teeth).
- Inadequate digestion or absorption (operations, antacids use, H₂ receptor antagonists, cholestyramine and anti convulsion medication.
- Significant loss of ingested foods (vomiting, blood loss, diarrhoea, fistulas, wounds, dialysis, corticosteroid therapy).
- Increased dietary requirement (fever, operations, trauma, some types of cancer, pregnancy, breast feeding, periods of growth).

These general hygiene issues should be checked so as to avoid the lungs becoming more susceptible to disease and the resultant complaints.
7.2. Techniques

7.2.1. Exhalation with pursed Lips
The patient is taught to breathe in slowly and deeply through pursed lips (blowing).

This technique is used for patients with obstructive lung disease such as COPD or emphysema.

In order to be effective the technique must be done slowly.

7.2.2. Deep Inhalation and Coughing
This technique is used to expand the lungs after pneumonia or atelectasis.

This is done sitting because in this position the lower part of the lungs can expand more readily.

This technique is useful after operations. A cushion is then gently held against the operative wound.

7.2.3. Abdominal Respiration
The upper thoracic region is blocked. This can be done passively by the osteopath with the help of a belt around the upper thorax.

The patient is asked to breath in via the abdomen, against resistance from the osteopath (by way of the hands under the diaphragm) or against a cushion held against the belly.

Exhalation is via pursed lips (blowing) and is slow.

This technique is used for patients with chronic and acute obstructive conditions.

The technique can also be used for athletes to improve the vital capacity.

7.2.4. Postural Drainage, Vibration and Percussion
Postural drainage:

The section of the lung that needs to be drained is placed upwards for several minutes. Vibration and/or percussion are done. Following that the patient is instructed to cough.

This technique is used in cases of fibrosis, bronchiectasis and atelectasis.

The aim is to improve the drainage.

The technique may not be used in case of haemothorax or rib fracture. If dyspnoea or wheeze occurs the technique must be stopped.
7.3. Osteopathic Techniques

7.3.1. Stretch of the pleural Dome, the upper Pleura and the Cervicopleural (Suspensory) Ligament

The patient is supine, the legs straight.

The osteopath brings the head of the patient into opposite sidebending (C₇) and ipsilateral rotation.

A hand is placed on the face of the patient, thumb under the occiput and 5th finger under the mandible.

The other hand is placed on the ventral side of the upper ribs.

During a deep exhalation both hands move apart.

For this technique to be effective, any musculoskeletal lesions of C₆ and/or C₇ must first be corrected.

The technique is repeated several times until motion and elasticity improve.

Video 24 - Stretch of the pleural dome, the upper pleura and the cervicopleural ligament
7.3.2. Stretch of the Cervicopleural (Suspensory) Ligament
The patient is supine, the legs are straight.

The osteopath brings the head of the patient into ipsilateral sidebending and opposite rotation while the pleural dome is fixed to caudal during a deep exhalation.

This fixation is held and the head is placed into opposite sidebending and ipsilateral rotation.

A mobilisation is done at the end of range, with circumduction.

7.3.3. Stretch of the Pleural Dome, the Cervicopleural Ligament and the upper Fascia
During exhalation the upper ribs are fixed caudally (not too posterior) while the head of the patient is taken into opposite sidebending (C7) and ipsilateral rotation (C6).

During inhalation (not too deep) the new end of motion is maintained.

The technique is repeated several times with improved mobility after each repetition.
9. About the Authors

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Both authors are holders of university degrees, namely the Master of Science in Osteopathy – University of Applied Sciences, and are very active with the promotion and academic structuring of osteopathy in Europe. In 1987 they began The International Academy of Osteopathy (IAO) and are, to this day, the joint-principals of this academy. The IAO is since several years the largest teaching institute for osteopathy in Europe. Both osteopaths are members of diverse professional organisations, including the American Academy of Osteopathy (AAO), the International Osteopathic Alliance (IOA), the World Osteopathic Health Organisation (WOHO), as part of their mission to improve osteopathic development.

This osteopathic encyclopaedia aims to demonstrate the concept that a proper osteopathic examination and treatment is based upon the integration of three systems: the musculoskeletal, visceral and craniosacral systems.
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