The Three leaves of Glénard
Examination of a functional aspect

An Interexaminer- and Intraexaminer Reliability Study

"[...] the container is governed by, and governs, the viscera"
(Stone C, 2000, p.59)

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1 Abstract

A look at the research methods applied in manual and osteopathic medicine quickly shows that the results of the interexaminer- and intraexaminer reliability often are inadequate.

Based on our research, a flaw in the verification of examination methods of visceral osteopathy can be described. In order to clarify this aspect of osteopathy, it is the aim of the present study to assess a method of palpatory examination of visceral osteopathy. This examination method focuses on two aspects, the evaluation of abdominal tone and tension-conditions, and is reviewed in relation to its interexaminer- and intraexaminer reliability. The anatomical basis for this test is "the tension-model of the three leaves of Glénard", a functional construct which had been described by the French surgeon Glénard Franz in his book "Les ptoses viscérale" (1899). This model is adopted in the concept of visceral osteopathy and forms the base of many osteopathic textbooks. At the time of our research, no scientific study could be identified that verifies this model and the statements derived from it. Thus it is the task of this study to testify the tension modell described by Glénard (1899, p. 535 ff) by means of the tone and tensiontest.

The basis of this survey is an inter- and intra-reliability design with repeated measurements to be able to testify the efficency of assessing the tone and tension of the abdomen. The structural analysis of the examination results is done by means of Cohen's Kappa index.

Before the examination, all osteopaths were trained with the objective of achieving a coordinated test-performance and interpretation. In the subsequent examination, seven osteopaths twice analyzed 33 patients. In the second run, the osteopaths carried out the examination wearing sleeping masks to prevent them from optically recognizing their patients. To assess tone and tension, the criteria hyper / normo / hypo were introduced and documented in a specific examination form. Additional assistents were appointed to document the findings and to ensure a smooth test run.

In general, the results of an assessment of the tone are more reliable (moderate reliability) than an evaluation of the abdominal tension (poor reliability). In total, it must be stated that the reliability of this test is too low.

Based on the results of this survey, a general trend in manual medicine can be confirmed. This trend points to the fact that in terms of an average rating, the findings of interexaminer reliability are less reliable than those of intraexaminer reliability.

A final assessment of this examination shows that the scientific investigation of both the "tension model of Glénard" as well as its use in visceral osteopathy is insufficient.

The present study is criticizing this situation and would like to suggest a further exploration of this revealing aspect of visceral osteopathy.

2 Introduction

In medicine, the clinical examination of the patient is an integral part of the diagnostic decision-making (Higgs, 2000). To achieve an optimal diagnosis for the patient, the results of the clinical examination are used according to the ciriterion of confirmation or exclusion. Considering these aspects, the clinical examination of the patient is of great importance, since the results obtained from it are a decisive criterion for the subsequent therapy (Mayer Fally, 2007, p. 11).

With their study, Franke et al. (1996, p.65) prove that by standardizing and structuring the anamnesis and the subsequent clinical examination, the diagnostic accuracy can be improved by 10%. He further states that as a rule the prerequisite for the subsequent therapy is the correct diagnosis. Errors that arise from the examination of the patient ultimately lead to a false diagnosis. The result is an inadequate treatment of the patient. For this reason, it is mandatory to verify the reliability of test methods as only testing procedures that are reliable and checkable have a benefit for the users and therefore are qualified for a manual examination of the patient (Lewit / Liebenson 2003, p. 47).

The manual analysis of osteopathy is designed to assess the condition of the body tissue. The aim of this analysis is to evaluate the functionality of the body tissue of the parietal, visceral and craniosacral system (Fieuw, 2005, p.XIII). The investigation of the visceral system was further developed and structured by the French Weischenck (1982) and Barral (1983) in the ninteen-eighties. Further specific diagnostic actions can be derived from the results of the global analysis which ultimately lead to an overall diagnosis. One of the tests ranking among global visceral examination is the tension- and tone test. It was developed by Weischenck (1982) who focused on the work of Glénard, Brunel and Stapfer and who published his osteopathic visceral concept under the title „*Traité D`Ostéopathie viscérale*“ (Paris: Maloine; S.A. Editeur, 1982.) This test is applied to evaluate the intra-abdominal pressure as well as the tension of the muscular portion of the abdominal cover. It forms the basis for assessing the intraabdominal pressure and tension-conditions. Based on its findings, further diagnostic steps can be taken with the aim to modify the cause of possible changes.

Personal experience in the training of osteopathic students have shown that the execution and the subsequent interpretation not always lead to consistent results and admit a large variety of interpretations. This problem can be clarified by a quote from Fieuw:

> *„[...] to feel the difference between a sunken package of the small intestine and a hypertensive abdomen is not an easy task. Either cannot be flattened, but in case of hypotension with an enteroptosis it is mass what you feel against your hand, not tension [...]”*
> *(Fieuw,personal communication, January 10th, 2001, translated by J. Supper)*

It has been shown that there is a general unreliability in the interpretation of manual test results (Flynn et al., 2002; Lewit / Liebenson, 2003) as they mainly base on a model or a visual concept (cf. chapter 6.5). For our examination, we have chosen the tone and tension test as its function can be described as a screening (Helsmoortel, 2002, p.37f). Furthermore, the results of this test affect further diagnostic testing. The frequently observed inconsistencies in interpretation the results induced a revision of the tone and tension test. The way we carried out the examination focuses on the reliability of the survey results provided by this test.

Until now, no evidence was found for a scientific examination of the tone and tension test in online medical databases, journals and or in the relevant clinical and medical literature (cf. chapter 8.2). The present work considers publications from the domains of clinical medicine, osteopathy, anatomy and physiology dating from 1875 to 2008.

The aim of this work is to find out whether a consistent statement can be made about the test results. Consistency means that the examination method, carried out under the same conditions, leads to identical results and therefore is reproducible (Sommerfeld, 2006, p. 45). In international terms, this process is called *reliability*. The revision of the study's reliability refers both to the comparative consistency of several examiners (inter-examiner reliability) as well as to the intersubjective consistency of one examiner (intra-examiner reliability).

For this purpose, an empirical study was carried out in which several osteopaths examine different patients. The test set-up operates under the same conditions: in every trial, the osteopaths stand upright, they operate independently of each other and examine tension and tone of the abdomen manually. Yet it has to be pointed out that in practce, ensuring the same conditions can only be aimed at, but never be completely achieved. Sommerfeld describes the initial situation of multiple testing as follows:

> *"[...] Absolute reliability is an unattainable ideal. The fact alone that living systems are subject to constant change (subject bias), which is why the initial conditions of repeated examinations can never really be identical, realtivizes the notion of reliability [...]"*
>
> *(Sommerfeld 2006, p.45, translated by J. Supper)*

Consequently, any clinical examination of repetitive testing procedures suffers from an a priori limitation. This has to be accepted as fact, nevertheless it affects the compara-bility of the test results. In order to minimize this impairment as effectively as possible, a standardization of the testing procedures was ensured. In addition, the time intervals between testing were kept as short as possible with the aim to minimize the potential changes which the patients might be subject to.

The two evaluation criteria for this test are the prevailing pressure in the abdomen (re-fered to as tension) as well as the tension of the abdominal cover (abdominal muscles, spine), hereafter designated as tone. Thus, the two terms "tension" and "tone" are used analogous to the nomenclature of Helsmoortel (2002) and Fieuw (2005) (cf. chapter 5.5. and 5.6.).

It seemed reasonable to execute the test in a standing position. The reason for this approach is the influence of gravity on the inner static and on the organ position. Studies of Bianchi et al. (1976) and de Zeeuw et al (1978) show that kidney dysfunctions can be easier realized when influenced by gravity. When testing body movements under the influence of respiration, Finet and Williame (1992) also examined their patients in a standing position. They chose this approach because it represented the posture in which people work every day. Moreover, a standing position led to reactions that were contrary to gravitational forces (Finet / Williams, 1992, p.147).

3 Basics

The present study focuses on a testing procedure applied in basic visceral examinations. With this procedure, the examiner is enabled to more specifically diagnose and examine the abdominal cavity. The purpose of this procedure is to help the examiner gather further information about the tension of the abdomen and the tone of the abdominal wall.

As a theoretical basis for this work, research was done in online medical databases, in the relevant scientific literature as well as in scientific journals (cf. chapter 8.2). As a result of the literary search, it became apparent that the interest in the intra-abdominal pressure conditions is manifold and not at all only limited to osteopathy.

3.1 Abdominal Pressure – Historical Context

This chapter is intended to chronologically review the history of the pressure conditions of the abdomen.

3.1.1 1850 to 1980

Anatomists and physicians have been interested in the pressure conditions of the abdomen ever since the middle of the 19th century, until the early 1930s. (Virchow, 1853; Landau, 1881; Glénard, 1899; Mathes, 1905; Robinson, 1907; Kaiser, 1912; Levy, 1924; Bohnen, 1931). At that time, the interest in intra-abdominal pressure seemed to have resulted from the conception that a change in intra-abdominal pressure was caused by the descent of the position of individual organs (see detailed discussion in chapter 3.4). It was assumed that the descent of position of the organs would faciliate the development of certain diseases.

Glénard (1899) also devoted himself to the question of the statics of the internal organs and explored mechanisms leading to changes in the position of abdominal organs. From the results of his examinations and autopsies, he developed a model in which the reduction of various organs is associated to symptoms of a generel morbid process. He called this process "Enteroptosis" (Glénard, 1899, p. 141).

In 1899, Glénard published the results of his studies under the title "*Les ptoses viscéral*". (Paris: Alcan, 1899). A large number of osteopathic and medical literature, which in the following will be analyzed and critically discussed, refers to this work. Mathes (1905), Robinson (1907), Kaiser (1912), Levy (1924) and Bohnen (1931) also describe the anatomic-physiological relations of the statics of the internal body organs. Apart from the intra-abdominal tension and unlike Glénard (1899), they identify the body shell as additional factor for the statics of the internal organs.

3.1.2 1980 until now

During the research for this work, it also became apparent that determining of intra-abdominal pressure in the clinical field, particularly in abdominal surgery, has been of interest to medical science since the mid-eighties.

The study model, by which Weischenck (1982) oriented himself, was developed by the French physician Franz Glénard (1899). Weischenck (1982) refined this model and integrated it into the visceral osteopathic therapy. The applied visceral examination can be divided into a global and an ensuing special examination of the abdominal cavity.

The current medical literature states that a lasting increase of the abdominal tension (abdominal hypertension) with values of 20 mm / Hg and higher (Bailey / Shapiro, 2000; Bertram et al., 2000) leads to dysfunctions of the cardiac cycle, the kidneys, the gastro-intestinal tract, the lungs and the central nervous system. Once an organ dysfunction and an acute abdominal hypertension have manifested themselves, one speaks of the "abdominal compartment syndrom, which can grow into a life-threatening crisis and has a fatality rate of 60% (Bertram et al., 2006; Töns et al., 2000).

In medical literature, the intra-abdominal standard pressure is indicated with values from 0 to 3 mm (Kirkpatrik et al., 2000; Lonardo, 2007). Under physical strain, a short-term increase of pressure up to 100 mm / HG is considered normal (Grillner et al., 1978), but long-term pressure increases above 15 mm / Hg at rest (Töns et al., 2000) are regarded as critical and include the risk of a developing "intra-abdominal compartment syndrom".

The effects the intra-abdominal tension has on the muscle-skeletal system are reflected as matter of analysis in several studies, particularly in the field of physiology. These studies confirm the reciprocal interaction of the intra-abdominal pressure on the tonus of the trunk muscles (Grillner et al., 1978; Hodges et al., 1997; Essendrop et al., 2002). Furthermore the impact of the intra-abdominal tension and its effects on the stability and strenghth of the lumbar spine has been discovered as matter of analysis in scientific studies (Hodges et al., 2000; Essendrop et al., 2002).

3.2 Abdominal Tension in Osteopathy

A.T. Still, founder of osteopathic medicine, dedicated himself to the analysis and treatment of the abdomen (Hartmann, 2002, p. 383). In his writings, he describes the importance of the perfect fixation of the abdominal organs by their ligaments and tendons (Hartmann, 2002, p.373). By doing so, Still emphasizes the fixation of the intestines by band structures and further states the importance of the proper function of the "gas producing engine" for the health. This can also be seen as a tension model.

In the field of osteopathic medicine, no studies or scientific publications relating to abdominal tension / abdominal tone have been identified (for a detailed description of the research see chapter 8.2). The "textbook of visceral osteopathy" by Helsmoortel (2002) uses the results of studies by Grillner et al. (1978), Hodges et al. (1997), Hodges et al. (2000) and Essendrop et al. (2002). It is cited as the scientific basis for the tension model (cf. chapter 4.1 and 5.5). Since no other osteopathic studies exist, the textbooks of visceral therapy of Weischenck (1982), Barral / Mercier (1983), Finet / Williams (1992), Stone (2000), Helsmoortel (2002), Fieuw / Ott (2005) and Liem (2005) are additionally referred to. In order to explain the anatomical / physiological and dysfunctional conditions of the abdomen, these authors rely on a hypothetical model. The common object of investigation are the position and the movement of the internal organs under the influence of respiration. Furthermore it is apparent that the model used is not homogeneous. There are differences both in describing what is to be understood as normal tone and tension circumstances as well as in the description of the dysfunctional deviations (cf. chapter 5.5 and 5.6).

The textbooks of Weischenck (1982), Helsmoortel (2002), Fieuw / Ott (2005) and Liem (2005) rely on the model of Glénard to explain the regular intra-abdominal conditions and their deviations (cf. chapter 4). The nomenclature used in these textbooks has proved to be similar as well. Ultimately, it has to be noted that when screening the material for this work, a direct concurrence with Glenard’s tension model could be found in the literature of Weischenck (1982), Helsmoortel (2002), Fieuw (2005) and Liem (2005). The authors Mathes (1905), Robinson (1907), Kaiser (1912), Levy (1924), Bohnen (1931), Barral / Mercier (1983), Finet / Williame (1992) and Stone (2000) also describe the anatomical-physiological relations of statics of the inner body organs. As opposed to Glénard (1899), they see the body wall in addition to intra-abdominal tension as a decisive factor for the statics of the inner organs.

Other findings, for instance the articles and studies of Clark (1904), Grilner et al. (1978), Hodges et al. (1997 / 1999 / 2000), Bailey / Shapiro (2000) and Essendrop et al. (2002) only touch on part of the issues discussed here, and will be presented within the framework of the addressed aspects.

3.3 Measuring Methods to Determine Abdominal Pressure

As early as the middle of the 19th century, efforts were made to determine the intra-abdominal pressure. Braune (1865) thus came to the conclusion that by means of pressure measurements, the intra-abdominal pressure changed due to position changes and contractions of the abdominal muscles. To this end, he led a hose attached to a glass pipe into the rectum, filled it with water and defined the pressure of the water accumulated in the rectum (Kaiser, 1912; Bailey / Shapiro, 2000). Recent studies confirm Braune's results (Schatz, 1875; Wilson, 1933; Hodges / Gandevia, 1997; Hodges / Gandevia, 1999; Baily / Shapiro, 2000; Essendrop et al., 2002).

Approximately 10 years after the experiments of Braune (1865), Schatz (1877), a gynecologist, introduced firstly intravesical measurements to determine the bladder pressure and confirmed Braune's measurements (cf. chapter 1912, p.1f).

3.3.1 Gold Standard for Measuring Abdominal Pressure

The procedure for determining the abdominal pressure using a balloon catheter is still regarded as the gold standard for determining intra-abdominal pressure. However, there also are other techniques to determine intra-abdominal pressure. These are the measurement methods for the intraperitoneal, rectal, gastric and / or femoral venous pressure (Bailey / Shapiro, 2000, p.23-29) as the pressure-conditions of hollow organs can be approximated to that of intra-abdominal pressure.

According to Bailey / Shapiro, measurement methods with the intraperitoneal catheter and the femoral vein pressure measurement have proven to be the most accurate, yet due to their invasive nature they are not used standardly.
Measurements with bladder catheters turned out to be almost equally accurate and are used as gold standard because of their easier implementation and less invasive nature (Schneider et. al., 2000; Töns et al., 2000; Bertram et al., 2006).

3.3.2 Measurements for intraabdominal Pressure

In medical literature, the intra-abdominal standard pressure is specified with values from 0 to 3 mm/Hg (Kirkpatrik et al., 2000; Lonardo, 2007). Short-term pressure increases up to 100 mm/HG are considered normal, for example in case of physical strain (Grillner et al., 1978), but long-term pressure increases over 15 mm/Hg (Töns et al., 2000) are regarded as critical and include the risk of developing a "intra-abdominal compartment syndrome." In his textbook (1983, Vol 2, p. 59), Barral specifies the pressure in the abdomen of a woman with 30/15/-5 cm/H2O (Douglasarea/umbilicus/ subdiaphragm). Yet the measurements of Barral can be doubted, since he names no sources for his data and the process of how he ascertains these data cannot be reconstructed.

The measurement methods mentioned in the previous chapter are used to determine the intra-abdominal pressure and represent the results in units mm/Hg. This form of measurement is not applied in the testing procedure examined here, because in this procedure the intra-abdominal pressure is judged by its values (excess/normal/too little) and not measured in a standardized way. Rather, this testing procedure is based on a model to differentiate the quality of the intra-abdominal pressure (cf. chapter 5.5).

3.4 Anatomical and Physiological Considerations of the Abdomen

The testing procedure examined here is based on the model of Glénard (1899). Glénard's model is applied in visceral / osteopathic concepts to explain the pressure conditions found in the abdomen. Later osteopaths like Weischenck (1982), Helsmoortel (2002) and Fieuw (2005) use the research results of Glénard (1899) and integrate his tension model into their concept of visceral osteopathy.

Studying the textbooks of Glénard (1899), Weischenck (1982), Helsmoortel (2002) and Fieuw (2005), it turned out that tension as "promoter of the liver" is a very important factor in the model of Glénard. To illustrate this, important aspects of anatomy and anatomical relationships are commented on in the following.

3.4.1 The Problem of Liver Weight

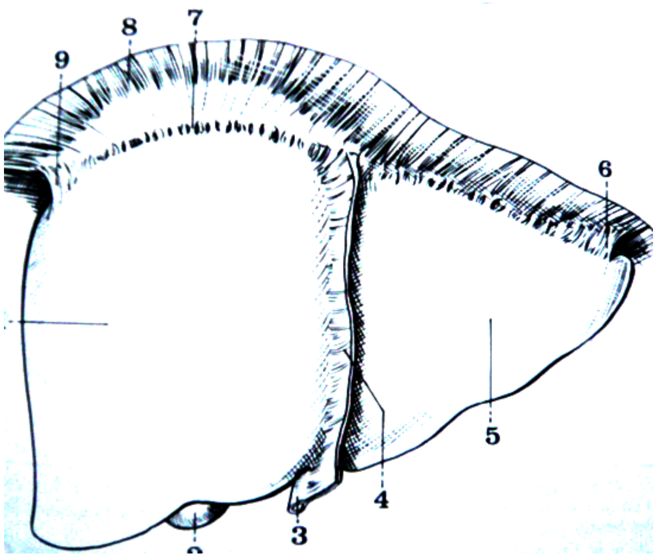
In a visceral osteopathic concept, the optimal position of the organs is a prerequisite for their optimal function. Deviations from this position can, according to the osteopathic approach (cf. chapter 5.1), negatively influence the function of the organs.

This statement can be verified by the clinical studies of Bianchi et al. (1976), De Zeeuw et al. (1978) and Van Dun et al. (2007). Bianchi et al. (1976) describe the result of their investigation, in case of a nephroptosis, 10 of 13 patients show a limitation of kidney-function. A further clinical investigation of De Zeeuw et al. (1978) provethe relation of kidney mobility and kidney function. On the basis of 25 patients De Zeeuw (1978) describes a connection of kidney circulation and kidney mobility.

In the osteopathic research a study of van Dun et al. (2007) could be detected. This study examined whether a connection between organ mobility and organ function exists. Van Dun et al. (2007) investigate in their study whether an osteopathic mobilization technique of the intestines leads to an increase of circulation of the Vena porta. For this purpose 15 patients are treated with an unspecific technique and 15 patients with a specific mobilization technique. As a result van Dun et al. (2007) describe a significant increase of the portal circulation in the group treated with the specific mobilization technique. The liver is the biggest gland organ of the human body (Pschyrembel, 2007). About the weight specifications of the liver in the medical and anatomical literature no homogeneous statement can be done. The liver weight becomes in an interval of 1500 - 3000 gr. indicated (Dancygier, 2003; Pschyrembel, 2007). Due to this high level of self-weight, in an visceral osteopathic approach the question arises which anatomical structures fix the liver in its position. In the visceral osteopathic draft it is accepted that the liver can change its standard position due to its high dead weight. For this reason the osteopaths ask themselves the question which anatomical structures fix the liver in theirposition (Weischenck, 1982; Helsmoortel, 2002).

In the classical medicine the footing structures of the liver mainly provethe interest in publications, that at the beginning of the 20.th century's were published (cf. chapter 3.4.2). Currently a changed position of the inferior margin of liver is described in the classical medicine literature (Bates, 1983) and the determination of the inferior margin of liver is an integrated component of the clinical investigation (Joshi et al., 2004; Joachimski, 2007; Kiser, 2008).

By means of the tissue structures of the coronary ligament of the liver and triangular ligaments dexter / sinister, the liver is solidly connected to the diaphragm. In addition, with the falciform ligament, the liver is connected to the anterior abdominal wall and is supported by the fixation of the ligament venosum at the V. porta (Bouchet / Cuilleret, 1991).



4 **Lig. falciforme**

6 Lig. triangulare sinister

7 Lig. coronarium

8 Diaphragma

9 Lig. triangulare dexter

FIGURE 1 : The liver and its ligaments from Bouchet und Cuilleret (1991, Bd.4, p.1951)

These ligament fixations and the diaphragm as a myofascial structure are, according to Glénard (1899), Weischenck (1982), Helsmoortel (2002) and Fieuw (2005), not able to support the weight of the liver by themselves. Therefore the authors describe other mechanisms involved in maintaining the postition of the liver.

These mechanisms can be differentiated by aspects of anatomical and physiological nature. The vast number of publications on this subject stem from the current text-books of visceral osteopathy. In the following chapter, the views of various authors will be discussed as well as anatomical aspects described that secure or change the position of the liver.

3.4.2 Anatomical Considerations

The present chapter gives an account of how various physicians and anatomists explain the fixation of the organs. As will be seen, no single opinion can be described as the factors in charge of the statics of the internal organs are liable to be assessed very differently. For example, Landau (1885) and Mann (1891) insist that if all bands were cut, the organs would still remain in place. Only if the specific weight was extremely deviating (cf. chapter 3.5.), the position would change. With this, the two authors emphasize the physiological aspect as supporting factor.

By contrast, Meltzing (1895) and Quincke (1905) hold the view that the ligaments do determine the place of the liver, yet its burden is carried by the tension of the abdomen. This view is supported by Schwerdt (1896) and Schatz (1912). Schwerdt (1896) and Schatz (1912) substantiate the supporting factors by saying that about one-eighth of the weight of the liver is carried by the ligaments and seven eighths by the intra-abdominal tension. In addition to anatomical features mainly physiological effects of digestion (tension) are described as positioning factor by them. Wenckebach (1907) also supports this view and emphasizes the influence of pathologically reduced stomach contents leading to a lowering of the tension and, resulting from that, of the organ. To support the views of Meltzing (1895), Schwerdt (1896), Quincke (1905), Wenckebach (1907) and Schatz (1912), Still, the founder of osteopathy, shall be mentioned. In "*Philosophy and Mechanical Principles of Osteopathy*" (Hartmann, 2002, p. 373 ff), he describes how the organs are fixed by the suspension system of ligaments and tendons and marks the importance of the gas-filling of the intestines as a fallback system for an optimal organ position and functioning.

Another support-affirmative aspect is described by Quincke (1914) who declares the support of the liver being an interplay of forces of the abdominal wall, the suction through the thorax, ligamental adhesion on the diaphragm and the tension of the abdominal cavity (cited by Mathes, 1905). With his declaration, Quincke (1914) extends the explanatory framework beyond anatomical relationships and physiological aspects of digestion, to physiological aspects of pressure differences and the anatomical function of the body wall.

Glénard’s model (1899) describes the support of the liver as interplay of three factors. These factors are the ligamental junction of the liver, the abdominal tension and the intrahepatic tension (cf. chapter 4). With this, Glénard enriches the explanatory models of that time which had explained the antigravitational hold of the liver as an interplay of the forces of the ligamental suspension system, the intestinal gas filling pressure and the abdominal muscular cover by the factor of intrahepatic tension (Glénard, 1899, p. 520).

He describes the intrahepatic tension as a supporting force caused by the pressure of body fluids present in the liver. To illustrate this, Glénard (1899) uses the image "of a grape on a stem." In this allegory, the stem is the Area Nuda indicating a adhere area that is connected to the liver at the diaphragm. In order to substantiate his model, Glénard filled the liver during an autopsy with water, injecting approximately one litre of fluid into the portal vein. It turned out that the "withered grap" straightened itself forward and to the right and returned to its original position. From this Glénard concluded that due to its own tension, the liver can maintain its position independently (Glénard, 1899, p. 577-580). Until today, this concept of intrahepatic tension has not been rebutted. As critical remark it must be stated that the singular execution of this experiment relativizes the content of the statement.

Around the same time, Dr. C. Schwerdt (1896) developed the theory of the "anti-gravitational force of tension". By means of a manometer, Schwerdt (1896) investigated the pressure in the abdomen of his patients. Schwerdt came to the result that the intestinal gases develop a force that is opposite to the gravitational force. Schwerdt's theory is confirmed by the clinical medical studies of Hodges et al. (1999, 2000). In these studies, the impact of an increased intra-abdominal pressure and the resulting effects on the spine were examined. With this analysis, Hodges et al. (1999, 2000) confirm that a progredient increase in intra-abdominal pressure leads to a straightening of the spine. This described straightening is said to grow synchronously with the increase of intra-abdominal pressure.

What is open to criticism in the studies of Hodges et al. (1999, 2000) is that the increase in intra-abdominal pressure has been caused by an electrical myographic stimulation of the trunk and respiratory muscles. This procedure does not correspond to the conditions of abdominal tension increase which are resulting from changes in dietary habits or dysfunctions of the digestive tract and which are the subject of the models described here.

The terms "*anti-gravitational function*" and "*intrahepatic tension*" are quoted by Helsmoortel (2002, p. 34-37). The anti-gravitational function of the intestinal tissue is enlarged by the embryologic growth component. According to the authors, the embryologic growth component causes the intestinal wall to develop a wall tension which is described as an anti-gravitational counterforce of the intestinal tube.

It seems as if until today, the theory of tension as supporting compound for the organs has not been refuted. To illustrate this, the opinion of the manual- therapists Liebenson and Lewit is cited:

“[...] The principal support of the viscera are: (a) the compact underlying visceral shelves; (b) the abdominal wall; (c) the visceral supports (mesenteries, ligaments) perhaps suspending one-eighth of the weight of the viscera [...]”

(Liebenson / Lewit, Journal of Bodywork and Movement Therapies, 2003, p. 48)

Fieuw’s osteopathic textbook describes the idea of tension as supporter of the organs as follows:

"[...] With the ingredients and the normal intraluminar gas production, a certain nominal lumina pressure is prevailend within a hollow organ that tensions the surrounding wall layer and bloats it up. This is why for the patient, an organ is lying in its normal position within the abdominal system [...]"

(Fieuw 2005, p. 1, translated by J. Supper).

Summarizing the views given here, it seems as if the notion of the intra-abdominal pressure being the supporting compound for the organs is widely accepted and has not yet been refuted. With the present work, we want to examine a testing procedure that, inter alia, includes the assessment of intra-abdominal tension.

3.5 Physiological Considerations

The pressure conditions of the abdomen are a complex topic. To understanding the many-layered process involved in forming the pressure conditions of the abdomen, it is advisable to observe them from different perspectives. Belonging to these different perspectives are the physiological principles of the abdomen.

3.5.1 Specific Density

As stated in chapter 3.4.2, it is useful to explain physiological conditions to allow for a better understanding of the tension conditions of the abdomen.

This is exemplified by the gynecologist Kaiser from Amsterdam who in 1912 drafted a document in which he published his findings with regard to intraabdominal pressure. In this publication, Kaiser quotes a contemporary physiological textbook (Zwardemaker, 1911, p. 290) and lists the specific density of the organs in the abdominal region. He concludes that: The specific density of the various abdominal organs was approximately equal to one: liver = 1.072, uterus = 1.052, muscle tissue = 1.041, and corresponds roughly to that of blood (1.058). As the specific density value of the organs almost equals one and as some presence of gases in the digestive tract could be noted, it may be assumed that a sort of zero gravity prevails in the abdomen (Kaiser, 1912, p. 26-27).

By means of the current literature (Pschyrembel, 2007) the conclusion done by Zwardemaker (1912) can be confirmed. No scientific investigation which examined the aspect of a "zero gravity in the abdomen" could be found. In this respect the assumption of the weightlessness must be considered as a hypothetical opinion by Zwardemaker.

3.6 Intra- and Extra-abdominal Pressure

3.6.1 Intra-abdominal Pressure

For a better understanding of the physiological factors that influence the arrangement of the abdominal cavity, the model of Barral / Mercier (1983) is used. This model is an osteopathic model which defines the trunk as a cavity separated by the diaphragm into two additional cavities (Robinson, 1907, p.56; Barral / Mercier, 1983, p. 83). Furthermore Barral / Mercier (1983) assume that there are factors influencing these cavities. They describe them inside and outside the abdominal cavity. The pressure inside the organs is supposively considerably higher than the pressure of the peritoneum cavity surrounding the organs (intraperitoneal).

As this statement is a hypothesis without further substantiation, studies were sought that provide information on the pressure conditions in the abdomen. During our research, medical examinations were identified that determined the intra-abdominal pressure conditions. One of these analysis is the survey of Yehoshua (2008), who examines the relation between stomach cases and weight loss at 20 overweight patients. Yehoshua (2008) defines the pressure conditions in the stomach lumen with an average of 19 mm / Hg and higher. Other medical examinations carried out by Dejardin et al. (2007) investigate the hydrostatic pressure of the peritoneum of 61 patients, indicating an average of 9,5 (+- 0,22) mm/Hg. Complementing the medical investigations of Henriksen et al. (1980) and Aranda (2000) that determines also the hydrostatic pressure of the peritoneum at 17 and / or 24 patients. The results of their investigations describe the hydrostatic pressure gradients. The surveys of Henriksen (1980) and Aranda (2000) described the intraperitoneal pressure with an average data of 11,2 mm/HG (Henriksen, 1980) and 8,1 to 13,8 mm/Hg (Aranda, 2000).

Based on the indicated pressure values of these investigations the hypothesis of Barral / Mercier (1983) can be confirmed for the example of the stomach. According to the laws of physics it can be deduced that the higher pressure in the stomach lumen (as opposed to the lower sorrounding - intraperitoneal - pressure) causes an extension of the stomach. This results in the stomach with its external contact surface (peritoneum) being pressed closely against the surrounding organs.

3.6.2 Extra-abdominal Pressure

The external factors affecting the abdomen can be described as follows: According to the osteopathic model of Barral / Mercier (1983), there is one aspect resulting from the relation of the two body cavities to each other and one aspect outside the abdomen. In their model, Barral / Mercier (1983, vol 1, p. 14) proceed from the assumption of a thoracic attraction that results from the lower pressure within the thoracic cavity and the higher pressure in the abdominal cavity. This pressure difference leads to a kind of suction of the abdomen through the thorax. They claim that this assumption is justified by the physical principle of the vacuum, which states that in order to achieve a physical balance, high pressure areas will always extend in the direction of surrounding low pressure areas.

This model, however, was not substantiated by Barral / Mercier (1983) in terms of scientific research, either. To the confirmation of their hypothesis, publications in the journals of the physiology could be brought in (Aliverti et al., 2008; Torquato 2009). They confirmed the thoracic low pressure during the breathing out and a thoracic overpressure during the inhalation, in relation to the abdominal pressure. Yet by using the physiological laws of the pressure balance (Moore et al., 1986), it can be conveyed that a smaller pressure in the thorax leads to an extension of the abdomen during the breathing out. The aspect outside of the abdomen consists on the one hand of the influence of the surrounding abdominal muscles as well as on the other hand of the prevailing atmospheric pressure outside the abdomen. Crucial for the cohesion of the visceral column is the pressure difference between intra-abdominal pressure (normal pressure 0 -3 mm / Hg according to Dabrowski, 2007) and extra-abdominal pressure (= atmospheric pressure at sea level approximately 760 mm / Hg) which is created by the effect the weight of the atmosphere has on us. This leads to an external compression of the abdominal cavity, supported by the contraction of the muscles surrounding the abdominal cavity.

Using the research done by Dabrowski (2007) and Moore's Textbook on Physical Chemistry (1996), the differences in the various pressure gradients could be confirmed. Thus the basic conditions for reconstructing this model are given. Ultimately, however, it remains an osteopathic model which has not yet been scientifically proven. According to Barral / Mercier (1983), the interaction between adhesion forces, different pressure gradients (intra- and extra-cavity) and the muscular body wall creates the physical forces that shape the organs into a homogeneous visceral column.

3.6.3 Intestinal Gas

In their visceral osteopathic concepts, Weischenck (1982), Helsmoortel (2002), Fieuw (2005) and others claim that the presence of gases in the gastro-intestinal system function as a carrier for the viscera (cf. chapter 5). Gases have a tendency to entropy, which means that they are expanding. Thus, the internal gas pressure has an expansionary trend which is limited by the body wall. It is this expansion of the hollow organs which contributes to a kind of zero gravitiy of the abdomen's full organs (Helsmoortel, 2002).

The intestine usually contains few gases. The quantities vary from 100 to 150 ml for normal healthy adults (Bedell et al., 1956; Greenwald et al., 1969; Stein/Wehrmann, 2006). The gases primarily stem from air swallowed when assimilating food, because during every act of swallowing, about 2-3 ml of air reach the stomach (Maddock et al., 1949). The nitrogen contained therein (78% constituent of air) can be attested in the intestine since it is only poorly absorbed by the intestinal mucosa and largely remains in the intestinal lumen (Schoen, 1925).

Another gas of the intestinal tract is carbon dioxide. It results from bicarbonate which is used to buffer the acid gastric juices secreted into the intestinal lumen. This reaction partly produces so much CO^2 that the CO^2 pressure in the duodenum can amout up to 300 to 480 mm/Hg. In other intestinal sections, the CO^2 is partially absorbed (Rune, 1972) then.

Other sources of intra-intestinal gases are those contents of air added to or contained in food (Lembke and Caspary, 1983). An apple, for example, contains about 20% air. Even the transfer of carbohydrates into the colon leads to a physiological carbohydrate absorbtion. The result is an increase of methane and hydrogen produced by bacteria. The previously mentioned gases such as carbon dioxide, nitrogen, hydrogen and methane account for approximately 99% of all intestinal gases. The remaining 1% consist of ammonia sulfide and undigested fatty acid according to the textbook of Gastroenterology (Hahn / Riemann, 1996).

4 Glénards Model

This study is based on Glénard's (1899) model of "the functional leaves of Glénard". In the following chapters, this model is explained.

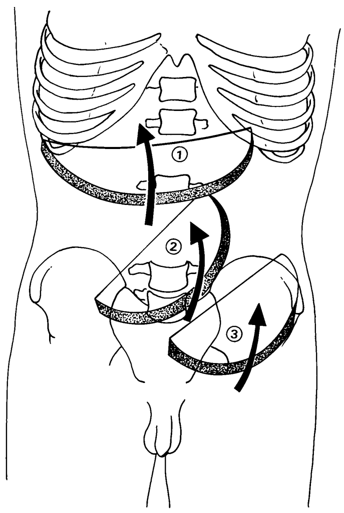
4.1 „The Three Leaves of Glénard"

The work is concerned with the examination of a testing procedure to evaluate the tension of the abdomen, tension describing the content pressure of the organs in osteopathic conception (cf. chapter 5.5). This tension is evaluated in those three specific regions of the abdomen depicted by Glénard's model.

In his book *„Les ptoses viscérales"* (1899), Glénard describes his experience resulting from decades of studies and autopsies. According to Glénard, the intestine is arranged in six loops which form six angles in the abdomen. Due to their special arrangement, these six digestive loops form three pinafores (leaves). In this book Glénard (1899) illustrates his experiments to ascertain this mysterious arrangement of the intestinal loops. To this end he filled air through the anus into the intestinal tract of corpses and observed how the bowel loops adjusted towards the underside of the liver. From this he concluded that the arrangement of the intestinal loops contributed to bearing the weight of the liver and developed his tension model of the "three leaves". These three leaves (Helsmoortel denotes them as "pinafores") include specific portions of the gastro-intestinal tract. They divide the abdomen into three functional levels (Glénard, 1899, p. 570).

Glénard describes the leaves as follows: The first leaf is stretched between the two tenth ribs and encompasses the stomach, the caput pancreatis, the second part of the duodenum and the colon transversum. The second leaf is situated directly beneath the first one and encompasses the small intestines and the caecum. The third leaf is found to the left under the middle leaf and contains the sigmoid. All three leaves are connected by their suspension system (mesos) to the rear trunk wall.

Fieuw (2005, p.3) regards the "three leaves of Glénard" as each consisting of the anchor points of the intestinal loops, the proper mesos and the hollow organ (as buoyancy balloons).



1. First (upper) leave of Glénard
2. Second (middle) leave of Glénard
3. Third (lower) leave of Glénard

FIGURE 2: Schematic representation of „Glénard's leaves" (From Weisschenk, „Traité d`Ostéopathie viscérale"1982, Maloine)

It should be added that this model is a functional approach to an anatomical situation characterized by the fact that no direct anatomical substrate can be described. The functional model of the three leaves is expressed through functional properties of anatomical structures, just as Glénard had described them. This model is taken up in the textbooks of visceral osteopathy by Weischenck (1982, p. 28), Helsmoortel (2002, p.112), Fieuw (2005, p. 3) and Liem (2005, p.41) and forms a basis for the diagnostic visceral examination of patients. A validation of this model showed that Glénard's functional approach is almost exclusively used in the textbooks of the French and Belgian osteopaths (Weischenck, 1982; Helsmoortel, 2002; Fieuw, 2005; Gaudron, 2008). Other anatomical works do not reflect this functional approach (Bouchet / Cuilleret, 1991; Leonhard, 1991; Sobotta, 2006; Netter, 2008).

4.2 Intra-abdominal Tension

Glénard, as well as his contemporaries Mathes (1905), Kaiser (1912), Levy (1924) or Bohnen (1931), tried to explain why a heavy organ such as the liver could maintain its position in the abdomen without being influenced by gravity and sinking down. His model assumes that the organization of the hollow organs in the abdomen is arranged in such a way as to help catch the weight of the liver. This is described by Glénard as "tension model".

It is the length of the intestines (approximately sixfolds the body size) which provides Glénard an explanation for the arrangement of the intestinal loops in the abdomen, represented, as explained above, in the form of six loops (Glénard, 1899, p. 568ff). If the hollow organs were sufficiently filled with bolus and gases, this particular orientation of the intestinal loops would contribute to bearing the weight of the liver from underneath. This mechanism he called "*intra-abdominal tension*". The concept of intra-abdominal tension is taken up by several doctors from that time. There are writings by Schwerdt (1896), Mathes (1905), Robinson (1907), Kaiser (1912), Levy (1924) and Bohnen (1931) originating from 1890 to 1935 which demonstrate that in addition to Glénard, other doctors tried the explain the footing of the internal organs. It seems as if in those times, the sagging of internal organs was a frequently encountered disease pattern, since a large number of doctors, especially gynecologists, concerned themselves with the supporting structures in the abdomen and the mechanisms leading to a sagging of the organs. The authors agree in recognizing tension as a supportive device bearing the weight of the organs. However, the importance of this support system was evaluated differently (cf. chapter 3.4.2.).

The notion of "*tension*" is not used by all authors in the same way. It appears that terms like "*abdominal pressure*" *("Bauchruck")* (Still, 1902, p. 396; Meltzing / Quinke, 1905, p. 84) and "*intra-abdominal pressure*" Schwerdt / Schatz, 1912, p. 73) describe the same fact. The way Glénard (1899) described his tension model and the concept of intra-abdominal tension, these terms are also used in the visceral osteopathic concepts of Weischenck (1982), Helsmoortel (2002), Fieuw (2005) and Liem (2005). Helsmoortel (2002) differentiated the notion of tension even further and complements it by additional aspects. His explanations will be analyzed in chapter 5.5.

4.3 Anatomical Basis of the Abdominal Wall

The term "abdominal wall" is not an explicit anatomical term, it is used here to describe the myofascial restriction of the abdomen. The abdominal skin is divided into skin with subcutaneous fat, fascia abdominalis superficalis, musculature and its hulls, fascia transversalis and peritoneum parietalis (peritoneum). In this chapter, these anatomical structures are discussed to the extent necessary for an understanding of the present work. Basis of this discussion are the anatomical atlases of Platzer (1986), Bouchet / Cuilleret (1991), Leonhard (1991), Lippert (1994) Sobotta (2006) and Netter (2008).

- **Skin:**

  The skin is the outer covering of the body and is made up of epidermis, dermis and subcutis. Because of its epithelial tissue and glandular secretions, it protects the body against mechanical, chemical and thermal damage as well as against many pathogens. It functions as temperature regulator by varying blood circulation and gland activity. Furthermore, it is involved in the fluid balance by protecting the body against dehydration through the production of fluids and salts. It contains a variety of nerve endings that react to pressure, heat, cold and injury which qualifies it as a somatosensory system (Leonhard, 1991). Through the hypodermis, it is attached to the underlying body structures (fascias) and forms a shift- and thermal regulation layer. The hypodermis contains variable proportions of fat tissues, nerves and subcutaneous blood vessels.

- **Fascia abdominalis superficialis:**

  As a thin connective tissue the fascia abdominalis superficialis clads the whole abdominal wall and lies between to the subcutis and to the M. obliquus abdominis externus and/or to the M. rectus abdominis/M. pyramidalis (Platzer, 1986).

- **abdominal muscles**

  the abdominal muscles can be described according to Platzer (1986) in following groups: A lateral muscle group with the M. obliquus externus/internus as well as the M. transversus abdominis. In front they end into an aponeurisis and forms the "rectus sheath”. A mediale muscle group with the M. rectus abdominis and M. pyramidalis. Both the lateral and the mediale muscle group connect the ribs with the pelvis. A deep dorsal muscle group with the M. quadratus lumborum and the M. psoas major create a connection of the first four lumbar vertebrae with the pelvis (M. quadratus lumborum) and with the femur (M. psoas). The abdominal muscles were innervated by intercostal nerves and the first three lumbar nerves.

- **Fascia transversalis:**

  It is the fascia of the internal abdominal wall which covers the area of the internal abdominal muscles. In the area of the umbilicus it is tight and affiliates after caudal with the inguinal ligament. In the dorsal aspect it covers the M. quadratus lumborum as also the M. psoas major (Bouchet / Cuilleret, 1991).

- **Parietal peritoneum:**

  The parietal Peritoneum is the part of the peritoneum that covers the abdominal cavity. Histologically it is composed of a two-layer tissue. The internal part is a flat single layer mesothelium (mucus membrane) which forms a smooth surface.

The subjacent layer is the Lamina propria, a connective tissue with elastic fibres and vessels which guarantees the nutrition of the mesothelium. The mesothelium is carrier of a brush border (Mikrovilli) and is used for the production of peritoneal fluid (approx. 50 ml) and the resorption of material from the peritoneal cavity. This liquid-filled peritoneal cavity is a flat slit between parietal- and visceral peritoneum (external cover of the abdominal organs). The peritoneal cavity separates both layer and is used as a gliding shift for the intraabdominal organs and the internal abdominal wall. The parietal Peritoneum is sensitively innervated by the N. phrenicus and the intercostal nerves. Lippert (1994) differentiate the parietal Peritoneum into a frontal part and an urogenital part (covering the urogenital organs). The french authors Bouchet and Cuilleret (1991) characterize the parietal peritoneum into four aspects: The Peritoneum parietal diaphragmale (covering the diaphragm), the peritoneum parietal posterior (covering the internal, dorsal abdominal wall), the peritoneum parietal anterior (covering the internal, frontal abdominal wall) and the peritoneum parietal inferior (covering the urogenital organs). The description of Bouchet and Cuilleret (1991) is used in a predominant way in the textbooks of visceral osteopathy (Weischenck, 1982; Helsmoortel, 2002; Fieuw, 2005 and Liem, 2005).

4.3.1 Alterations of Tone of the Abdomen

The visceral osteopathic concepts Weischenck (1982), Helsmoortel (2002) and Fieuw (2005) assume that the intra-abdominal tension and the tone of the abdominal skin stand in mutual relation to each other. Based on the work of Glénard (1899), Weischenck (1982), Helsmoortel (2002) and Fieuw (2005) discuss and explain the aspect of the tonus of the abdominal skin.

Fieuw (2005, p.1) describes the tone of the body musculature as a passive acceptor of the nervous system with the purpose to preserve the bodily functions. Furthermore Fieuw describes how the tone of the abdominal musculature adjusts to the predominant intra-abdominal tension and concludes:

"The content controls the cover."

(Fieuw, 2005, p. 1, translated by the author.)

This notion of the abdomen's tension influence on the body wall can also be found in Helsmoortel (2002, p. 38). Both authors differenciate the adjustment mechanisms applied by the body in response to a change in tension. The response pattern to a tension change is described by Helsmoortel (2002) and Fieuw (2005). They claim that it is both, a reaction of the abdominal wall and a reaction of the intestinal tone. This will be further explained in chapter 4.4.1.

In contrast, the reaction of the intestinal tone is not mentioned in Glénard (1899, p. 537ff) (cf. chapter 5.5). Glénard explains the adjustment reactions of the abdominal wall

(1899) by saying that the body wall would reduce its muscle tone in response to an increased intra-abdominal tension (enlargement of the content). In case of a reduced abdominal tension, the body wall would increase its muscle tone (reduction of the content).

According to Glénard, the palpation of the tone of the abdominal wall is a vital part of examining the abdomen (Glénard 1899, p. 61) which serves, inter alia, the evaluation of the tension conditions of the abdomen. This form of clinical examination of the tone of the abdominal skin also is applied in the visceral osteopathic concept of Weischenck (1982, p. 89ff) and Helsmoortel (2000, p.103) and is part of the testing procedure discussed here. The present study explores the "tonetest in an upright position" as outlined by Helsmoortel (2002, p.103).

4.4 Anatomical Basis of the Intestinal Wall

In this chapter the adaptation mechanisms of the hollow organs are described. For a better understanding of the following chapters it is necessary to describe the anatomy of the intestinal wall from the outer side of the hollow organs to the lumen. The description is carried out by the present anatomy literature of Bouchet/Cuilleret (1991), Leonhard (1996) and Junqueira / Carneiro (1996).

- **Visceral peritoneum (tunica serosa):**

  It is a two-layer tissue which is situated at the outer side of the organs. This outer side consists of one flat single - layer (mesothelium) that restricts the pleura - area and guarantees for a smooth shift of the organs. Subjacent this mesothelium is the lamina propria, a visko-elastic connective tissue with vessels and elastic fibres (Bouchet / Cuilleret, 1991) .

- **Tunica muscularis:**

  As the name already says it is about: The muscular layer of the hollow organs. It consists of an external longitudinal muscular layer and an internal circular muscular layer. There are two exceptions. Exception are the stomach, which has an additional third obliquely muscle layer, and the colon, on which the external longitudinal muscle layer constitutes three strips (taeniae coli). Between both muscle layers, the supplying vessels and myenteric plexus are situated. The plexus is an autonomous nerve plexus that acts relatively independently of the central nervous system. It provides the motor innervation of the muscle layer and the secretomotor innervation of the mucosa. The muscle layers function as a transportation system of nutritious material (peristalsis), and within the stomach cause a grinding and mixing of the food pulp (Leonhard, 1996).

- **Tela submucosa:**

  This is a shifting mucous membrane with visco-elatic characteristics. It is situated between the tunica muscularis and the tunica mucosa of the intestine. The tela submucosa houses the submucous arteries, veins, lymphatics and the autonomous enteric plexus (Leonhard, 1996).

- **Tunica mucosa:**

  This internal mucous membrane is formed by three different shifts and will be described from outside towards inside: Outside there is the muscle shift of the mucous membrane (lamina muscularis mucosae) responsible for the subtle tuning of the mucosa, e.g. establishing contact with the food or guaranteeing evasion of peaked foreign bodies.

  The Lamina propria mucosae is provided in the median and is the area of arterial, venous and lymphatic vessels. It is mainly responsible for supplying the intraluminal mucous membranes and has viscoelastic characteristics. The internal layer of the lumen of the hollow organs is the mucous membrane epithel (tunica mucosa) which forms a complete connection to the lumen. This mucous membrane protects the gut-surface from the ingredients. This is the place of delivery of the digestive secretions and of resorption of the nutritional contents (Junqueira / Carneiro, 1996).

4.4.1 Alterations of Tone of the Intestinal Wall

Based on the description of the anatomical aspects of the intestinal wall, its possible adjustment reactions can now be addressed. In Helsmoortel's (2002) and Fieuw's (2005) visceral osteopathic concept, a modification of the content pressure of hollow organs also leads to a reaction on part of the intestinal wall. This response pattern of the intestinal wall is of fundamental importance for understanding the concept of tension. To illustrate this, the works of Helsmoortel (2002) and Fieuw (2005) are used again, as they give the most detailed account for these mechanisms. According to Fieuw (2005), these adjustment mechanisms take place in the intestine every day because the food supply is not always the same in its composition and quantity. These adjustments consist of two sequences. The first one is an adaptation response of the viscoelastic fibers of the gastro-intestinal tract. In the second one, the tone of the musculature of the gastro-intestineal tract changes according to food quantity and food composition in the intestinal lumen. These operations were needed to ensure a sufficient contact of the bolus with the intestinal wall and to guarantee an optimal processing and transport (transit).

Studies, published in physiological journals, proof the viscoelastic adaptation of the intestinal wall to the content pressure (Bharucha et al., 2001) and describe a direct relationship between content pressure and muscle strength of the intestinal musculature (Pehlivanov et al., 2001 and 2002). A study by Waldron et al. (1989) has investigated possible adjustments of the intestinal wall to changes in the intraluminal pressure conditions. All studies come to the conclusion that if the pressure conditions led to an expansion of the colon, the result was a change in tone of the colon muscles. These studies provide evidence for the visceral concept of Helsmoortel (2002) and Fieuw (2005) who describe the reactive changes of the muscle tone of the intestinal wall to changes of the intestinal contents.

5 Osteopathic Model

Now that the abdominal skin and hollow organs of the abdominal cavity have been described, the abdomen and the aspect of self-regulation shall be depicted from an osteopathic point of view.

In "*Philosophy and Mechanical Principles*" (1902), Still classifies the human body as a coherent and self-regulatory system, a system in which, if in a physiological state, nature could unfold its healing potential. With this statement, Still (Hartmann, 2002, p.383) introduces the notions of self-regulation and self-healing. As the present work is dealing first and foremost with the body shell and the abdominal organs, these aspects shall be in the center of our considerations. For a better understanding of the complexity of these self-regulation process, they are differentiated according to their sites of action. Conceptually, there are regulatory process that take place locally in the organ itself as well as in adjacent organs. These mechanisms are described with the aid of the works of Glénard (1899), Weischenck (1982), Stone (2000), Helsmoortel (2002) and Fieuw (2005).

5.1 Position as Essential Factor for the Function of the Organ

As introduction to this chapter serves a quote from Still's publication "*Philosophy and Mechanical Principles of Osteopathy*" (1902). It explores an important factor of the osteopathic approach: The position of the organs.

Still writes:

> *"[...] The osteopath should know whether the position change of the viscera has an effect on the regular blood flow and other fluids. How much deviation in the intestines may, if at all, be tolerated, without bearing negative results [...]"*
>
> *(Hartmann, 2002, p. 384)*

With this statement, Still stresses the importance of precisely knowing the standard position of organs, their vascular nourishment and nerves (Hartmann, 2002, p.373). This interest in the position of organs results from Still`s osteopathic approach, because he (Hartmann, 2002, p. 383) assumes that an organ can only function optimally if it is in its standard position. Thus a prerequisite for an optimal functioning is the standard position. It ensures that the vessels and nerves are not squeezed / stretched or twisted and thus can fulfill their mission to supply the organs with essential nutrients. For this reason, any deviation from the regular position led to a corresponding deterioration of organ function and simulaneously declining health (Hartmann 2002, p. 391).

Helsmoortel seizes Still's concept and combines it with the notion of tension. According to Helsmoortel, it is the standard tension of an organ that makes for maintaining its autonomy and its regular function (Helsmoortel 2002, p. 36). This standard tension enables the organ to keep its regular position in the abdomen as only a standard position ensures an optimal supply with nutrients through the mesodermal supply system. Any long-term modification of the standard tension led to a change in position, thus leading to a poorer supply with nutrients. Helsmoortel's statement is supported by Bianci et al. (1976) and De Zeeuw et al. (1978) who in their studies focus on the function of sunken kidneys. They come to the conclusion that kidneys in lowered positions are reduced in terms of their filtration performance as well as in terms of blood circulation.

According to Glénard (1899), Helsmoortel (2002) and Fieuw (2005), an organ which is characerized by a reduced tension (an osteopathic would call this "hypotension") will relocate and sink (Helsmoortel, 2002, p. 37). For this reason, what is of particular value for osteopaths when examining patients is the manual diagnosis of the position and tension of the organs. Based on the findings, the osteopath can make a statement about the functional status of the organ in question.

5.2 Local Regulation

Being aware of the regulatory process that describe the interplay of tension and content is important. Therefore, the next chapter will summarize the regulatory process which locally take place in the organ when a change of tension is taking place. The regulatory process is a key element of a visceral osteopathic approach and therefore are to be analyzed separately.

5.2.1 Hollow Organs

Helsmoortel (2002) and Fieuw (2005) describe the body's regulatory mechanisms in case of disturbances or chronic changes in tension. These mechanisms take place locally at the intestinal wall and express themselves by adjusting the intestinal wall's visco-elastic and muscular portion to the modified tension conditions (Junqueira, 1996; Silbernagel / Despopoulos, 2001).

According to the visceral concept of Helsmoortel and Fieuw, a volume reduction of the intestinal contents causes the reactive relaxation of the visco-elastic fibers as well as an increase in muscle tone. Resulting from that, the intestinal lumen narrows. (Fieuw, 2002, p. 1). In case of an extension of the intestinal contents, both Helsmoortel (2002, p. 34f) as well as Fieuw (2005, p.2) describe an opposite reaction pattern of the intestinal wall. With this, an overarching principle becomes evident that guarantees the preservation of the standard tension and simultaneously an undisturbed functioning of the organs.

5.2.2 Full Organs

The regulatory process in full organs differs from those of hollow organs. They do not have a muscular portion and are covered by a relatively solid organ capsule (Bouchet / Cuilleret, 1991; Leonhard, 1991; Platzer, 1986; Sobotta, 2006). According to Glénard's (1899) visceral concept, even here the principle of tension increase as a reaction to changes in content pressure can be observed. With full organs, the increase in tension is achieved by means of a raise of blood flow (Glénard 1899, p.441f, Helsmoortel 2002, p. 35ff), thereby multiplying the pressure within the organs and thus leading to an increase in tension.

The following chapters examine global regulations. It must be noted that these regulatory mechanisms will only take place once the local mechanisms of the hollow and full organs have proven inadequate to ensure the digestive function of the viscera (Helsmoortel, 2002; Fieuw, 2005).

5.3 Global Regulation

According to Helsmoortel's (2002) visceral osteopathic concept, the body will always try to react to a reduction in tension with a local increase in tension (hypertension). This reaction corresponds exactly to the auto-regulatory capabilities that are designed to preserve the position of the organ, thereby ensuring its functioning (Helsmoortel, 2002, p. 36). Inadequate or depleted local auto-regulative forces lead to a "supporting activation" of adjacent organs. These counter regulations are no longer local, but global. In osteopathy, they are called "*compensation mechanisms*". These compensatory mechanisms are utilized once a tissue problem cannot be resolved on a local level. Visceral osteopathy differentiates these support mechanisms even further. Helsmoortel (2002, p. 38) and Fieuw (2005, p.1) declare that both of these compensatory mechanisms take place in the abdominal content and the abdominal skin.

5.3.1 Global Regualtion by Means of Content

Glénard (1899) was the first to discuss this principle of self-regulation in his tension model. As the intestine is locally arranged in six loops and arches and also attached at the rear of the abdomen, the prerequisite is given for the complex, three-layered system of self-regulation in the tension model (cf. chapter 4.1). However, if by long-term illness or by a reduction in tension a descent of organs was to take place, with the result of the intestine pulling on its fixation at the dorsal wall, this would lead to a breaking of the arches and correspondingly to a longer transit time of the bolus. This prolonged transit would lead to an increased fermentation, resulting in a more extensive gas production. With this, the swelling and the increase in tension of "the leaves of

Glénard" was initiated, with the result that the position of the descented organs was corrected (Glénard, 1899, p. 539ff).

Weischenck (1982), Helsmoortel (2002) and Fieuw (2005) have adopted Glénard's tension model and detailed the regulatory mechanisms even further. The following chapter summarizes the findings of Helsmoortel (2002) as his description of the self-regulatory mechanism are the most accurate. The necessary arguments are outlined schematically to simplify the complexity of the process.

Helsmoortel distinguishes two forms of organ impairment. Primarily, the organ function may be affected by metabolic and / or mental disorders (Helsmoortel, 2002, p. 37; Stone, 2000, p. 181). Secondly, according to Helsmoortel (2002) it may result from a malfunction of an adjacent organ. This would correspond to a compensation mechanism. Helsmoortel (2002) claims that an organ's first response to a disruption of its function is to increase the blood flow, thereby stimulating the metabolism. Should the disturbance last over a longer period, the organ could no longer manage the increased blood supply. With this, the energizing tension-interplay of content and body wall would exhaust itself (cf. chapter 5.5). The loss of these autoregulatory corrections would necessarily lead to a descent of tension and as a result to a descending position of the organ. This lowering of the organ led to an increased burden of the organ lying underneath which in turn would increase its own tension (hypertension) in order to maintain its position while stabilizing the sinking organ (Helsmoortel, 2002, p.37).

5.3.2 Global Regulation by Means of the Abdominal Wall

The chapter "tone of the abdominal wall" the mutual influence of abdominal content (organs) and abdominal wall was already mentioned. In visceral osteopathic conception, this relation has a model function. To be able to make a statement about the function of the abdomen, this relation is included in visceral-osteopathic diagnosis. The interaction between abdominal content and abdominal cover can be attested by means of the following case studies which scientifically demonstrate the mutual influence of abdominal pressure and abdominal contents.

Studies by Hodges et al. (1997, 1999 and 2000) show that an increase in intra-abdominal pressure leads to an increase in muscular tone of the abdominal wall. With this they confirm an assumption which is the at the core of visceral-osteopathic conception: the influence of body shell through body content. That this influence is also possible in reverse is demonstrated by studies of Grillner et al. (1978) and Essendrop et al. (2002). They confirm the increase of intra-abdominal pressure through muscle contractions of the abdominal wall.

Adopting this mutual interaction, our attention will now be directed to the supportive influence of the cover on the content. This cover is defined as "body-boundary which limits the content of the abdomen on every side." The voltage of this body cover is supported by the standard pressure of the content and induces a reflexive counter-tension of the abdominal cover (Helsmoortel, 2002, p. 96). This tension of the abdominal skin is referred to by Helsmoortel (2002) as "Ruhetonus", by Fieuw (2005) as "Normo-tonus (normo-tone)". Consequently the term "*normo-tone*" will be used here as it is commonly used implementing clinical studies or at osteopathic training sites.

According to Helsmoortel (2002) and Fieuw (2005), a reactive change of the normo-tone is leading to changes in the muscle-tone of the abdominal wall due to a change in tension: In case of reduced tension, it is the muscular portion of the abdominal wall that reacts with an increased tone. Thus, the motor system as integral part of the body fullfills an anti-gravitational function. This increase in tone of the abdominal wall stabilizes the descending organ, thereby securing the position and thus the functioning of the organ concerned (Helsmoortel, 2002, p. 98; Fieuw, 2005, p. 2).

The reaction pattern of the cover resulting from an increase in tension is described differently by the authors: Helsmoortel (2002) links an increase in tone of the body wall's muscular portion to an increase in intra-abdominal pressure conditions. The analogue expansion of the content brought a reactive increase of tone in order to limit the extention. The purpose of this process being the preservation of the body axis (Helsmoortel, 2002, p. 97).

Fieuw (2005) assumes that as a first response to an increased tension and correspondingly to an increase in volume, the tone in the muscular cover will reduce. This assumption stands in contrast to Helsmoortel theory. In Fieuw's point of view, the decline in tone would extend the inta-abdominal space and give more space to the content. This response pattern is not further substantiated by Fieuw but is compared with the changes of the abdominal wall that occurs during pregnancy (Fieuw, 2005, p. 2). Fieuw's statement is consistent with the descriptions by Glénard (1899, p. 537ff). Glénard, explaining the adaptation reactions of the body wall to changes in tension, describes the changes as a reduction in muscle tone to an increased intra-abdominal tension (enlargement of the content) and an increase in muscle tone to a a reduced abdominal Tension (reduction of the content).

5.4 Summary

As a final consideration of the two textbooks of Helsmoortel (2002) and Fieuw (2005), it must be noted that the statements of Fieuw are very similar to Glénard's tension model and Weischenck's (1982) further specifications of it. As Fieuw (2005) gives no scientifically validated list of references, the lack of evidence for his statements must be critizised.

By contrast, the statements of Helsmoortel on this subject are scientifically confirmed. The studies by Grillner et al. (1978), Hodges et al. (1997 and 1999) from the previous chapter give evidence for this. Here, a rise in intra-abdominal pressure was commonly induced by the movement of the skeletal muscles. Yet this form of increasing tension is not identical with Helsmoortel's: In his model, the increase in tension is triggered by metabolic or psychogenic stress factors. In this respect, the question remains as to whether an increase in tension initiated by short-term movements in the abdomen lead to the same reaction from the muscular cover as everyday increase in tension caused by metabolic and / or psychogenic causes.

5.5 Tension

The testing procedure studied in this work is oriented to assess tension conditions of patients. During the research for this work, it soon became apparent that the notion of tension is inconsistently used in the medical and osteopathic publications this work refers to. Therefore, the notion of tension shall be formulated in more detail here.

The term "*tension*" originates from the Latin and means "tenseness", "stress" or "tensity". Being a common term in medical literature, it is best translated with "stress" or "pressure". It describes the blood pressure, the abdominal pressure, the pressure and tension headache (Pschyrembel, 2007, p. 1896).

In osteopathic literature, a further aspect is added to the concept of "tension". Liem defines "tension" as a reaction force with which a structure will react to a stimulus (Liem, 2005, p. 65). Helsmoortel (2002) and Fieuw (2005) differentiate the concept of "tension" even more. They describe the pressure of the lumen within a hollow organ as an expression of the lumen's ingredients and the associated gas production. This gas production would lead to a swelling of the wall of the hollow organ, thereby stretching it. Because of their visco-elastic and muscular proportions, the wall could adapt this pressure content. This adaptability of the viscera combined with with content pressure is called "tension" (Helsmoortel, 2002, p. 33; Fieuw, 2005, p. 1).

Since the concept of tension focuses on variable capacities of the organs involved, the next step will give an account of these various deviations. To this end, the osteopathic textbooks by Weischenck (1982), Finet and Williame (1992), Helsmoortel (2002), Fieuw (2005) and Liem (2005) are used, since only here, the term "standard tension" and the deviations from it are described.

5.5.1 Standard Tension

As stated above, there is no exact and coherent definition for the term "standard tension". For this reason, a survey of the various definitions is indicated.

- Weischenck (1982, p. 17) characterizes the standard tension of the abdomen as a consistent, homogeneous and shape-preserving mass in which no specific organ contours can be identified.
- Finet and Williame (1992) compare the tissue response of normo-tensiv tissues as reaction to a palpation stimulus to that of a trampoline. It corresponds to a free and harmonious movement of the tissue response (Finet and Williame, 1992, p. 41).

- Helsmoortel describes the standard tension of an organ as a state allowing the organ to maintain its position and thus its function (Helsmoortel, 2002, p. 36). The normal tension of an organ was equivalent to its internal anti-gravitational force. Standard tension was characterized by the tissue's intitial yielding and accepting the stimulus when compressed. The result was a balance between force and adjustment response of the tissue, for normal elasticity would allow relative to the stimulus. The standard tension was characterized by the internal forces of tension matching the outer limits of the organ (Helsmoortel, 2002, p. 33). Another aspect of tension appears in the embryology of the viscera. During its development the viscera is subject to heavy compression forces due to the faster growth of the adjacent ectoderm tissues. According to Helsmoortel (2002), the visceral tissue (entoderm) thus compressed responds with a force directed outside (at the adjacent tissues) which can also be considered as an additional tension factor.

- Liem (2005, p. 65) describes tension according to its response pattern to an external elongation stimulus. Normo-tension was characterized by the tissue's elastic yielding and rebounding as reaction to an elongation impulse.

- The "Practical Guide to Clinical Medicine" of the University of San Diego (2008) does not describe tension itself, but the results of the examination of a healthy (normo-tensiv) abdomen. As a result, it is noted that in a healthy abdomen, no organic structure could be identified by palpation because the abdomen felt like a homogeneous mass. Only pathological influences enabled the examiner to identify the relevant organs.

- Fieuw (2005) does not describe tension itself, but the results which the tensionstest supplies in case of prevailing normo-tension:

  „If you palpate the individualregionsof the corresponding "leaves of Glénard" on the standing patient, one finds the maximum at the first leaf and the minimum of the third leaf, while the second leaf holds a middle position [...]"

  (Fieuw, 2005, p.3, translated by the author)

In visceral osteopathy , the "normo-tension" represents an ideal situation ensuring the health of the organ (cf. chapter 5.1). Since this ideal state, however, is subjected to metabolic and psychological influences (Stone, 2000 and Helsmoortel, 2002) disorders and deviations of the "normo-tension" can occur. These deviations are called Hypotension resp. Hypertension which will be explained next.

5.5.2 Hypertension

Hypertension is characterized by an excess of tension.

- Finet and Williame (1992, p. 44) characterize hypertension as a lack of tissue response to a stimulus that disrupts the dynamics of the tissue.

- According to Helsmoortel (2002, p. 33), tissue responds to a compressive stimulus with resistance, meaning that the tissue cannot absorb the impulse and rejects it. In this case, the internal forces reach beyond the organ boundary, with the organ tending to take up more space.

- Liem (2005, p. 65) describes hypertension as not yielding to pressure stimuli. An increased resistance indicates a high state of stress.

- Fieuw (2005) depicts hypertension via tissue condition of the hollow organs with an expansion of the visco-elastic fibers and an initial increase in tone of the organ muscles (Fieuw 2005, p. 1). Regarding additional reactions of these various organ components, no further statements are made.

5.5.3 Hypotension

Reduced tension is defined in osteopathic nomenclature as "hypotension".

- Helsmoortel (2005) describes hypotension as a deficit of the internal anti-gravitational forces leading to a possible sinking of an organ's position (cf. chapter 5.1). Furthermore, a loss of the tissue's elasticity is described. In addition, the impulse directed towards the tissue receives no direct answer, but is transfered to the depth of the tissue. As the internal tension forces are reduced, the same applies to the space usually taken by the organ (Helsmoortel, 2005, p. 33).

- Liem (2005, p. 65) explains that a strong bounce without rebounce points to a drop of tension (hypotension).

- Fieuw (2005) explains hypotension by means of the different tissue parts of the hollow organs (cf. chapter 4.4). Hypotension leads to a relaxation of the elastic fibers and an eventual increase in tone of the organ walls muscular portion (Fieuw, 2002, p. 1).

5.5.4 Conclusion

As far as can be seen, Glénard's tension model (1899) was the one to introduce the notion of tension and explained the pressure conditions in the abdomen. Glénard's notion of tension refers both to the pressure in the hollow as the full organs. With respect to the present literature on current osteopathy by Helsmoortel (2002) and Fieuw (2005) the concept of tension has been extended.

While for Glénard the organ wall only had a passive nature that yielded reactively to the content pressure of the organs, both Helsmoortel and Fieuw assign an active character to the body wall. This active character was based on the intesinal walls visco-elastic and muscular histological structure. Helsmoortel and Fieuw include the force of the intestinal contents described by Glénard (Glénard, 1899, p. 566) as well as the reactive stress of the intestinal wall in the forces, which together form tension (Helsmoortel 2002, p. 33; Fieuw 2005, p. 1).

Helsmoortel extended the concept of tension by an embryological aspect. This was based on the observation that during its growth, the intestinal tube was subject to heavy compressing forces leading to an influence and responsiveness on part of the intestinal tube, “erecting resistance". These erecting forces were characteristic for the intestinal tissue and had to be attributed to the tenseness of the intestinal wall. For this reason, they also are an element of tension. Apart from the aspects described above, Helsmoortel (2002), just like Glénard, uses the notion of tension both for hollow and full organs. Fieuw (2005) applies the term tension to hollow organs, yet without justifying his doing so. Due to our own considerations, we assume that the term "tension" can only be applied to those organs with a muscular part within their walls (hollow organs).

Considering the explanations above, one point of criticism emerges: neither Weischenck (1982), Finet and Williame (1992), Helsmoortel (2005), Liem (2005) nor Fieuw (2005) coherently define the notion of tension in their osteopathic textbooks. Thus the term tension still gives cause to interpretations and speculations. These varying definitions of "tension" are expressed by individual descriptions and lists of attributes. With this, no good starting point for the application and intepretation is given. Then again, we assume that it is not the overall claim of these textbooks to convey osteopathic theory and concepts in the first place, but to be designed as supplementary teaching material. Since the testing procedure reviewed here also includes an assessment of the tone of the abdominal wall, the next chapter is concerned with an explanation of the term "*tone*".

5.6 Tone

In osteopathic medicine, an assessment of the tone of the abdominal wall is always incorporated in an examination of the abdomen. In the osteopathic model, the body wall consists of muscle as well as bony portion (Helsmoortel 2002, p. 103). According to our findings, an examination of the abdomen and an associated assessment of the tone of the entire body wall (muscular and bony) is exclusively practiced in osteopathic medicine. By contrast, in clinical medicine it is solely the tonicity that is assessed as part of the abdominal examination.

In medical literature, "*tone*" specifies the condition-based degree of tonicity of an organ or body part. This feature may relate to muscles, blood vessels or nerves (Pschyrembel, 2007).

At this point, the "Swiss Association of Osteopathy" shall be instanced. It introduces a definition of tone that differs from the osteopathic definition known to us. In their terminology, "*tone*" is a term used for the tonicity of skeletal muscles. In order to diagnostically examine the condition of tone, what is needed, according to the of the "Swiss Association of Osteopathy", is to move a joint. The degree of tactile resistance during passive movement would give an impression of the muscle tone. By pressing or touching tense muscles alone, no precise indication of the conditions of tone (Swiss Association of Osteopathy, 2003) could be gained. With the previous observations (cf. chapter 4 and 5.5) in mind, this interpretation of the term "*tone*" is rejected.

Present osteopathic textbooks apply the term "*tone*" the same way as used in medicine. Fieuw (2005, p. 1) states that "*tone*" describes the tensity of a skeletal muscle, yet adds that the term "*tone*" had to be seen with respect to the body cover. His statements suggest that it is the content of the body cover that conducts the tone (Fieuw, 2005, p. 1). This is one of the basic statements of Fieuw's osteopathic concept: he hereby declares the tone of the body cover as "victim of the tension of the body's inside". Thus, it was the tone of the body cover that was conducted by the pressure gradient from the inside of the cavities, since it had to adapt to it. (Fieuw 2002, p. 1). The adjustments of the body cover had to make among others were changes of the muscle-tone of the body wall. The normal status and its changes will be described in the following, since they are essential for an understanding the test procedure examined here.

5.6.1 "Ruhetonus" or Normo-tone

"Ruhetonus" or normo-tone was already addressed in chapter 5.1. and shall be complemented at this point to some by some definitions from clinical and osteopathic medicine:

- In the "Journal of Bodywork and Movement Therapies", Liebenson and Lewit claim that in an upright position, the "Ruhetonus" of the abdominal had to be understood as a passive pressure on the viscera (2003, p. 36).
- The "Practical Clinical Guide" (2003) of the University of San Diego describes the normo-tone in a lying position as non-resistant and yielding.
- Zelenkova et al. (1997) characterize the standard-tone of the abdominal wall as flat, solid-elastic and not painful.
- Helsmoortel (2002) describes the tone of the body wall as resulting from a stretch stimulus from outside. Apart from the reaction of the muscular cover, also the response of the bony structures (spine and pelvis) should be taken into account. In the case of a normo-tone, muscle tissue and bone tissue felt elastic and would give the impulse of a sudden, but not too strong resistance. If a bone regardless of its environment felt like independant, then its standard elasticity was given. This is Helsmoortel's description of a standard-tone of a bone. His concludes that given these circumstances, a bone was in its homeostatic balance. (Helsmoortel 2002, p. 103).

All of the classification above are similar in their subjectiveness regarding the nature of the tone of the abdominal wall. Beyond that, Helsmoortel's (2002) description of the tone of the body cover additionally instructs the examiner in terms of a testing and interpretation of the tone. This classification by Helsmoortel (2002) outlines an aspect of the assessment of the tone of the body shell. This aspect is also applied in visceral osteopathic examinations.

5.6.2 Hypertonia

In osteopathic medicine, an increase of tone is indicated with the term "*hypertonia*". In medical nomenclature, however, this term is ususally used as synonym for high blood pressure. Here, the notion "*elevated tone*" usually assesses the stress state of musculature.

To better understand how an elevated tone can be diagnosed, some explanations from clinical and osteopathic medicine:

- Bursey et al. (2000, p. 42) characterize an increase in muscle tone as increased muscular defense that may indicate an organic disease.
- Helsmoortel (2002) evaluates hypertonia in terms of its reaction to a rebound. The muscular portion of the body wall is tested with a rebound (short-term stretching impulse in transverse direction of the muscle) and / or a stretching impulse in longitudinal direction. The bony portion of the body wall was also screened using a rebound test. In case of hypertonia, the result was a positive rebound characterized by a loss of elasticity and rigidity of the bone (Helsmoortel, 2002, p.39). Helsmoortel bases this test on the adaptability properties of living bone tissue. This model was made by J. Wolff (1832-1902), a German anatomist and surgeon, for the first time and describes the adaptability of the bone to influencing loads.
- In the "handbook of signs and symptoms" (Spring House, 2006, p. 25) an abnormal rigidity and inflexibility is ascribes to an increased muscle tone.
- The "Practical Guide of Clinical Medicine of the University of San Diego" (2007) characterizes an increased tone as resistance to the pressing of the abdominal wall, often in combination with a painful abdominal wall tension.
  By placing the hand flat on the abdomen, subsequently increasing the pressure and simultaneously inflecting the finger joints, the muscle tone could be estimated.

Conceptually, these statements share a classification of hypertonia as "resistance", "rigidity" and "high tension" of the muscles. The observations of Helsmoortel (2002) also give an instruction as how to diagnose such as a hypertonia in osteopathic examinations.

5.6.3 Hypotonia

Just as the previous chapter detailed an increase in tone, this chapter serves to illustrate the body wall reduction of tone.

- Stone (2000, p. 47) describes the tone of the body wall as factor supporting the visceral organs in their position. If the tone of the body wall collapsed, the organs would sink down - a process that would affect their functioning.

- Helsmoortel (2002) characterizes the body wall hypotonia analogous to hypertonia in its response pattern to a rebound test. According to Helsmoortel, a hypotonic muscular body wall shows an inadequate response to a rebound test, with scarcely a reaction to the stretching impulse. The rebound test of the bony portions of the body cover is charcterized by Helsmoortel in a intense yielding to the stimulus, with an sufficient response of the bone (Helsmoortel, 2002, p. 103).

5.6.4 Conclusion "Tone"

In conclusion, it became apparent that in osteopathic literature, only little material could be identified that focuses on the examination and evaluation of the tone conditions of the body wall. Helsmoortel`s textbook (2002), which served to describe the tone, prove to be the most comprehensive source both in quantity and quality regarding its statements on this subject. Yet, the described execution and interpretation of the "rebound test" of the body wall require a lot of experience. To an inexperienced examiner, they offer a lot of room for interpretations.

"It is easy to teach technique. It is difficult to teach interpretation."

(M. M. Patterson, 2000, p. 380)

This quote from Patterson (2000), an American osteopath, underlines the last statement, for Patterson comments on a problem widely known in manual and osteopathic medicine: the interpretation and evaluation of test results. At this point, the aspect of one's own clinical experience has to be focused on, because only a daily, experienced application of testing procedures may lead to a secure interpretation of test results (McConnel, 2000, p.3).

Considering the importance of the body cover as supporter of the viscera (Weischenck, 1982, p.22; Barral / Mercier, 1983, Bd. 1, p. 67; Finet and Williame, 1992, p. 131; Stone, 2000, p. 47 and Fieuw, 2002, p. 1), the prevailing lack of osteopathic testing procedures screening the tone of the body wall cannot be understood. Under these conditions, it seems questionable whether the test can be precisely implemented and interpreted in one's own surgery. With this study, the application of the test and the reliability of its results shall be validated.

6 Palpation

Palpation is an essential part of osteopathy. In view of its importance, this study analyses several of its aspects in the following chapters.

6.1 Palpation in general

In the testing procedure studied here, manual palpation is the tool with which to assess tone and tension.

"*Palpation*" originates from the Latin "palpare" and can be translated as "to stroke". In medicine, palpation is described as an examination of the body by touch (Pschyrembel, 2007, p. 1421). The palpation can be performed with one or more fingers, the palm as well as single- or two handed.

In addition to palpation, inspection, percussion and auscultation are also part of a physical examination. These examination techniques shall not be further expanded on as they are of no relevance for the present study. Study criteria assessed by palpation are consistency, flexibility, agility, pain sensitivity and the size of the examined organs or body structures. These criteria are universally applied both in classic as well as osteopathic medicine. Yet in osteopathy, a further value is attached to palpation which will be explained next.

6.2 Palpation in Osteopathy

The position of Clark (1904), an American osteopath, serves to emphasize the importance of palpation in an osteopathic approach. In his opinion, palpation is the most important examination method in osteopathy. He is supported by Burns (1907) who declares that palpation is the primary method for obtaining a diagnosis.

The rapid technical developments of the past one hundred years have also had their influence on osteopathy. The perceptions of imaging representation methods such as computed tomography have been integrated in osteopathic diagnostics. Yet the great importance of palpation in osteopathy remains unchanged. In support of this statement, we will cite an essay by Patterson (2000) on osteopathy from the "Journal of the American Osteopathic Association". "*Still viewed palpation as the bedrock of osteopathic technique*", Patterson says here (2000, p.387). He further explaines that palpation implied a confidential relationship between patient and osteopath and also a sensitive understanding of the tissue reaction on the osteopath's part. This distinguished it from a purely mechanical execution of palpation and contributed to a deeper understanding of the patient.

The way Patterson describes interactive process of osteopathic examinations, palpation cannot possibly be understood as a mere touching and palpating of body tissues to make a diagnosis.

> *"Consequently there should be constant mental contact with the tissues through the tactual corpuscles, and interpretation, or else the feel of tissues give little but reliable information."*
>
> *(McConnel s.a. published bei JAOA, 2000, p. 395)*

With this quotation from Still, McConnel directs the focus onto the mental contact during a palpation process. This mental aspect of palpation has solely been identified in osteopathic literature and thus illustrates a specific aspect of osteopathic palpation. Since the exact significance of this relationship cannot be resolved, we depend on interpretations when explaining mental contact. But it can be assumed that the term "mental" describes a non-physical attribute of the human body.

In "*Osteopathy Research and Practice*", Still (Hartmann, 2002, p. 507) labels the mental system as ruler of the five senses. In another chapter, he claims that the standard picture of form and function of all body parts had to be viewed with the mental eye, for otherwise the osteopathic work was doomed. Based on these statements, we take the term "mental" in this context as a form of spiritual and emotional alertness. If we combine our interpretation with Still's description of a "constant mental contact through the tactual corpuscles", the image of a focused mind emerges, which absorbs and analyzes all sensitive and sensory information with all its alertness. In our opinion, this state of mental concentration must be considered as an integral part of an osteopathic palpation. Just as palpation is of irreplaceable value for osteopathy, so is the exact anatomical and physiological knowledge of the human body for palpation. Therefore, this is further elaborated on in the next chapter.

6.3 Anatomical Aspects of Palpation

> *"[...] Think anatomically: When looking, listening, feeling and percussing imagine what organs live in the area that you are examining [...]"*
>
> *(A Practical guide to Clinical Medicine, 2007)*

A precondition for palpation is the examiner's profound anatomical knowledge. By means of his anatomical knowledge he is capable of orienting himself on the patient's body in order to reach the exact body tissue which is the focus of his attention. Yet a precise localization of body structures by itself is insufficient for palpation. Thus the examiner needs specific knowledge about the tissue he wants to palpate. This form of knowledge can be obtained by the study of anatomy, physiology and histology. Thus, the examiner is able to gain in impression of the analyzed tissue and interpret the findings of palpation (Patterson, 2000, p.380).

In osteopathy, the precise knowledge of these sciences is repeatedly emphasized. In his "Principles of Osteopathy", Tasker says: *"Osteopathy has further developed the art of palpation to a admirable degree, and this art is based on an exact knowledge of structure and function"* (Tasker, 1916, p. 17, translation by the author , N. W.).

Still (1899) is often cited for demonstrating the importance of an accurate knowledge of body tissue. A publication by the “American Osteopathic Association” (2000) supports this. In their magazine, McConnel (s.a.) published a study on palpation. McConnel refers repeatedly to Still’s works which describe the essential need for knowledge of the body`s structure and function as to make an accurate diagnosis. Furthermore, McConnel notes that Still has not yet found a "king route" to train the ability for palpation. His own training consisted of years of daily palpation exercises to obtain an exact and intimate knowledge of the tension and the tone of the body tissue.

This special interest of osteopathy in the body tissues has remained an important issue until the present day. Stone (2000, p.152) describes a particular method for palpating the abdomen. She explains how by a slow increase in pressure of the flat hand on the abdomen, the different layers of skin, abdominal muscles and viscera can be palpated. By varifying the pressure, one could change from layer to layer, thereby gaining an impression of the tissue condition of the three different body tissues (cf. chapter 6.5.).

When osteopaths speak of palpation, this implies both the detailed knowledge of the palpating tissue as well as a mental contact with the tissue.

6.4 Palpation – a Model Conception

As this study is mainly centered around the aspect of palpation, it must be mentioned that palpation is based on a model. The model is based on the notion that internal body tissues cannot be directly touched. Therefore, the examiner develops a model concept of the tissue palpated according to his anatomic / physiological / histological knowledge. This model concept or, as the case may be, this reduced pattern of reality then has to be grasped by using palpation. The originally intended purpose of palpating a specific body tissue cannot be fulfilled (with the exception of the skin surface), as it is impossible to directly touch body structures within the body due to the intermediate body tissue. This difficulty is supported by the following quotation by Finet and Williame:

> *„[...] It is not literally possible to palpate a given organ – the anatomy does not allow us to grasp or have direct contact with an organ. We cannot palpate a kidney, intestine, spleen or liver [...]”*
>
> *(Finet and Williame 1992, p. 41)*

Recapitulating, it may be said that palpation being based on a model can only mirror a limited aspect of reality. The fact that the evaluation of the results depends on the subjective interpretation and visualization of the examiner limits the validity of their evidence.

6.5 Palpation Applied

After presenting the various aspects of palpation, we will now focus on the implementation aspects of palpation. Both clinical medical as well as osteopathic models are used and discussed. The selection is limited to a description of abdominal palpation, since this aspect of palpation is part of the present work. Other palpation patterns will not be specified as they are irrevelant for this study.

Viewing the material this study is based on, it emerged that when applied, the palpation of the abdomen should meet two aspects. On the one hand, an evaluation of the surface body tissue is to take place by palpating, on the other hand, deeper body structures, such as the organs, should be assessed. In this context, publications of clinical medicine are used which demonstrate the basic aspects of palpating the abdomen. Authors of these publications are Zelenková et al. (1997), Bursey et al. (2000), Bickley (2000) and the team of authors for the clinical guideline of the University of San Diego (2007).

6.5.1 Palpation Applied in Clinical Medicine

As a starting position, all the above authors suggest that the patient adopt a lying position with flexed legs so that the abdominal wall could relax. In order to assess the outer structures of the body cover as well as the deeper structures within the body, the subsequent palpation would be done in two steps.

6.5.1.1 Surface Palpation

The surface palpation is intended to evaluate the structures of the body cover, for example skin and muscles. Appraisal criteria are the attributes and the algesia of the body tissue. These included temperature, moisture, and the flexibility of the skin. In addition, the stress state and the elasticity of the abdominal muscles and their reponse pattern to a stretch impulse (rebound) are evaluated.

The palpation is executed either single handed or bimanual with the upper hand determining the pressure of palpation and thus providing palpation depth. The subjacent hand should not impose any pressure and is the actual palpation hand. This method of palpation generally is applied before deep palpation. Since the surface palpation is often perceived as pleasant, it also serves to win the patient’s confidence. One effect of this gain of confidence is the reduction of body tension, thereby faciliating the subsequent deep palpation. According to Zelenková et al. (1997), the cooperation of the the patient is a prerequisite for deep palpation. It should again be stressed that with the exception of the skin surface, a direct palpation of the internal body tissue is not possible, because palpation is always based on a model concept of body tissue (cf. chapter 6.4).

6.5.1.2 Deep Palpation

The changeover to deep palpation is characterized as fluent. This form of palpation serves to grasp the deeper body structures, mainly the organs. Size, shape, consistency, algesia and mobility of the internal organs are focused on. As with surface palpation, for deep palpation a uni-and bimanual palpation technique is described. How exactly an organ-specific palpation is to be carried out differs from author to author, which is why no single palpation technique for the internal organs can be distinguished.

6.5.2 Palpation Applied in Osteopathic Medicine

The description of osteopathic palpation of the abdomen is based on the visceral textbooks by Weischenck (1982), Barral / Mercier (1983), Finet and Williame (1993), Stone (2000), Helsmoortel (2002), Fieuw (2005) and Liem (2005).

Of these authors, Weischenck (1982) and Helsmoortel (2005) are the only ones who in their osteopathic examiniations mention the palpation of the body cover. Their execution in form of single handed or bimanual palpation is comparable to the descriptions in clinical internal medicine. Again, Weischenck (1982) and Helsmoortel (2002) are the only authors who carry out the surface palpation of the body cover in a standing position. They justify this approach claiming that only in a standing position the influence of gravitational forces on the body cover could be detected.

Barral (1983), Finet and Williame (1992), Stone (2000), Liem (2005) and Fieuw (2005) in their textbooks do not take the aspect of a surface palpation into account, but only describe the palpation of the internal body tissue. To reflect on the execution of deep palpations of the various organs would be beyond the scope of this work. It is noted that the palpation techniques for body organs are not uniform and vary in application and initial position. The described examination criteria for an in depth-palpation are size, shape, consistency and algesia of the internal organs, together with an evaluation of the peritoneal tissue within the abdomen.

In addition to these criteria, palpation is used to determine the mobility and motility of the body tissue. Mobility and motility of the body organs are specific motion characteristics of body tissue within the osteopathic concept. Due to the lack of relevance to this work, these osteopathic motion aspect are not discussed. Instead, we defer to the relevant scientific literature.

6.6 Conclusion

After the existing material has been thoroughly investigated, the following conclusions can be drawn as to how palpation should be carried out:

- It is impossible to directly touch body structures within the body due to the intermediate body tissue.

- When palpating the abdomen, practices can be divided into a suface palpation of the body cover and a deep palpation of the body organs. Surface palpation: This type of palpation is detailed without exception in all clinical internal examination methods (Zelenková et al., 1997; Bursey et al., 2000; Bickley, 2000; the clinical guidelines of the University of San Diego, 2007) and partly in the osteopathic literature (Weischenck, 1982; Helsmoortel, 2005) available to us. Deep Palpation: In case of a deep palpation of the body organs, for both, clinic-internistical palpation as well as visceral osteopathic palpation, the palpation of the full organs is carried out inconsistently.

- We assume that palpation of internal organs and body tissues is rated higher in osteopathic medicine than in internal medicine. This is proved by the quantity of organ-specific palpation techniques as well as the variety of qualitative analysis parameters (Weischenck, 1982; Barral / Mercier, 1983; Finet and Williame, 1993; Stone, 2000; Helsmoortel, 2002; Fieuw, 2005 and Liem, 2005).

- In osteopathic medicine, high importance is attributed to the assessment of the various aspects of body tissue (mobility and motility) and the abdominal peritoneal tissue. This aspect of palpation is not accounted for in clinical examinations (Zelenková et al., 1997; Bursey et al., 2000; Bickley, 2000 and the clinical guidelines of the University of San Diego, 2007).

- A differentiated description of the palpatory examination of the hollow organs in the abdomen as well as a variety of criteria for palpatory examinations were exclusively found in osteopathic textbooks (Weischenck, 1982; Barral /Mercier, 1983; Finet and Williame, 1993; Stone, 2000; Helsmoortel, 2002; Fieuw, 2005 and Liem, 2005). In contrast, the palpation of the hollow organs as used in clinical medicine restricts itself as a rule to a capturing of pain- and filling conditions of the organs (Zelenková et al., 1997; Bursey et al., 2000; Bickley, 2000 and the clinical guidelines of the University of San Diego, 2007).

- The visceral osteopathic textbooks reveal a lack of investigation methods to palpatory evaluation the body cover (Barral / Mercier, 1983; Finet and Williame, 1993; Stone, 2000; Fieuw, 2000 and Liem, 2005). In light of the relation between body cover and body contents as formulated in visceral-osteopathic concepts, this cannot be comprehended. We believe that there is still the need for detailed descriptions of the various palpations techniques of the body shell.

- In a visceral osteopathic examination, the body organs are examined in different initial positions (Barral / Mercier, 1983; Finet and Williame, 1993; Stone, 2000; Helsmoortel, 2002; Fieuw, 2005 and Liem, 2005). These variations cannot be detected in clinical internal examinations. They are restricted to examinations in a dorsal position (Zelenková et al., 1997; Bursey et al., 2000; Bickley, 2000 and the clinical guideline of the University of San Diego, 2007).

7 Critical Approach in Medicine

On part of the osteopathy associations, many efforts have been made to integrate osteopathy in the state health system. For osteopathic medicine, this means that it has to be demystified, just like clinical medicine has been for the past 30 years (Mayer Fally, 2007, p. 5). In our opinion, one aspect of this demystification is a critical and scientifical inspection of all testing procedures in osteopathy.

7.1 History

One of the main objektives practicing physicians strive for is to cure and prevent diseases. This treatment is based on the physician`s insight into the ailment and his resulting therapeutic decisions or further diagnostics. Frequently, these decisions do not correspond to the current medical standard of knowledge, which is why the effect of the chosen therapies often does not meet the expectation (Bleuer et al., 2008). As a result, in the late 1970s in Hamilton, Canada, a work group was formed that developed concepts for a systematic approach to improve the decision-making process in clinical everyday life (Guyat et al., 1992; Antes, 1998, p. 87/88).

Further efforts to improve cross-social health were made in 1976 by the Canadian Task Force group. The aim of this prevention-oriented organization was to find out how with periodic health checks, the health of Canadian citizens could be improved (Canadian Task Force Group, 1994). At the end of the 1970s, the British physician and epidemiologist Cochrane (1979) critizised the professionalism of physicians by saying:

> *"[...] It is surely a great critism of our profession that we have not organised a critical summary by speciality or subspeciality, adapted periodically of all randomised controlled trials [...]"*
>
> *(Cochrane 1979, p. 1931-1971)*

With this statement, he pointed out the need for clinical-systematic reviews to update the existing clinical knowledge and make it accessible to all physicians. It was the British public health service that adopted this idea and had systemic reviews of relevant medical issues implemented. This approach attracted international interest and led to the foundation of the Cochrane Collaboration in 1993. The Cochrane Collaboration is now a worldwide network of professionals from the health sector, developing the systemic review of health-related issues.

According to Bleuer et al. (2008), these three projects, the activities at the McMaster University, the Canadian Task Force and the establishment of the Cochrane Collaboration, were the milestones for developing an "evidence-based medicine" in the 1990s. The evidence-based medicine is a possible prospect for improved treatment / care of patients and a better evaluation of them. Physicians are thereby enabled to obtain the best information from clinical studies and publications for the benefit of their indivdual patients or patient groups.

Sackett (1997), a Canadian physician and pioneer of evidence-based medicine, defines the evidence-based Medicine as follows:

> *"It is the conscientious, explicit and sensible use of the best current external scientific evidence for decisions in the care of individual patients"*
>
> *(Sackett 1997, p. 23)*

Accordingly to Bleuer et al. (2008), two core elements of an "Evidencs based – approach are thus recognizable: The decision-making process should explicitly be based on the best scientific information available. Decisions and doctrines are categorically to be doubted and must always be justified.

From these statements, a fundamental attitude of the evidence-based medicine is conceivable. It addresses the critical review of one's own clinical decisions and of the resulting therapies. The following issues are according to Jonitz (2007) the basic requirements for a critical approach and should help in the critical evaluation of ones own clinical skills:

- What does my patient need?
- What can I do, and what do I know?
- What should I be able to do and know in order to help my patient optimally?

7.2 Evidence-based Approach in Manual Medicine

Since the present work investigates the examination of a manual testing procedure, we will focus on palpatory diagnostic methods in manual medicine.

In accordance with the concept of evidence-based medicine, the clinician is enabled to apply the most appropriate diagnostic methods by critically considering all clinical studies and medical publications. The interpretation of these test results and the correctly derived treatment should contribute to optimizing the health of the patient. Even in manual medicine the trend is visible to critically reflect on the way how manual medicine is practiced.

In manual medicine, efforts have been made to scientifically study the diagnostic and therapeutic methods used and to review their reliability. The reason for this may have been caused by the experience that have occured when applying and interpreting diagnostic tests. It became evident that in manual medicine, the interpretation of test did not lead uniform results (Lewit / Liebenson, 2003). The study criteria established there were, amongst others, the consistency of results between different examiners (interexaminer reliability) and compliance of an examiner in repeated testing (intraexaminer reliability). For further clarification of these terms we refer to chapter 8.1.

Two authors have attempted to further explain the difficulites the clinician is confronted with. The first one is Raspe, a founding member of the German "Netzwerk Evidenzbasierte Medizin". According to Raspe (1998), the inconsistency of the test results is caused by the clinicans lability and his vulnerability to self- and other-delusion. With this, Raspe describes the property of clinical staff of not being homogeneous in their qualitative perfomance during a clinical-analytic diagnostis. In addition, a clinician tends to be uncritical with his diagnostic findings and the resulting therapy.

The second author is the physician Lewit, who since the early ninteen-sixties carried out studies in the field of manual medicine. Together with his colleagues Liebenson, he commented on clinical diagnostics in manual medicine in his publication "*Journal of Bodywork and Movement Therapies*" (2003). There he explains that palpatory testing only had a limited significance since only 15% of all patient clinical presentation were captured by testing and could be explained (Bigos et al., 1994; Waddell et al., 1996).

According to his statements, the difficulty of manual diagnostic was due to the variety of unscreened testing procedures which (with their varying conclusions) led to dubious results. Another hindrance in manual diagnostics results from the specific situation of clinicians and patients. Because the clinician is in a feedback situation with the patient, it is possible for the patient to interfere with the interpration of the test results (Lewit / Liebenson, 1993). In his opinion, these difficulties were the reason why the science of manual medicine is still in its infancy. Solutions as how to solve this problem are proposed by Lewit/Liebenson (2003) as follows:

- Only those testing procedures should be carried out which have been scientifically tested and whose statement is valid and reliable.
- Various testing procedures should be used and integrated
- Treatment techniques on patients are to be applied correctly and accurately

Lewit and Liebenson's (1993/2003) critique of the diagnostic methods of manual medicine resembles a similar critical attitude that has partly become apparent in osteopathic medicine. This attitude is explained by the infrequent efforts to critically review the methods of manual osteopathic diagnosis and therapy in terms of assessing the reliability and effectiveness of their results (Sucher, 1994; Kuchera et al., 2002, 2005, 2006; Terrier / Finet, 2004). When reviewing the manual diagnostic tests, it became clear that the analysis was mainly directed towards the following study criteria (Kuchera et al., 1980, 1982; Podlesnik, 2006):

- Movement asymmetry
- Position asymmetry on the basis of anatomical landmarks
- Differentiation of tissue texture / tissue alterations
- Assessment of tissue resistance

The testing procedure that is being examined in the present work corresponds in content to the latter criterion. The aim of the examined testing procedure is to assess the tissue tension and tissues resistance of the abdominal organs as well as its muscular cover.

8 Basics

This study is based on a research of clinical medical literature and medical databases. The result of this research influenced the methodology of this report and will be outlined in excerpts in the course of this chapter.

8.1 Explanations and Definitions

To understand content and statistical analysis of the testing procedure analyzed here, this chapter serves to explain the technical terms used in this study.

Reliability:

The term reliability describes the formal accuracy of scientific studies. Reliability indicates the credibity of an examination or the dependability of a measuring instrument. A reliable test implies the absence of random errors and assures that the examination / measurement is repeatable. This means that repeated examinations / measurements under identical conditions lead to the same results.

Even under identical conditions though, any form of reproducibility can only be aimed at since living systems are subject to constant change (Sommerfeld, 2006, cf. chapter 2). Correlations of test results of different examiners can be compared with regards to reliability. In this case, it is called interexaminer reliability. If the same comparison of analogous examination results is done repeatedly and under the same conditions but only by an individual examiner, this is called intraexaminer reliability (Weiß, 2008, p.285f)

Cohen's Kappa:

To evaluate inter-and intraexaminer reliability, a statistical unit of measurement is needed that indicates the degree of concurrence. This statistical measure is Cohen's Kappa index. In case of a concurrence of one hundred percent of two or several findings, the research result is a Kappa index of one (k = 1). If the concurrence of various examination results compares wih purely random results, this is indicated with a Kappa index of zero (k = 0) (Weiß, 2008, p.285). (A detailed explanation of the Kappa coefficient values is given in chapter 10).

Blinding:

This term describes an approach applied to improve the internal validity of scientific studies. The aim of blinding is to deny study participants information about content and purpose of the study, thereby avoiding a conscious or unconscious bias against the study hypothesis. A frequently used form of blinding is to leave the study participants oblivious with regards to the type of intervention they are to receive or which hypotheses is to be verified with the study (Schumacher / Schulgen, 2007, p. 258f).

Some studies employ a comparitive group ignorant of the hypotheses und the associated intervention. In this case, the patient is not informed about the type of intervention he receives. This is called single-blinding study. Another option is to leave patients and assistants uninstructed about the natur of the intervention. This is denoted as double-blinding study. The third form of blinding leaves the person in charge of analyzing the experiment as well as the assistants and also the patients ignorant on the exact kind of intervention. This test arrangement is called triple-blinding study.
To sum up, it should be mentioned that studies that assess manual therapy / testing exclude a double-blind, as the user must be familiar with the treatment procedure in question (Schumacher / Schulgen 2007, p. 258ff). This condition is also true for the present study.

Arithmetic mean

In descriptive statistics the arithmetic mean is a commonly used means to denote the average value of a qualitative characteristic. To arrive at it you take the sum of all individual values divided by the number of individual values. A disadvantage of the mean is that it can be greatly influenced by outliners, i.e. data that vary drastically from the majority of the data (extremely high or low values). This possible disadvantage has to be taken into account when interpreting the mean as it can induce incorrect assumptions (Weiß, 2008, p. 55f).

Confidence interval

The term confidence interval also originates from descriptive statistics. The function of the confidence interval is that based on a random sample, a statement is to be made about an unknown total. Since it is highly unlikely that the results of the random sample match the unknown total, statistically a range of value (bandwidth) likely to include the majority of parameters is defined. The range of values in which the parameters are estimated to appear is called confidence interval. It always contains a statement about how reliable the representation of parameters is (Lindenberg / Wagner, 2007, p. 169; Weiß, 2008, p. 177ff).

Standard deviation

In descriptive statistics, the term standard deviation denotes the variability of dispersion of collected attributes. The standard deviation makes a statement about how far the attributes differ from the mean and refers to the degree of distribution around the mean. Statistically, two-thirds of all data collected range in the interval of mean plus standard deviation and mean minus standard deviation (Lindenberg / Wagner 2007, p. 30ff; Weiß, 2008, p. 65).

8.2 Basic Literature

The following chapters list the study material on which the testing procedure examined here is based. The focus was on studies that assess both inter-and intra-reliability of diagnostic manual testing. A further emphasis was placed on studies that assess palpatory testing procedures.

The research of the basic material was done in the databases PubMed, Medscape, Ostmed, DIMDI, JAMA and Web Osteopathic. Since the number of keywordswas extensive in the search input, it is mentioned here only in part: "tension," "tone", "abdomen", "Glénard", "splanchnoptosis", "visceroptosis", "examinating abdomen", "palpating abdomen", "palpating liver", "palpating abdominal pressure", "palpating liver-position", "palpatory findings", "tenderness", "Osteopathic tests", "Visceral tests", "reliability", "interrater reliability", "intrarater reliability",”interexaminer reliability”, “intraexaminer reliability”.

Resulting from the research it turned out that only a small number of studies examine testing procedures applied in visceral osteopathy. Among these publications are the studies of Rontet (1988), Finet / Williame (1993), Terrier / Finet (2004), Robyr (2004); Podlesnik (2006) and Van Dun et al. (2007). This lack of studies shows that the scientific study of palpatory diagnosis in osteopathy only has begun, while there is a great need for further scientific examinations.

By contrast, during the clinical and medical research a larger number of studies could be identified that investigate palpation- and testing procedures of the abdomen (Gilbert, 1994; Zoli et al., 1995; Kirkpatrick et al., 2000; Joshi et al., 2004; Polyzos, 2007;...). A common characteristic of these studies is the fact that they mainly concentrate on the following examination criteria:

- Existence of an aorta-aneurysm
- Percussion and palpation of the full organs
- Verification of the statement of the rebound tenderness test of the abdomen

Concentrating on theses topics shows that palpating the abdomen in clinical internal medicine is mainly meant to diagnose and adequately identify acute disorders and emergency situations. Most studies examining palpatory testing were identified in the field of manual examinations of the musculoskeletal system.

8.2.1 Literature on Palpatory Examination of the Musculo-Skeleton System

The aspect of palpatory examination in manual medicine has been reviewed in numerous scientific studies in terms of its reliability. The conclusions of these studies confirm that palpation leads to unreliable results.

A quote from Lewit / Liebenson (2003) seizes this controversial aspect of manual palpation in medicine:

> *"The question about palpation's reliability should not be turned against palpation, but should be turned towards asking how to develop reliable, responsive, and valid instruments?"*
>
> *(K. Lewit, C. Liebenson, 2003, p. 46)*

With this quotation, Lewit / Liebenson (2003) illustrate the evidence of studies that prove the insufficient results of the palpation of motion parameters. They claim that the use of such an instrument would not make sense if there were more suitable methods for diagnosing the causes of patient complaints.

Researches by Bigos et al. (1994) and Erhard / Diletto (1994) show that in only 15% of all cases, the cause of pain on the lower back are diagnosed as a specific dysfunction of the musculoskeletal system. In view of these facts, Liebenson and Lewit (2003) argue that only those palpation techniques should be applied in manual medicine that already have demonstrated their reliability in terms of test results and thus can be used as valid instruments.

According to its release date, the literature discussed in this work is reviewed in chronological order.

FRENCH ET AL. (2000) analyze the concurring results of several chiropractors when examining the spinal column. Three chiropractors took part in the study, examining nineteen patients with a chronic lower back pain The following methods were applied:

- Visual postural analysis
- Description of pain by patient
- X-rays of the lumbar spine
- Leg Length Test
- Neurological status
- Movement analysis
- Static Palpation
- Orthopaedic tests

As a result of the study, the findings of intra-reliability turned out to be of moderate value (k = 0.47). The findings' interreliability achieved a Kappa index of k = 0.27, significantly worse than those of intra-reliability. In addition, the decision to manipulate a particular segment turned out best at the height of the segment L5/S1 (k = 0.25) and the worst at the level of the Ilio-sacral-joint (k = 0.04).

Concluding, French et al. (2000) explain that this examination method is not reproducible and leads to no reliable results. The composition of examination techniques alone does not provide the chiropractor with usable information for him to determine the level of the vertebrae to be manipulated.

CHRISTENSEN ET AL. (2003) review the results of palpatory examinations of muscle tension in the anterior chest muscles. To determine inter-observer reliability, two experienced chiropractors examined 29 patients with symptoms and 27 patients without symptoms. To analyse the intra-observer reliability, a chiropractor examined fourteen patients with symptoms and fifteen patients without symptoms.

Object of investigation is the palpation of the tension degree of the musculature. This is measured at fourteen fixed points of the anterior chest wall in a sitting position. Assessment criterion was the presence or absence of muscle tension and / or pain. The data of the inter-observer reliability yield Kappa values of k = 0.22 - 0.3. For the intra-observer reliability, the Kappa value of the examination on two consecutive days amounts to k = 0,21 - 0.28, the examination within one day k = 0.44 - 0,49.

Christensen et al. (2003) summarize the data evaluation concluding that there were huge differences in the palpation results of two different chiropractors (their task was to examine patients with pain in the chest area as well as asymptomatic probands). These limited the validity of palpatory diagnostics extremely when having to assess musculoskeletal chest pain.

HENRY ET AL. (2006) analyze three different examination methods to identify an iliosacral joint block. To date, only one of these methods has been scientifically probed, and Henry et al.'s study (2006) compares all three methods in terms of the concurrence of their results when carried out by two different physicians. Both physicians independently examine 24 patients (with an average age of 68 years) with lower back pain syndromes. The examination was carried out according to the following criteria:

- Determining the side of the iliosacral dysfunction
- Determining the position of the base of the sacrum
- Determination of hip bone position

The test is evaluated by using Cohen's Kappa quotient and the evaluation scheme of Landis and Koch (1977). Landis and Koch (1977) recommend that a quotient of 0.2 Kappa should be considered as poor, a value of 0.4 as moderate, a value of 0.6 as substantial and a value of 0.8 as almost reliable. The data are analyzed as follows: To determine the side of the iliosacral dysfunction, the "Standing Stork Test" yielded the best inter-examiner reliability of k = 0.27, whereas the "flexion test in a sitting position" only yielded k = 0.06 and thus was the worst match. The analyses of the position of the sacrum base is carried out with the "standing flexion test" with k = 0.37 and the "standing extension test" with k = 0.05.Determining the hip bone position using the "medial malleoli symmetry test", k corresponds to 0,21. When recording the position of the "spina iliaca anterior", k yielded 0.15.

Due to their research, Henry et al. (2006) assume that the application of a multi-test system helped to improve matching test results from different examiners. The previous studies which centered around the palpatory examination of the pelvis showed conflicting findings with only poor or moderate concurrence. According to Flynn et al. (2002), examination methods with insufficient concurrence of results may not be included in palpatory examinations. According to Henry et al. (2006), an imperative is to maximize the concurring results of palpatory examinations of the pelvis. Based on his research results, Henry et al. (2006) suggest to make maximization of the inter-examiner reliability a precondition for all studies analyzing sensitivity and sensibility of palpatory examinations. This approach would serve the appreciation of osteopathic medicine and clinical care, because a manual treatment is based on the results of the palpatory examinations. Furthermore, Henry et al. (2006) mark that the use of reliable analytical methods would serve the user, since by doing so, he places confidence in his own treatment decisions.

ROBINSON ET AL. (2007) examine the interexaminer reliability of one palpation test and six pain provocation tests of the iliosacral joint. In their study, they examined 56 women and 6 men aged 18 to 50 years. Fifteen of the probands did not suffer from lower back pain, and twice a day the test persons were examined by experienced manual therapists. The result of the examination shows kappa values of k = 0.43 - 0.84 for the pain provocation tests and Kappa values of k = - 0.06 for the palpation test. Robinson et al. (2007) evaluate the reliability of pain provocation tests with moderate to good, the reliability of the palpation test, however, with poor. Furthermore, they point out that a cluster of pain provocation tests should be classed as a valid measure.

LEWIS / VALENTINE (2007) assess the intraexaminer reliability of diagnostic examinations of the muscle length test of the M. Pectoralis minor. In this study, an examiner assesses 45 probands with shoulder symptoms and 45 probands without shoulder symptoms in a lying position. Main criterion is the length measurement from the posterior aspect of the acromion to the base. This enables an assessment of the length of the M. pectoralis minor. For the purpose of the study, a relation between muscle length and shoulder symptoms was established so that a length measurement from the posterior aspect of the acromions to the base of more than 2.6 cm was determined as a positive result. In terms of patient data and findings, the examiner remained blinded. The order of the examinations was random.

As a result of the study, the pectoralis minor length measurement test yielded an excellent intraexaminer reliability for the dominant and non-dominant side of the asymptomatic probands. The test for the painful and non-painful side of probands with shoulder symptoms also showed an excellent intraexaminer reliability. The data calculated for sensitivity, sensibility and positive / negative likelihood ratios suggested that the test lacked precision as described in literature and therefore should, when applied in “clinical reasoning processe”s, be interpreted cautiously.

MARTIN / SEKIYA (2008) examine the findings of four clinical tests applied in case of hip pain. These four tests were:

- Faber test
- Flexion / internal rotation / adduction provocation test
- Log roll test
- Palpation of the trochanter major for pain symptoms

To check the interexaminer reliability, 70 probands are being examined by an orthopaedist and a physiotherapist. The average age of the test persons is 42 years, 32 of them women and 38 men with the following diagnoses:

- Degenerative joint changes (39%)
- Tears of the articular lip (50%)
- Femoro acetabular compression (69%)
- Relaxation of articular capsule (40%)
- Bursitis trochanterica (41%)
- Iliopsoas tensinitis (14%)
- Adduktor strain (3%)

The probands can be multi-diagnosed; the kappa coefficients are calculated in accord with the 95% confidence interval. The Kappa values are put together as follows:

- Faber test: k = 0.63
- Flexion / IR / adduction compression test: k = 0.58
- Log roll test: k = 0.61
- Trochanter pain test: k = 0.66

The result of the examination is indicated by Martin / Sekiya (2008) as fair according to the kappa index (k => 0.40).

ARAB ET AL. (2008) examine the inter-and intra-reliability of motion and pain provocation tests of the iliosacral joint. They hypothesize that the use of combined testing procedures leads to more reliable results than the application of a singular test. To verify this hypothesis, four palpation tests and three movement tests are carried out on 25 patients aged 20 to 65 years. The is applied by two therapists who test each side of the body thrice. After analysing the results, Arab et al. (2008) describe the intra- and interexaminer reliability with k = 0,36 - 0.84 and k = 0.52 - 0.84 for the single test application. The intra-and interexaminer reliability of clustered testing is given with Kappa values of k = 0.44 - 1.00 and k = 0.52 - 0.92.
Based on the evaluation of the test results, Arab et al. (2008) come to the conclusion that the combined application of pain provocation and motion tests is of more reliable clinical use than the singular application of a test.

Summarizing the available studies, the following statements can be made:

- Evaluating the concurrence of palpatory examination results, it shows that usually the Kappa values for intrareliability are higher than those for interreliability.
- No uniform validity can be ascribed to the stated reliability of palpatory or diagnostic testing procedures. The interpretation of the reliability using the Kappa index varies from poor to substantial for different palpatory tests.
- The validity of pain provocation tests is more reliable than motion testing.
- Multiple test systems help to improve the concurring test results of different examiners.
- Clustered testing procedures of pain provocation and motion tests show the highest degree of reliability. They can be considered as valid measuring instruments.
- To execute a test on one day shows higher concurring values than a testing on consecutive days.
- Individual palpatory testing procedures do not show the reliability as described in literature and should be interpreted and used in the “clinical reasoning process” with caution.
- Examination methods which show a lack of concurrence of test results should not be included in palpatory examinations.

8.2.2 Literature on Palpatory and Percussory Examination of the Abdomen

As mentioned at the beginning of chapter 8, this chapter discusses in extracts the literature dealing with the analysis of palpatory and percussory examination of the abdomen. The relevant literature is dealt with in chronological order, without considering the examination criteria.

GILBERT ET AL. (1994) study the diagnostic evidence of 65 persons in relation to the position of the inferior margin of liver. Prior studies with regard to liver function show that for 15 patients, the liver has become diseased. The applied examination techniques are palpation, light percussion and auscultatory percussion. Gilbert concludes that both palpation as well as auscultatory percussion are useful examination techniques to determine the position of inferior margin of liver.

ZOLI ET AL. (1995) compare the concurrence of examination results of manual palpation and percussion of the liver vs. ultrasonic testing. Size, position and consistency of the liver are the aspects focused on. Analyzing 100 healthy persons and 100 persons diseased with liver cirrhosis – all of them studied by blinded examiners - Zoli et al. (1995) conclude that manual examinations cannot achieve accurate results in terms of liver size. Yet to determine the position of the inferior margin of liver and consistency, these "bedside techniques" can be considered a satisfying diagnostic tool.

GODFRIED ET AL. (2000) compare the accuracy of the results provided by a manual examination of the spleen by palpation and percussion. The results are reviewed by means of ultrasonic testing and scintigraphy. Analyzes of the results showed that the manual examination is characterized by a low sensitivity and an acceptable specificity. The results of the palpatory examination were more convincing regarding specificity and sensitivity than those of auscultatory examination. Godfried (2000) comes to the conclusion that ideally both techniques should be combined because then their statements could receive a specificity of almost 90%.

DUBEY ET AL. (2000) investigate the sensitivity and specificity of a diagnostic assessment of splenomegaly by palpation and percussion. The results are then compared with the results of an ultrasonic examination and statistically analyzed.

- Auscultation achieved a sensitivity of 67% and a specificity of 75%. With a BMI higher than 29.5 kg/m2, the false-negative results increase significantly.
- Palpation achieved a specificity of 96.8% with high false-negative values and a low sensitivity of 44.5%.
- The combined use of palpation and percussion results in the best clinical benefit.

FINK ET AL. (2000) analyzed the palpatory examination serving to diagnose an aorta aneurysm. Fink et al. hypothesize that in diagnosing aortoa aneurysms, manual analysis is of great importance. Their research is based on the examination of 200 patients by two internal medicin blinded to the mutual findings and the findings of earlier ultrasonic examination (99 patients with and 101 patients without aneurysm).
The examiners were given a ten minute training before testing; the testing was carried out in one day. First, the examiners specified the waist circumference before they determined, using deep bimanual palpation, the aorta diameter. In case the aorta diameter was larger than three centimeters, an aneurysm was diagnosed. The result of their study was the following: The sensitivity of the testing procedure (correct positive results) ranges around 68% and its specificity (correct negative results) arount 75%. The concurrence of findings (interexaminer reliability) is given as 77% and corresponds to a Kappa value of k = 0.53.

As a further result, the sensitivity of the testing procedure increases according to the size of the aneurysm's diameter (61% for aneurysms from 3.0 to 3.9 cm and 82% for aneurysms larger than 5 cm). The waist circumference is seen as another factor influencing the sensitivity indicated, with a sensitivity of 91% for a waist circumference less than 100 cm and 53% for waist circumferences wider than 100 cm. Fink et al. (2000) come to the conclusion that the palpatory examination to discover an aorta aneurysm exhibits a moderate sensitivity, increasing with decreasing body mass index. Unlike previous studies, this study shows a relatively high sensitivity. Fink et al. (2000) explain this on the grounds that the examiners were focused on the study of aorta aneurysms and not distracted by other medical considerations. Another reason for this high sensitivity Fink et al. (2000) saw in the ten-minute training of the examiners were given before the test.

With regard to this type of analysis, Venkatasubramaniam et al. (2004) have carried out a study in 2004 to check the significance of diagnostic palpatory examinations of aorta aneurysms. In this study, a doctor and a nurse respectively examined 164 patients as to whether they suffered from an aorta aneurysm. After evaluating the test results, Venkatasubramaniam et al. (2004) conclude that the degree of concurrence with which an aorta aneurysm can be excluded is the same with a doctor as well as a nurse. With this study, Venkatasubramaniam et al. (2004) support the results of Fink et al.'s study from 2000. The following statements can be derived from these two analyses:

- A manual palpatory examination can be considered a useful complement / screening to ultrasonic examination due to its high sensitivity.
- The lower the body mass index, the higher the sensitivity of the testing procedure.
- With increasing diameter of the aorta aneurysm, also the sensitivity of the testing procedure increases.

JOSHI ET AL. (2004) compared and verified the different examination techniques for diagnosing hepatomegaly. In their study, three doctors (blinded from the clinical patient data and the findings of their colleagues) examined 180 patients, using percussion and palpation for diagnosing a possibly existing hepatomegaly. All patients were previously examined ultrsonically, where upon a liver enlargement of 20% for all patients was found. The Kappa values for the comparative concurrence of the examiner's findings revealed values of k = 0.44 - 0.53 for palpation, for percussion k = 0.17 - 0.33.

After evaluating these findings, Joshi et al. conclude that both palpation as well as percussion were unsuitable for determining hepatomegaly, since their findings were neither accurate nor reliable.

YEN ET AL. (2005) investigate the inter-examiner reliability of abdominal examinations of 86 children (aged three to nineteen) recorded in a children's emergency department with the diagnosis "acute abdomen". The examination was carried out by three different medical professions.

The following aspects were studied:

- Presence / absence of abdominal distension
- Abdominal percussion
- Abdominal palpation
- Abdominal tension of the abdominal wall
- Reboundtenderness
- Bowel sounds

The examiners were permitted to record the medical history of their patients. Each examination took place for each doctor in a separate room with only one patient at time, so the doctor was blinded to the findings of his colleagues. The time frame was limited to a maximum of 30 minutes per patient. The test results are evaluated applying the Kappa index. For all three medical professions, it shows lower values than a moderate concurrence (k = -0.04 to 0.34). The only exception is the "rebound tenderness" – examination with average moderate Kappa values of k = 0.54 were noted.yen et al. (2005) critically note that they intentionally did not define what exactly constituted positive findings. Therefore the examination results were liable to an individual interpretation on part of the examiner which might to a degree explain the unreliability of the testing results. Yen et al. (2005) indicate that a positive diagnosis is involved in the specification of the subsequent course of action. Due to an a priori acceptance, this would lead to different findings on part of the different examiners. This is due to the assumption that doctors on call made their decisions based on the findings supplied by physical examination and medical history.
According to Yen et al. (2005), the results of their study indicate that no feature of an abdominal examination seems to be consistently reliable. New strategies in the examination of an acute abdomen should be developed that rely on fail-safe examination techniques and unambiguous definitions.

LICCARDIONE ET AL. (2007) review the examination of 92 patients (67% of them diagnosed with diabetes mellitus type 2) with regard to palpatory abnormalities related to existing diabetes mellitus type 2. Taking into account age and sex, a variation of the tissue at the level of Th11 to L2 on the right side is described as the only significant correlation between Diabetis mellitus type 2 and palpatory features. For these changes in tissue, viscerosomatic reflex activities are held responsible which according to the osteopathic concept result from an organic disease and lead to a chronic over-stimulation of the sympathetic vegetative nerve fibers.
Liccardione et al. (2007) describe the following changes of the body tissue as a result of this sympathetic over-stimulation:

- Lesions (cool and pale)
- Trophic changes (dryness, scaly skin or abnormal pigmentation)
- Changes of tissue (doughy, thickened and fibrotic)
- Increased tissue tension and deficit of tissue movement

The analysis of all palpation findings found a match in terms of interexaminer reliability, with a Kappa index of k = 0.35 - 0.68. Mobility impairments of the spinal segments Th11 to L2 and alterations of tissue are the most common changes of an existing diabetes mellitus type 2. With their study, Licciardione et al. (2007) support the visceral osteopathic approach, which states that changes / disorders of the internal organs lead to changes in the body cover.

Based on theses studies, the following statements can be summarized:

- The reliability of palpation techniques achieves a higher specificity and sensitivity than percussion techniques.
- Palpation and percussion techniques are valid instruments to determine a changed position of the inferior margin of liver as well as liver consistency. For the determination of hepatomegaly or to measure the liver size, these examination techniques cannot provide accurate results.
- Of greatest clinical benefit is a combined use of percussion and palpation techniques to determine the position of a full organ.
- For the palpatory-diagnostic examination of the abdomen, an increased body mass index and/or an increased waist size of the probands participating leads to an increase of false-negative findings.
- A training carried out shortly before the examination increases the examiner’s sensibility and sensitivity and therefore optimizes the testing procedure. Increased sensitivity in palpatory examination is refered to the examiner’s focus on predetermined symptoms and to a lack of distraction by other medical considerations.
- To blind the examiner to the findings of his colleagues, it is recommended to carry out the examination in separate rooms.
- To standardize the study conditions for all participants, a time frame for every examination is defined.
- To increase the reliability of the test results, it is recommended to define what constitutes a positiv finding before the examination. This minimizes the subjective interpretation of test results by the individual examiner.
- There is a relation between organic functional loss and palpatory deviation. This statement supports the visceral osteopathic concept stating that dysfunction of internal organs leads to changes in the body cover.

8.3 Basic Considerations of Methodology

The previous two chapters discussed the literature which covers palpatory diagnostic examinations of the musculoskeletal system and the abdomen. The findings were essential for the the organization of this survey and provide a basic framework for its methodological structure.

This survey serves to assess a palpatory testing procedure. In visceral osteopathic medicine, this testing procedure is part of any basic examination. The osteopath's decisions on further diagnostic and therapeutic measures, derived from his palpation findings, (Yen et al., 2005; Henry et al., 2006) are important guidelines for the successful treatment of the patient. The medical literature examined here tells us how the reliability of the findings of palpatory diagnostic testing can vary considerable and does not always possess the unambiguous quality required in a "clinical reasoning process" (Henry et al., 2006). According to the statements of different authors, testing procedures whith poor concurring results should prefereably not be integrated into the "catalogue of examinations" (Liebenson / Lewitt, 2003; Henry et al., 2006). This approach would serve to boost the practitioner's confidence in his therapeutic decisions and contribute to the enhancement of manual medicine.

For this reason, in the run-up to the considerations for this testing procedure, diagnostic percussion tests were excluded as compared to palpatory testing, a lower reliability can be assumed for them (Joshi et al., 2000; Dubey et al., 2000).

According to Fink et al. (2000) and Christensen et al. (2003), the intraexaminer reliability in running a test for several days is less than for testing within one day. Furthermore, Fink et al. (2000) recommend to implement a training for the therapists just before the testing procedure. In his experience, this approach leads to an increase in inter-and intrareliability and promotes the reliability of analytical results.

Another aspect to promote an increased in reliability of the findings consists in defining the examination results during training as exactly as possible in order to avoid their individual interpretation. This approach is based on the examination results of the study carried out by Yen et al. (2005). There they describe that by consciously avoiding uniform definitions of what is to be understood as a positive result, a reduction in the findings' intrareliability can be achieved.

In the studies of Fink et al. (2000), Joshi et al. (2004) and Yen et al. (2005), a form of blinding is achieved by the therapist's carrying out the examination a separate room, thus remaining unaffected by the findings of his colleagues. In addition the examination time frame was defined and limited for all therapists alike. This approach is recommended by Yen et al. (2005) to achieve homogeneous examination conditions.

As specified above, the reliability of test results is determined by means of Cohen's Kappa value. This statistical analytical method is applied to assess the correlation between inter and intraexaminer concurrence.

From the results of the literature review the following preconditions will be inferred for this study:

- A palpatory testing procedure is assessed.
- The testing procedure is completed within a day.
- Before the examination, a training is carried out with the osteopath.
- The palpation's findings are to be defined precisely for the osteopaths.
- To avoid interference by other colleagues, the examination takes place in separate room.
- To reduce their distraction from the palpatory examination, the osteopaths have an assistant at their disposal for the documentation of their findings.
- Due to their osteopathic training, all osteopaths are familiar with the testing procedure.
- None of the probands is informed about the content of the study. Additionally, they remain blinded with regard to the object of investigation.
- To statistically analyze the reliability of the test results, Cohen's Kappa index is used. The test results are assessed in terms of their inter-and intrasubjective concurrence.
- To verify intrareliability, the osteopath examines each proband twice. To suppress visual as well as acoustic recognition, the second examination is carried out in silence, using a sleeping mask.

9 Methodology

After the previous chapters were dedicated to considerations generating the specific framework of this analysis, the following chapters present the exact methodology and course of action of this study.

9.1 Study Design

The present analysis focuses on a single-blinded, methodological clinical study. It is meant to contribute to an assessment of the reproducibility of test results in terms of inter- and intrasubjective concurrence.

The study was conducted with a patient group unacquainted with background, content and therapists of the study. Simultaneously, the therapists were uninformed about both patients or patient data (age, medical history). The author of this study did not participate in the examination, but served as a principal investigator and organizer. This study design was chosen to ensure neutrality to the highest possible extent.

9.2 Probands

Male and female patients aged 24 to 82 years volunteered for this study. The patients were selected in advance from our osteopathy practice's patient pool and had to give their written consent to participate in the examination. The probands were assured that the examination was no therapeutic treatment. In addition, the probands were informed that at any time and for any reason, they could leave the examination.

Since the probands were known to us, we tried to provide for a wide range of different tension and tone conditions in the selection of the probands. For this purpose, the probands chosen where to cover a wide age spectrum and a broad field of various constitutional types (cf. chapter 12.2.2).

9.2.1 Group Size

To ensure a sufficient supplie of statistically usable data, a proband group of 30 to 40 persons was assessed. To minimize the risk of probands not appearing (failure phenomenon), a total of 55 probands was invited to participate in the study. Of these 55 probands, 26 turned up. Since this number was too small for our purpose, we decided to include the seven participating osteopaths in the examination and to also introduce them as probands. Thus, the group consisted of 33 probands, including nine men (27%) and 24 women (73%).
The average age of the probands was 50.4 years (standard deviation: 12 years), with the youngest aged 29 and the oldest 82. The median age amounted to 49 years. The avarage proband BMI was 24 (standard deviation: 2.8), with the lowest BMI calculated with 19 and the highest with 30. The median was equal to the average 24.

9.2.2 Inclusion Criteria

Before the inclusion criteria will be explained, it must be noted that this testing procedure is not a matter of diagnosing or excluding a certain pathology. The test examined here is used to determine the pressure / tension conditions of the abdomen. So it may apply to any person, without specific inclusion criteria to be met.
To ensure that the examination is not unilateral, the following inclusion criteria were specified for the probands:

- The probands should be patients of our osteopathy practice, so that any possible counter-indications (see exclusion criteria) on the basis of medical history and patient records could be excluded.

- To provide a preferrably wide range of different tension- and tone patterns, the men and women selected were aged between twenty to 85 years. Due to previous literature researches it can be assumed that aging process affect tensions and tone conditions.

- Both nutritional and constitutional conditions of the participants were to be as diverse as possible. This consideration was motivated by two reasons: First, a selection like this represents a large proportion of the total population and thus includes the patients seeking osteopathic treatment. On the other hand, Glénard (1899) and Weischenck (1982) link the relation of volume increase and decrease to tone and tension changes. Therefore, a body mass index of 15 - 40 kg/m2 (slight underweight to obesity grade 3, according to the WHO classification, 2008) was taken as basis, because we believe it to contribute in some degree to diverse kinds of different tension and tone forms. It should be noted that during our research, no literature could be identified that describes a direct relation between body mass index and tension type.

- Only those probands were to participate of whom it could be expected to not ingest or drink for the duration of the entire examination.

- A prerequisite for a voluntarily participation in the examination was an a priori written consent.

9.2.3 Exclusion Criteria

As the test was carried out repeatedly with each proband, we considered it necessary to exclude the following criteria:

- Pregnancy
- Presence of suspected aorta aneurysms
- Acute abdominal pain
- Acute abdominal pathologies
- Probands with congenital and / or pathological abdominal deviations
- Probands on long-term medication who were subject to an increased risk of bleeding or fractures (aspirin, heparin, Marcumar, corticosteroids)

9.3 Osteopaths

A majority of inter-reliability studies is carried out by two to three therapists to assess the intersubjective concurrence (Fink et al., 2000; French et al., 2000; Venkatasubramaniam et al., 2004; Joshi et al., 2004; Sommerfeld, 2006; Yen et al., 2005; Henry et al., 2006). To compare test results of only two to three therapists seems quantitatively too low for us to arrive at representative statements. Therefore, for this study, six to ten osteopaths were decided on.

In order to recruit these osteopaths, 35 osteopaths from the city of Berlin were asked first by telephone whether they were willing to participate in the study. 15 osteopaths agreed to participate and were afterwards invited in writing. All osteopaths had completed their osteopathic training, followed by several years of pracitcal osteopathic experience. In view of expected drop outs, also five osteopathic students in their fifth year of training at Sutherland College were invited. As all osteopaths have been trained at Southerland College, they are familir with this testing procedure. After interviewing the osteopaths, it was safe to assume that the osteopaths applied the tension / tone test in their own practice when diagnostically examining their patients.

Of twenty invited osteopaths, thirteen canceled their participation at short notice so that the study was carried out with seven osteopaths (three men (43%) and four women (57%)), which corresponds to the initial predefinition of six to ten therapists. Three of the osteopaths were students in their fifth year of osteopathic training.

Each osteopath carried out the examination twice for all 32 probands. This number results from the fact that those osteopaths who were also probands could not examine themselves. Hence the number of examinations is reduced by one in relation to the number of probands.

9.4 Assistants

During the planning phase of the study, observations were made about how the examination was to be improved and what actions were helpful to further increase its reliability.

As a result of these considerations, we thought it reasonable to disburden the osteopaths of the necessary documentation of their findings and thus to promote their concentration on the testing procedure. Consequently, each osteopaths was paired with an assistant to document the examination results and to registrate the patients. As a second test run was carried out with the osteopaths wearing sleeping masks, the assistant guaranteed the correct procedure of the examination and the recording of the results.

9.5 Tools / Equipment

The verification of intrasubjective concurrence of an examination procedure is based on the condition that all subjects are to be examined at least two times. To reduce visual recognition and an associated optical memory effect, the osteopaths were furnished with a sleeping mask in the second examination which prevented effectively all visual perception.

To record the findings, for each examination a separate documentation sheet was designed. It was drafted in such a was as to to obtain an accurate and clear documentation. The assistants could note the findings by an appropriate cross. For the gathering of all examination results, a Microsoft Excel file was used.

Using a scale and a tape measure, all probands were measured and weighted by the principle investigator. Based on these data, the proband-specific body mass index was determined. Prior to the examination, the principle investigator tagged all probands well visibly with a registration number. This ensured that the patients remained anonymous with regard to the osteopath and that only the principle investigator could assign patient to registration number. The patient-specific findings were recorded by the assistant using the appropriate registration number.

9.6 Implementation of Study

9.6.1 Recruiting

To recruit the participants, a period of eight weeks was assessed. Eight weeks prior to the study, 35 osteopaths and osteopathy students living in the Berlin city area were contacted by telephone and interviewed with regard to their participation in the testing. Of these interviewees, fifteen osteopaths showed their willingness to participate in the testing, and were then invited in writing.

Simultaneously, 55 patients were selected and interviewed eight weeks ahead of the investigation, using the inclusion criteria from our osteopathy practice’s patient pool. All patients who verbally gave a positive answer were thereupon invited in writing. In the invitation letter, patients were again reminded that they were voluntary participants in a study. Due to their status as study participant, they would not receive an osteopthic treatment, but rather made themselves available for an osteopathically unspecified treatment.

9.6.2 Locality and Date

The study was carried out on March 29, 2008 (M = 13 clock) in the physiotherapy practice of "Jeanette Suchardt" in the Wismarerstrasse 44 in Berlin Lichterfelde. The following reasons led to the selection of this locality:
The practice has nine separate consulting rooms which can be locked by doors. This guaranteed that every osteopath had his own separate study room at his disposal and remained uninfluenced by acoustically witnessing the examination results of his colleagues (Fink et al., 2000; Joshi et al., 2004; Yen et al., 2005). Moreover, the practice is characterized by a sufficiently large waiting area, so that almost all patients had the chance to sit down.

9.6.3 Training

As mentioned in chapter 8.3, the osteopaths were trained for thirty minutes ahead of the examination in order to improve the consistency of test results. This training had two main objectives: It serves to practice the exact manual execution of the tension and tone test afresh, to unify possible varying performances and to eliminate execution errors (Fink et al., 2000). Secondly, the theoretical part of this training was used by the principal investigator to define the normal tension and tone forms and its deviations (hyper / hypo). Following the study by Yen et al. (2005), this approach was deemed necessary to create a universal presentation / visualization of the expected palpation finding.

9.6.4 Procedure

Due to adverse weather conditions during these days, 13 osteopaths and 29 probands cancelled their participation on short notice or did not show up unexcused.

The osteopaths and assistants arrived one and a half hours before the test started. Next, the assistants were introduced into the handling of the documentation sheet and supplied with the information they needed to support the osteopaths. Afterwards the test training of the osteopaths and the assistents took place as described in chapter 9.6.3. After completing these preparations, all arriving probands were welcomed by the principle investigator and made familiar with the premises. The principle investigator then collected their personal data (current weight / height) and tagged them with a well visible registration number. Since the probands were unknown to the osteopaths / assistants, the registration number could be used to document the proband-specific test results.

The following general conditions illustrate the subsequent testing procedure: To guarantee a smooth procedure and coherent study conditions, a time frame of 2 minutes per proband and per examination was agreed on (Yen et al., 2005). Next, the principle investigator marked the regions of the "three leaves of Glénard" on the abdomen of the probands. This ensured that the regions of the abdominal cavity were uniformly examined by all osteopaths.

During the first examination, the probands called on the seven osteopaths in the order of their registration number. To avoid a mix-up of the examination rooms, they were marked by rising numbers on the outside. The probands registration number was noted by the assistants in the documentation sheet, and the osteopath carried out the tone / tension examination on the patient. As agreed beforehand, the whole examination of all probands lasted two hours and was performed in a rather uncomfortable body position for the osteopaths. To spare the osteopaths this physical strain, he carried out the examination in a seated position.

FIG.3: Photograph of the carrying out of the Tone and Tensionstest with sleeping mask. From the left to the right: osteopath, proband, assistant

After a first thorough examination of all probands by all osteopaths, the second examination intended to verify the intrasubjective reliability was initiated after a short break. This was done by the osteopath examining all probands for a second time. Then the results of both examinations could be compared to each other. To prevent them from visually recognizing the probands, the osteopaths carried out the examination using a sleeping mask. Moreover, as during the second test the probands had to remain silent in order to prevent an acoustic recognition. During the second examination, the principal investigator changed the order of patients arbitrarily. In view of the number of probands it can be assumed that thus any form of recognition on part of osteopaths was virtually impossible. Upon completion of the second examination, the documentation sheets were collected by the principal investigator. Probands were asked not to eat and also not to drink greater quantities of beverages during the examinations as this might have influenced the tension conditions of the abdomen.

After the examination procedure was finished, a rich buffet was served for all participants.

9.7 Description of Intervention

This chapter describes the exact performance of the tests as described in the literature of Helsmoortel (2002) and Fieuw (2005).

9.7.1 Osteopathic Examination of Tone

This study is intended to diagnose the wall of the muscular and bony container in its tone by using palpation. This means that all sides of the container have to be checked: anterior abdominal wall, back including spine.

The test is performed with both hands and an anterior / posterior palmar hand contact. On an muscular level, this is done by a slight rebound test or a strain test to analyze the reaction of the muscle tissue as an answer to this provocation and thus to detect its tone. The bony structures are also assessed using a rebound test which gives an impression about the elasticity of the bone. If this bone is uninfluenced by its environment, this is expressed by a standard elasticity. As with the tension test, the standard elasticity is an expression of the local autonomy of a structure, which in this case is bony (Helsmoortel, 2002, p. 103).

9.7.2 Osteopathic Examination of Tension

If according to Fieuw the abdomen of a standing patient is pressed with the flat (palmar) hand and if the various regions of the corresponding leaves of Glénard are palpated (1: between the tenth rib; 2: in the regio umbilicalis; 3: between regio pubica and regio umbilicalis), the maximum of normo tension will be found at the first sheet, its minimum at the third sheet, with the second sheet occupying a mean position (Fieuw, 2005, p.3). Helsmoortel describes the test execution as follows:
The right hand is put on the abdomen, the left hand lies very lightly of posterior with its palm on the spine: Local tension finding: Does is feel firm or empty between the hands? By doing so, both hands are placed at the same height. First, the lower abdominal, then the upper quadrants are examined (Helsmoortel, 2002, p.169)

10 Statistical Evaluation of the Results

The test results were collected in Microsoft® Excel® sheets and evaluated with SPSS® 14.0. statistical software. Data sets are complete, except the results of examiner O7 of test person 16 for both runs of the tension tests.

Cohen's kappa (κ-index/κ-value) was used for the characterization of the agreement of the pairs of osteopaths (inter-examiner reliability) and the agreement of the single osteopaths in the two consecutive tests (intra-examiner reliability).

The ranges of the test results (of the two test runs of the same or of the pairs of examiners) have to be symmetrical for the calculation of Cohen's kappa. Thus, kappa for intra-examiner reliability of osteopath O6 could not be calculated for the tension test on the third leaf, because - in contrary to the other osteopaths and his own results of the second test run- he did not diagnose hypotension in any subject during the first test run.

In order to provide an insight into the statistical method, a 3x3 contingency table of the theoretical results of two examiners is displayed in TABLE 1.
The basic equations for the calculation of Cohen's kappa were taken from Sackett et al., 1991.

The number of agreements (O_{ii}) between the two examiners are marked dark green in the diagonal, the number of disagreements in the results of the two examiners light green.

Calculated values are denoted yellow. C_i are the column sums and R_i the row sums of the frequencies. n is the total number of the comparisons.

		Examiner 1			
		Hypert.	Normot.	Hypot.	Row sum (R)
Examiner 2	Hypert.	O_{11}	O_{12}	O_{13}	R_1
	Normot.	O_{21}	O_{22}	O_{23}	R_2
	Hypot.	O_{31}	O_{32}	O_{33}	R_3
Column sum (C):		C_1	C_2	C_3	n

TABLE 1: 3x3 Contingency table of the possible results of the tone and tension tests.

The number of agreements, expected on the basis of chance only (E_{ii}), is calculated for each diagonal cell individually with the following formula:

$$E_{ii} = \frac{R_i \cdot C_i}{n}$$

Therefore, the probability of agreement on the basis of chance (p_E) can be specified by:

$$p_e = \frac{\left(\sum_{i=1}^{l} E_{ii}\right)}{n}$$

The probability for the actual agreement is equivalent to the relative frequency of agreements. O_{ii} are the values from the cells in the diagonal:

$$p_0 = \frac{\left(\sum_{i=1}^{l} O_{ii}\right)}{n}$$

Normally, Kappa (κ) is calculated with the following standardized formula:

$$\kappa = \frac{P_0 - P_e}{1 - P_e}$$

According to Fjellner et al. (1999, p.511-516), κ-values greater than 0.4 are considered to indicate an acceptable interobserver reliability.

Additionally to the numeric presentation of the κ-index, the results are interpreted with the degrees of agreement, which are often used in the actual scientific literature (Landis and Koch, 1977, p.159-174).

$\kappa < 0.20$	poor
$0.20 < \kappa < 0.40$	fair
$0.40 < \kappa < 0.60$	moderate
$0.60 < \kappa < 0.80$	substantial
$0.80 < \kappa < 1.00$	almost perfect

For the evaluation of the inter-examiner reliability, these calculations were done for all pairs of osteopaths and both test runs individually. For the evaluation of the intra-examiner reliability, the results of the two tests were compared for each osteopath individually.

After these basic calculations, additionally the arithmetic means as well as their 95%-confidence intervals, standard deviations, minima and maxima for the κ-values of the two test runs individually and of both together were calculated.

The 95%-confidence intervals are the range of values, where the mean κ-index in further samples can be expected with a probability of 95%. For this, the sample has to represent the characteristics of the population of examiners. The standard deviation is a measure for the dispersion of the results around the mean value, the other statistical measures are generally known.

The results of examiner O5 will be used as an example, to show, how the κ-value of the intra-examiner reliability of the tone test was calculated. The actual results of this examiner in both test runs are summarized in TABLE 2.

		Examiner O5 Test run 2			
		Hypert.	Normot.	Hypot.	Row sum (R)
Examiner O5 Test run 1	Hypert.	7	1	4	R1= 12
	Normot.	2	3	6	R2= 11
	Hypot.	1	3	5	R3= 9
Column sum (C):		C1= 10	C2= 7	C3= 15	n= 32

TABLE 2: Example for the calculation with the results of examiner O5, 1st and 2nd test run.

The theoretical distribution of agreements and disagreements, that would be expected on the basis of chance is calculated from the actual frequencies (cf. TABLE 2) and is displayed in TABLE 3.

		Examiner O5 Test run 2			
		Hypert.	Normot.	Hypot.	Row sum (R)
Examiner O5 Test run 1	Hypert.	$R_1*C_1/N=$ $= 12*10/32=$ $= 3.75$	$R_1*C_2/N=$ $= 12*7/32=$ $= 2.62$	$R_1*C_3/N=$ $= 12*15/32=$ $= 5.63$	$R_1= 12$
	Normot.	$R_2*C_1/N=$ $=11*10/32=$ $= 3.44$	$R_2*C_2/N=$ $= 11*7/32=$ $= 2.41$	$R_2*C_3/N=$ $= 11*15/32=$ $= 5.16$	$R_2= 11$
	Hypot.	$R_3*C_1/N=$ $=9*10/32=$ $= 2.81$	$R_3*C_2/N=$ $= 9*7/32=$ $= 1.97$	$R_3*C_3/N=$ $= 9*15/32=$ $= 4.22$	$R_3= 9$
Column sum (C):		$C_1= 10$	$C_2= 7$	$C_3= 15$	N= 32

TABLE 3: Expected frequencies on the basis of chance.

From the diagonal cells of TABLE 2 and TABLE 3, the observed and expected agreement are calculated with:

$$p_e = \frac{(3{,}75 + 2{,}41 + 4{,}22)}{32} = 0{,}324$$

$$p_0 = \frac{(7 + 3 + 5)}{32} = 0{,}469$$

and thus:

$$\kappa = \frac{P_0 - P_e}{1 - P_e} = \frac{0{,}469 - 0{,}324}{1 - 0{,}324} = 0{,}214$$

11 Results

In this chapter, results of the statistical evaluation of the results will be presented separately for the inter-examiner reliability and intra-examiner reliability of the single tests.

11.1 Inter-Examiner Reliability

This chapter is intended to present the inter-examiner reliability, i.e. the agreement of different osteopaths in their findings. The results of the inter-examiner reliability are presented separately for each test. The order of the presentation does not indicate a valuation of the reliability.

11.1.1 Tone Test

The κ-values for the agreement of the single pairs of osteopaths in the tone test are summarized in TABLE 4 for both test runs, individually.

Tonetest	Test 1							Test 2						
Examiner	O1	O2	O3	O4	O5	O6	O7	O1	O2	O3	O4	O5	O6	O7
O1	-	0.50	0.25	0.27	0.33	0.14	0.27	-	0.11	0.20	0*	0.29	0.07	0.10
O2		-	0.29	0.18	0.33	0.32	0.20		-	0.21	0.06	0.33	0.23	0.19
O3			-	0.26	0.16	0.38	0.07			-	0*	0.26	0.37	0.00
O4				-	0.27	0.38	0.21				-	0*	0.17	0.06
O5					-	0.29	0.23					-	0.25	0.09
O6						-	0.08						-	0.08
O7							-							-

TABLE 4: Results (κ–values) for all single pairs of examiners during the first and second run of the tone test. (0*... negative κ–values are quoted as 0).

A single pair of examiners (O2 vs. O1) exceeds κ= 0.40 in the first test run. However, in the second test run, this pair reaches only a subaverage agreement (κ= 0.11).

While in the first test run, agreement is distinctly higher than agreement expected on the basis of chance, in the second test run, results of several examiners differ to such a high extent, that a random assignment of the tone would deliver similar results.

The distribution of the κ-values of all 42 comparisons (both test runs) is presented in a stem-and leaf-plot in Fig. 4.

Test 1		Test 2	N (T1)	N (T2)	N (Total)
	0.9				
	0.8				
	0.7				
	0.6				
	0.5				
9	0.4		1		1
23377	0.3	27	5	2	7
134667799	0.2	013558	9	6	15
3679	0.1	0168	4	4	8
77	0.0	000066688	2	9	11

FIG. 4: Distribution of the κ-values for the reliability of the tone test for both test runs individually and with pooled results.

While in the first test run κ-values between 0.20 and 0.30 can be observed most frequently, most results lie between 0 and 0.10 in the second run. κ–values <0.10 are by far more frequent in the second test.

The descriptive data (mean, standard deviation (SD), 95%-confidence interval (95%-CI), minima (Min) and maxima (Max)) calculated from the raw data in TABLE 4 are summarized in TABLE 5 for each test individually and for the pooled results of both tests.

Tone Test	n	Mean	SD	95%-CI	Min	Max
Test run 1	21	0.26	0.09	0.21 - 0.30	0.07	0.50
Test run 2	21	0.15	0.11	0.09 - 0.20	0.00	0.37
Total	42	0.20	0.12	0.16 - 0.24	0.00	0.50

TABLE 5: Descriptive data for the κ–values of the both tone tests individually (Test 1, Test 2) and with pooled κ-values (total).

Under consideration of both test runs, it can be deduced, that the mean κ-index lies between 0.16 and 0.24 (mean value in the actual sample: κ=0.20). Reliability is low (on average “fair”, maximum “moderate”).

The 95%-confidence intervals show, that results of the first and second test run differ significantly. Agreement is worse during the second test run than during the first one. This can be affirmed by an independent samples t-test (t=3.34, p= 0.002).

11.1.2 Tension Test on the first Leaf

The κ-values for agreement of the single pairs of osteopaths in the tension test on the first leaf are summarized in TABLE 6 for both test runs, individually.

1st Leaf Tension	1st Test							2nd Test						
Examiner	**O1**	**O2**	**O3**	**O4**	**O5**	**O6**	**O7**	**O1**	**O2**	**O3**	**O4**	**O5**	**O6**	**O7**
O1	-	0.10	0.14	0.16	0.19	0.08	0.13	-	0.15	0.07	0.04	0.11	0.08	0.28
O2		-	0*	0*	0*	0.11	0.08		-	0.26	0.05	0.21	0.14	0.09
O3			-	0.17	0.09	0.12	0.08			-	0.38	0*	0*	0.12
O4				-	0.34	0.07	0.01				-	0*	0*	0.05
O5					-	0.05	0.00					-	0.17	0.05
O6						-	0.08						-	0.09
O7							-							-

TABLE 6: Results (κ–values) for all single pairs of examiners during the first and second run of the tension test on the first leaf. (0*... negative κ–values are quoted as 0).

The distribution of the κ-values of all 42 comparisons (both tests) is presented in a stem-and leaf-plot in Fig. 5.

Test 1		Test 2	N (T1)	N (T2)	N (Total)
	0.9				
	0.8				
	0.7				
	0.6				
	0.5				
	0.4				
4	0.3	8	1	1	2
	0.2	057		3	3
0124679	0.1	11346	7	5	12
0000046888889	0.0	000035556788	13	12	25

FIG. 5: Distribution of the κ-values for the reliability of the tension tests on the first leaf for both test runs individually and with pooled results.

Most κ-values are lower than κ=0.10 in both test runs indicating poor reliability. Only one pair of osteopaths achieved a higher agreement than κ=0.20 in the first test run, in the second test it were four pairs of examiners.

The descriptive data (mean, standard deviation (SD), 95%-confidence interval (95%-CI), minima (Min) and maxima (Max)) calculated from the raw data in TABLE 6 are summarized in TABLE 7 for each test individually and for the pooled results of both tests.

Tension test (1st leaf)	n	MW	SD	95%-CI	Min	Max
Test 1	21	0.09	0.08	0.06 - 0.13	0.00	0.34
Test 2	21	0.11	0.10	0.06 - 0.16	0.00	0.38
Total	42	0.10	0.09	0.07 - 0.13	0.00	0.38

TABLE 7: Descriptive data for the κ–values of the both tension tests on the first leaf individually (Test 1, Test 2) and with pooled κ-values (total).

The results of both test runs differ only slightly. With pooled data of both test runs, the mean κ-value is κ= 0.10 (95%-CI: 0.07-0.13). The mean inter-examiner reliability can be interpreted as "poor", in the best cases it is "fair", only.

11.1.3 Tension Test on the second Leaf

The κ-values for agreement of the single pairs of osteopaths in the tension test on the second leaf are summarized in TABLE 8 for both test runs, individually.

2nd Leaf Tension	1st Test							2nd Test						
Therapist	O1	O2	O3	O4	O5	O6	O7	O1	O2	O3	O4	O5	O6	O7
O1	-	0.08	0.08	0.09	0.08	0.11	0.23	-	0*	0.05	0.11	0.11	0.09	0.14
O2			0*	0.27	0.16	0.15	0.05			0.03	0.03	0.24	0.16	0.09
O3				0.12	0*	0.28	0.11				0.15	0.10	0.34	0.17
O4					0.14	0.11	0.27					0.18	0.27	0.12
O5						0.00	0.23						0.23	0.31
O6							0.16							0*
O7							-							-

TABLE 8: Results (κ–values) for all single pairs of examiners during the first and second run of the tension test on the second leaf. (0*... negative κ–values are quoted as 0).

The distribution of the κ-values of all 42 comparisons (both tests) is presented in a stem-and leaf-plot in Fig. 6.

Test 1		Test 2	N (T1)	N (T2)	N (Total)
	0.9				
	0.8				
	0.7				
	0.6				
	0.5				
	0.4				
	0.3	14		2	2
22778	0.2	236	5	3	8
00024555	0.1	01235568	8	8	16
00047888	0.0	00235899	8	8	16

FIG. 6: Distribution of the κ-values for the reliability of the tension tests on the second leaf for both test runs individually and with pooled results.

The distribution of rater agreement is rather similar in both tests, as can be observed in the κ-values.

Values between 0 and 0.20 can be observed most frequently. Reliability is very low („poor"). In each test run, only five pairs of osteopaths reached an agreement greater than 0.20.

The descriptive data (mean, standard deviation (SD), 95%-confidence interval (95%-CI), minima (Min) and maxima (Max)) calculated from the raw data in TABLE 8 are summarized in TABLE 9 for each test individually and for the pooled results of both tests.

Tension test (2nd leaf)	n	Mean	SD	95%-CI	Min	Max
Test 1	21	0.13	0.09	0.09 - 0.17	0.00	0.28
Test 2	21	0.14	0.10	0.09 - 0.18	0.00	0.34
Total	42	0.13	0.09	0.11 - 0.16	0.00	0.34

TABLE 9: Descriptive data for the κ–values of the both tension tests on the second leaf individually (Test 1, Test 2) and with pooled κ-values (total).

Similar to the first leaf, results of the first and second test run differ only slightly. Therefore, the total value is almost the same. Under consideration of the results of both tests, the mean κ-value equals κ–0.13 (95%-CI: 0.11-0.16) indicating a low reliability ("poor"), maximum values can be interpreted as "fair".

11.1.4 Tension Test on the third Leaf

The κ-values for agreement of the single pairs of osteopaths in the tension test on the third leaf are summarized in TABLE 10 for both test runs, individually.

3rd Leaf	1st Test							2nd Test						
Examiner	**O1**	**O2**	**O3**	**O4**	**O5**	**O6**	**O7**	**O1**	**O2**	**O3**	**O4**	**O5**	**O6**	**O7**
O1	-	0*	0*	0.00	0.06	°	0.14	-	0.10	0.00	0*	0.29	0*	0.13
O2		-	0.06	0*	0.25	°	0.16		-	0.06	0.04	0.10	0.08	0.12
O3			-	0*	0.19	°	0.04			-	0.22	0.12	0.13	0.10
O4				-	0*	°	0*				-	0.14	0.19	0.17
O5					-	°	0.04					-	0.03	0.16
O6						-	°						-	0*
O7							-							-

TABLE 10: Results (κ–values) for all single pairs of examiners during the first and second run of the tension test on the third leaf. (0*... negative κ–values are quoted as 0, ° could not be computed).

The distribution of the κ-values of all 36 comparisons (both tests) is presented in a stem-and leaf-plot in Fig. 7.

Test 1		Test 2	N (T1)	N (T2)	N (Total)
	0.9				
	0.8				
	0.7				
	0.6				
	0.5				
	0.4				
	0.3				
5	0.2	29	1	2	3
469	0.1	0011233668	3	10	13
00000003366	0.0	000023589	11	9	20

FIG. 7: Distribution of the κ-values for the reliability of the tension tests on the third leaf for both test runs individually and with pooled results.

In the figure above, a high number of κ-values indicating agreement not beyond agreement on the basis of chance are noticeable (κ=0). In the first test run they can be observed in seven of the 15 (47%), in the second test run in four of the 21 comparisons (19%). Agreement is generally low. In total, κ>0.20 can be observed only in three of the 36 pairs of examiners (both test runs). While κ-values predominantly range between 0 and 0.10 in the first test run, most of the κ-values in the second test run range between 0.10 and 0.20. However, these slight differences are not of importance for the reliability of this test.

The descriptive data (mean, standard deviation (SD), 95%-confidence interval (95%-CI), minima (Min) and maxima (Max)) calculated from the raw data in TABLE 10 are summarized in TABLE 11 for each test run individually and for the pooled results of both tests.

Tension test (3rd leaf)	n	Mean	SD	95%-CI			Min	Max
Test 1	15	0.06	0.08	0.02	-	0.11	0.00	0.25
Test 2	21	0.10	0.08	0.07	-	0.14	0.00	0.29
Total	36	0.09	0.08	0.06	-	0.11	0.00	0.29

TABLE 11: Descriptive data for the κ–values of the both tension tests on the third leaf individually (Test 1, Test 2) and with pooled κ-values (total).

Results of the tension test on the third leaf differ slightly more distinctly in the results of the first and second test run than in the tension tests on the first and second leaf. That means, during the second test run an (insignificant) improvement compared to the first test run can be observed in this test on the third leaf (Independent samples t-test: t= 1.467, p=0.15).

Under consideration of the results of both test runs, a mean κ-value for the tension test on the third leaf is computed with κ=0.09 (95%CI: 0.06-0.11). Mean inter-examiner reliability of this test is very low („poor“) and also the best results may only be interpreted as „fair“.

11.2 Intra-examiner Reliability

This chapter is intended to present the intra-examiner reliability, i.e. the agreement in the results of both test runs of each single osteopath. Analogous to chapter 11.1, the order of the presentation of the tests is independent from their reliability.

11.2.1 Tone test

The κ-values for intra-examiner reliability are summarized in TABLE 12. The percentage of opposite test results tested in one and the same patient is presented in the right column. This is the relative frequency of tests, where an examiner diagnosed hypertonus in one and hypotonus in the other test run.

Examiner	κ	% Opposite res.
O1	0.31	9.4
O2	0.55	9.4
O3	0.00	3.1
O4	0.58	3.1
O5	0.21	15.6
O6	0.57	0.0
O7	0.24	3.1

TABLE 12: Results (κ–values) of the tone test of all seven therapists as well as relative frequencies of opposite test results in the two tests.

Three of the seven examiners (O2, O4, O6) reached an intra-examiner reliability greater than 0.40. However, agreement of one single osteopath did not exceed agreement on the basis of chance (O3).

In TABLE 12 can be observed, that all except one therapist rated up to five (15.6%) totally opposite results (hypo- and hypertone) in the two tests. On average, 6.3% of opposite results can be observed during the repetition of the test.

The descriptive data (mean, standard deviation (SD), 95%-confidence interval (95%-CI), minima (Min) and maxima (Max)) calculated from the raw data in TABLE 12 are summarized in TABLE 13.

Tone test						
n	Mean	SD	95%-CI		Min	Max
7	0.35	0.22	0.14 -	0.56	0.00	0.58

TABLE 13: Descriptive data for the κ–values for intra-examiner reliability of the tone test.

The mean value of the seven κ-values is κ=0.35 and thus indicates a “fair” reliability. The confidence interval is broad ($0.14 < \kappa < 0.56$), because calculations were done with only seven values and data variability is high.

11.2.2 Tension Test on the first Leaf

The κ-values for intra-examiner reliability are summarized in TABLE 14. The percentage of opposite test results tested in one and the same patient is presented in the right column.

Examiner	κ	% Opposite res.
O1	0.18	0.0
O2	0.39	9.4
O3	0.13	9.4
O4	0.26	6.3
O5	0.15	18.8
O6	0.35	6.3
O7	0.22	0.0

TABLE 14: Results (κ–values) of the tension test of the first leaf of all seven therapists as well as relative frequencies of opposite test results in the two tests.

None of the seven therapists achieved intra-examiner reliability greater than κ=0.40. Nevertheless, *none of the results indicates agreement on the basis of chance only.*

Again, opposite results (hypo- and hypertension) can be observed in most of the examiners (five of seven). In the worst case (O5) six opposite results (18.8%) had been diagnosed. On average, 7.1% of opposite results can be observed during the repetition of the test.

The descriptive data (mean, standard deviation (SD), 95%-confidence interval (95%-CI), minima (Min) and maxima (Max)) calculated from the raw data in TABLE 14 are summarized in TABLE 15.

Tension test 1st leaf					
n	Mean	SD	95%-CI	Min	Max
7	0.24	0.10	0.15 - 0.33	0.13	0.39

TABLE 15: Descriptive data for the κ–values for intra-examiner reliability of the tension test on the first leaf.

The mean value equals κ=0.24 (95%-confidence interval: κ= 0.15-0.33). That means, reliability of this test can be interpreted as “fair”.

11.2.3 Tension Test on the second Leaf

The κ-values for intra-examiner reliability are summarized in TABLE 16. The percentage of opposite test results tested in one and the same patient is presented in the right column. This is the relative frequency of tests, where an examiner diagnosed hypertension in one and hypotension in the other test.

Examiner	κ	% Opposite res.
O1	0.20	3.1
O2	0.07	28.1
O3	0.26	6.3
O4	0.27	0.0
O5	0.10	25.0
O6	0.37	3.1
O7	0.20	18.8

TABLE 16: Results (κ–values) of the tension test of the first leaf of all seven therapists as well as relative frequencies of opposite test results in the two tests.

Analogous to the first leaf, none of the κ-values exceeded κ=0.40 *and none of the results indicates agreement on the basis of chance only.*

Again, opposite results can be observed in the findings of five osteopaths. In the worst case (O2) nine opposite results (28.1%) had been diagnosed. On average, 12.1% of opposite results can be observed during the repetition of the test.

The descriptive data (mean, standard deviation (SD), 95%-confidence interval (95%-CI), minima (Min) and maxima (Max)) calculated from the raw data in TABLE 16 are summarized in TABLE 17.

Tension test 2nd leaf						
N	Mean	SD	95%-CI		Min	Max
7	0.21	0.10	0.12	0.30	0.07	0.37

TABLE 17: Descriptive data for the κ–values for intra-examiner reliability of the tension test on the first leaf.

The mean value equals κ=0.21 (95%-confidence interval: κ= 0.12-0.30). That means, mean intra-examiner reliability is slightly lower in the second than in the first leaf and can be interpreted as „fair“.

11.2.4 Tension Test on the third Leaf

The κ-values for intra-examiner reliability are summarized in TABLE 18. The percentage of opposite test results tested in one and the same patient is presented in the right column.

Examiner	κ	% Opposite res.
O1	0.04	40.6
O2	0.33	15.6
O3	0.09	21.9
O4	0.26	3.1
O5	0.17	28.1
O6	°	0.0
O7	0.13	6.3

TABLE 18: Results (κ–values) of the tension test of the first leaf of all seven therapists as well as relative frequencies of opposite test results in the two tests.

Analogous to the first and second leaf, none of the κ-values exceeded κ=0.40 and *none of the results indicates agreement on the basis of chance only*.

Again, opposite results can be observed in the findings of six osteopaths. In the worst case (O1), thirteen opposite results (40.6%) had been diagnosed. On average, 16.5% of opposite results can be observed during the repetition of the test.

The descriptive data (mean, standard deviation (SD), 95%-confidence interval (95%-CI), minima (Min) and maxima (Max)) calculated from the raw data in TABLE 18 are summarized in TABLE 19.

Tension test 3rd leaf						
n	MW	SD	95%-CI		Min	Max
6	0.17	0.11	0.05 -	0.28	0.04	0.33

TABLE 19: Descriptive data for the κ–values for intra-examiner reliability of the tension test on the first leaf.

The mean value equals κ=0.17 (95%-confidence interval: κ= 0.05-0.28).

The mean reliability of this test has to be interpreted as „poor“.

11.3 Summary of the Results

In this chapter, the results of the examination will be summarized.

11.3.1 Inter-examiner reliability

Tone Test

Under consideration of the results of both test runs, a mean κ-value of κ= 0.20 (95%CI: 0.16-0.24) for the tone test could be found. The results of the first and second test run differ significantly (p= 0.002). A worse mean agreement (κ= 0.15) had to be observed during the second test run than during the first one (κ= 0.26).

Tension Test on the first Leaf

Under consideration of the results of both test runs, a mean κ-index of κ= 0.10 (95%CI: 0.07-0.13) for the tension test in the first leaf was calculated. The results of the first and second test run differ only slightly (mean value in test run 1: κ= 0.09, mean in test run 2: κ= 0.11).

Tension Test on the second Leaf

Under consideration of the results of both test runs, a mean κ-index of κ= 0.13 (95%CI: 0.11-0.16) for the tension test in the second leaf could be calculated. Again, the results of the first and second test run differ only slightly (mean value in the first run: κ= 0.13, mean in test run 2: κ= 0.14).

Tension Test on the third Leaf

Under consideration of the results of both test runs, a mean κ-index of κ= 0.09 (95%CI: 0.06-0.11) for the tension test in the third leaf was calculated. The results of this test differ more than in the other two leaves. However, the difference between the two test runs is not statistically significant. In the test of the third leaf an improvement can be observed in the second test run compared to the first one (mean value in test run 1: κ= 0.06, mean in test run 2: κ= 0.10).

11.3.2 Intra-examiner Reliability

The highest mean value of the κ-values of all seven therapists can be observed in the tone test. However, it equals κ=0.35 and thus can be interpreted with „fair" reliability, only. Intra-examiner reliability of the tension tests decreases from the first to the third leaf.

The mean value of the seven κ-values of the test on the first leaf is κ=0.24, the mean values for the second and third leaf are κ=0.21 and κ=0.17, respectively.

12 Discussion

12.1 Discussion of Method

The investigation of manual palpation is exposed to many factors, that may influence its course. These factors may influence the preconditions as well as the results of the study, both in a calculable and incalculable way. In this chapter, the considerations and decisions made for preventing adverse influences on this study will be presented.

These considerations and decisions will be discussed in the next chapters, organized in relation to the osteopaths, the participants and the method.

12.1.1 The Osteopaths

The methods used in this study were chosen to solve the question if palpatory tone and tension tests performed by osteopaths can be examined reliably. First of all, the question arises, if the seven osteopaths participating in the study are representative for all osteopaths. The first restriction arises from a local limitation of the osteopaths taking part in this study. The selection of the osteopaths was limited to the region of Berlin in order to prevent an otherwise high organisational and financial effort. It has to be emphasized that it is not the expressed objekt of this study to investigate a representative cross section of all osteopaths. On the contrary it was one of the prerequisites of this study to invite only osteopaths who know these methods and use them in their daily practice for certain. Based on personal experience with students and teachers of other schools of osteopathy, it can be assumed that the tone and tension test is not common knowledge among all osteopaths.

However, knowledge of the curriculum of the „College Sutherland“ makes it safe to assume that all students of this school were taught these tests and that they are familiar with them. Therefore only osteopaths who finished their osteopathic training at the „College Sutherland“ and students of this institution shortly before their final examinations were invited to this study. All participating osteopaths affirmed, that this palpation test is a part of their everyday routine examinations.

The training at the „College Sutherland“ is a five-year extra occupational qualification focussed on parietal, visceral and craniosacral aspects of an osteopathic treatment. After the education at the „College Sutherland“ and after passing the final in-school examination, the students are permitted to the examination of the Federal Council of Osteopaths in Germany (BAO, Bundesarbeitsgemeinschaft für Osteopathie in Deutschland). In this respect, the seven osteopaths are representative for all osteopaths in Germany who are admitted to the examination of the BAO.

12.1.1.1 Restrictions Concerning the Osteopaths

We are convinced, that each osteopath develops an individual style for examination and treatment in the course of his professional development. This diversity expresses itself in an individual application and rating of osteopathic methods which implies that diagnostic tests are subject to an individual selection.

The training offered before the examination aimed at the standardization of the test for all osteopaths involved, and additionally gave them the opportunity to practise it again.

In an interview with the probands after the examination about their impressions of the tests, the following statements were collected:

Pressure administered during the tests varied in quality and intensity with the different osteopaths. Especially osteopath O1 and O7 used evidently higher pressure than their colleagues. Although the main investigator of the study had marked the zones on the abdomen, osteopaths used different hand positions. The test persons described that only four osteopaths placed their hands accurately in the marked zones. The hand positions of the other three osteopaths deviated laterally. The most serious differences were described for the test of the third leaf, where cranio/caudal as well as lateral deviations were noticed. The course of the testing procedure and the osteopaths themselves were perceived as very pleasant by the probands, and none of them felt uneasy.

An initial training for all participating osteopaths was offered in order to standardize the performance of the test as well as the interpretation of their results. Based on the probands statements, our assumption was confirmed that each participating osteopath performed the examination with individual characteristics. Individual differences are described by the probands in quality and quantity of the applied pressure and in different variations of the hand positions.

Analogous to the patients, the osteopaths were interviewed about their experience during the examination immediately after the investigations. The analysis of these oral interviews lead to the following results:

- None of the osteopaths felt disturbed in the performance of the tests by the use of a sleeping mask. On the contrary, all osteopaths described the subjective effect that palpatory perceptions were more intense while using this mask.

- By wearing the sleeping mask the osteopaths could not perceive the test persons visually. Thus a visual recognition of the patients (memory effect) was precluded.

- Five of the seven osteopaths judged their examination results as more neutral while wearing a sleeping mask, because they experienced the visual impression of the probands as an influencing factor for the interpretation of the palpatory results in the first test run.

- About half of the allotted time into the second test run six of the seven osteopaths felt very tired and noticed in part a substantial lack of concentration.
- The support of an assistant was unanimously judged as useful and helpful by all osteopaths.
- None of the participating osteopaths felt influenced by the results of their colleagues. It was impossible to directly hear the rating of their colleagues because the tests were performed in separate examination rooms. Additionally, the patients were instructed to avoid talking, which prevented the verbal information about the previous test results.
- Without exception, the osteopaths judged the participation in this survey positively. The frequent performance of the tests led to an improved understanding of the interpretation of the tone and tension tests.

The sleeping masks used in this study are a methodological aid for the examination of intra-examiner reliability. They were used in the second test run only in order to prevent a visual recognition of the probands. In osteopathic practice sleeping masks are not used. Therefore, their usage is a change of the normal examination conditions for the osteopaths. Nevertheless, the masks were accepted by the osteopaths as useful means to prevent visual recognition which furthermore intensified palpatory perceptions. These statements can only partly be brought into accordance with the results of the examination. The result of the inter-examiner reliability of the tension tests, which is (slightly) higher in the second test run (when the sleeping mask was used), would support the statements. But, by contrast, inter-examiner reliability of the tone test is significantly higher in the first test than in the second one, suggesting an opposite effect. These inconsistencies allow no definite valuation of the osteopaths' statements about the effect of the sleeping mask, but at least, the mask fulfilled its initially intended function, the prevention of visual recognition of the probands.

The whole testing procedure took approximately 2.5 hours (training included). In this period the osteopaths worked continuously and concentrated. The only interruption of their concentrated work was the time, when probands changed and a short break between the first and the second test run. In consideration of the described symptoms of fatigue and lack of concentration during the second test, the break turned out to be too short and / or the duration of the whole procedure was too long. These negative impacts were not calculable in advance of the examination and raise the question, how long therapists can take part in such an investigation without a negative influence on the reliability of their examination results.

On basis of the examination results, a distinct reduction of the reliability in the second test run can only be described in the palpation of the tone (cf. table 27). Since tone and tension tests were performed directly after each other and reliability of the tension tests of all three leaves increases in contrast to reliability of the tone test, the question concerning the influence of the results by fatigue of the osteopaths has to remain open.

In order to assess the reliability of this palpation method, the examiners participating in this study had to have practical skills of several years. With this inclusion criterion, it should be granted that the osteopaths had sufficient experience in the application of these testing methods. Due to a number of short-notice refusals, the study actually had to be run with only four experienced osteopaths and three students in the fifth and thus last year of their osteopathic training (cf. chapter 9.3). By this, the fundamental precondition that only experienced osteopaths were allowed to take part in this study was violated. However, only by this violation it was possible to fulfill another fundamental precondition, a sufficient number of osteopaths (between six and ten).

Osteopath	O1	O2	O3	O4	O5	O6	O7
Years of osteopathic practice	0	0	6	0	4	6	3

TABLE 20: Practical experience of the osteopaths.

After statistical evaluation of the test results, it became apparent that on average 10.6% of the results of the two consecutive tension tests for intra-examiner reliability were totally opposite (hypo- vs. hypertension, cf. TABLE 21). That means, on average every 9^{th} result of the second test run is totally opposite to the first one. When this aspect is investigated in both, students and experienced osteopaths, no relevant difference can be observed between the two groups (10.63% opposite results by students; 10.55% by experienced osteopaths).

Examiner O5 who has rated tension oppositely most often (21.7%) is one of the experienced osteopaths and the osteopaths with the lowest proportion of opposite results (O4 and O6 with 3.1% each) are one student and one experienced osteopath. On the basis of this distribution of opposite results, it is obvious, that there is no distinct difference between students and experienced osteopaths.

Focusing on the degree of concurrence of the intra-examiner reliability, students reach a higher mean κ-value with $\kappa=0.29$ compared to their colleagues with longer experience ($\kappa=0.23$, cf. TABLE 22). However, both results are far from desirable values. To sum up, the participation of students in this test program shows no negative effects on the results. In fact, there seems to be the opposite effect, which can be seen in an improvement of test results.

Osteopath	Years of job experience	Tone	1st Leaf Tension	2nd Leaf Tension	3rd Leaf Tension	Mean
O1	0	9.4%	0.0%	3.1%	40.1%	13.15%
O2	0	9.4%	9.4%	28.1%	15.6%	15.63%
O4	0	3.1%	6.3%	0.0%	3.1%	3.13%
O3	6	3.1%	9.4%	6.3%	21.9%	10.17%
O5	4	15.6%	18.8%	25%	28.1%	21.68%
O6	6	0.0%	6.3%	3.1%	°	3.13%
O7	3	3.1%	0.0%	18.8%	6.3%	7.05%
Mean		6.24%	7.17%	12.05%	19.18%	
Mean proportion of opposite results of all students					10.63%	
Mean proportion of opposite results of all experienced osteopaths					10.55%	

TABLE 21: Proportions of opposite results of all osteopaths.

Osteopath	Years of job experience	Tone	1st Leaf Tension	2nd Leaf Tension	3rd Leaf Tension	Mean value κ-index
O1	0	0.31	0.18	0.20	0.04	0.18
O2	0	0.55	0.39	0.07	0.33	0.34
O4	0	0.58	0.26	0.27	0.26	0.34
O3	6	0.00	0.13	0.26	0.09	0.12
O5	4	0.21	0.15	0.10	0.17	0.16
O6	6	0.57	0.35	0.37	°	0.43
O7	3	0.24	0.22	0.20	0.13	0.20
Mean value κ-index		0.35	0.24	0.21	0.17	0.24
Mean κ-value of all students					κ = 0.29	
Mean κ-value of all experienced osteopaths					κ = 0.23	

TABLE 22: Intra-examiner reliability of the tone and tension tests. κ-values of the single osteopaths.

12.1.1.2 Conclusion

The sleeping mask at least fulfilled the initially intended function, the prevention of visual recognition of the probands. Nevertheless, it is a change in the normal examination conditions in comparison to everyday routine of the osteopaths. Inconsistent results allow no definite valuation of the osteopaths' statements about the effect of the sleeping mask. However, the general question arises in how far does visual perception affect palpatory examinations. If such a relation could be noticed, it would be an important aspect in manual examination and should be investigated in further studies.

The decision to perform the examination in separate rooms turned out to be an effective method to preclude influencing of the examiners by their colleagues. Moreover, the separation contributed to the comfort of the probands during the course of the examination.

The support of the osteopaths by assistants found positive echo in the osteopaths and probands. The aim of the assistants, to simplify documentation for the osteopaths, to support the osteopaths and the probands has been achieved.

The frequent administration of the same testing procedure caused a training effect in all osteopaths, leading – according to their statements – to a better understanding of the tone and tension conditions in the abdomen.

Almost all osteopaths described a lack of concentration and fatigue symptoms during the second test. These negative impacts on the concentration of the osteopaths by the 2.5 hours of the procedure could not be foreseen in advance of the examination. However, considering the results of the statistical evaluation, there is no proof of negative impacts by these factors: Concurrence was even (slightly) higher in the second test run in three of the four palpatory tests. A possible influence by the sleeping mask and as a consequence by a lack of light in the second test run have to be considered, too. The question if symptoms of fatigue influenced the results of the reliability tests, cannot be answered based on the actual data and is a further aspect for studies in manual therapy.

In order to minimize a so-called „therapeutic effect“, the osteopaths were instructed to keep time for palpation as short and pressure as light as possible. This precondition is not representative for this testing procedure and thus violates the prerequisite of investigation as opposed to the everyday practice situation of the osteopaths.

The study was conducted with seven osteopaths, which was according to plan. However, this was only possible by a violation of one inclusion criterion. Due to many short-notice refusals of experienced osteopaths, three students in their last year of their osteopathic training were included. The inclusion of students did not affect the results negatively, as can be proven by the slightly higher intra-examiner reliability reached by them. Nevertheless, due to the low number of experienced osteopaths and students it is not suggestive to generalize this result. However, it suggests the assumption, that students are more familiar with the tone and tension tests than their more experienced colleagues, whose osteopathic training ended up to six years ago.

The high mean proportion of 10.6% of totally opposite results in both test runs (e.g. hyper- vs. hypotension) leads to the interpretation that osteopaths are highly uncertain in the exact rating of tone and tension conditions. An individual and unstandardized examination style of the osteopaths was observed in this study.

To what extent the initial training had an influence on the result of the examination cannot be conclusively decided. A comparative study without training would be necessary for a valid prediction on the efficacy of the consensus training. Considering the poor to fair results of inter-examiner reliability and the individual differences in the performance of the tests, it has to be concluded that the training did not fulfill its purpose (cf. chapter 9.6.3).

According to the results, the assessment of the tone is more reliable than the assessment of the tension.

Comparing the results of the tension tests of the different leaves, it is obvious that it is most difficult for the osteopaths to palpate the tension of the third leaf, where opposite results could be observed most frequently.

12.1.2 Probands

It is a general prerequisite of an examination of a palpatory test to grant an as complete range of the object of investigation as possible, comprising all its possible forms (range of variation). Therefore, it was planned to select the test persons with regard to a complete variation of different tone and tension conditions.

For an objective documentation of this prerequisite, it would have been necessary to examine the test persons by means of a stomach tube or a bladder catheter and to measure the abdominal pressure conditions. Since these measuring procedures are invasive and unacceptable for the test persons, another method was used to grant a high range of variation of different tone and tension conditions.

This was done by inviting only test persons, whose tone and tension conditions were known from a former osteopathic examination. The test persons were selected from the patient pool of our osteopathic practice. The assessment of the different tone and tension conditions is a subjective procedure and cannot be assessed objectively. However, this drawback seemed acceptable compared to our personal long experience with diagnostics of the abdomen, and the availability of a proband group with a wide range of tone and tension conditions.
Furthermore, additional aspects were considered during patient selection:

- In the visceral osteopathic concept, Fieuw describes a relation between an increase / decrease in weight due to excess / reduced nutrition and changes in tone and tension (Fieuw 2005, p. 1ff). Under consideration of this relation, patients were selected, who represent a variety of different nutritional status (over- / under- / normal weight).

- Osteopathic literature describes a descent of the abdominal organs by a reduction of tension (Helsmoortel, 2002; Fieuw, 2005). This process of organ descent is described to happen with increasing age. Therefore, a broad range of age was a criterion for the selection of test persons, too.

Under consideration of the results of the study, it is rather safe to assume that a sufficient range of variation of different tone and tension conditions was considered.

12.1.2.1 Restrictions Concerning the Probands

In order to document the variation of different tone and tension conditions, age, body weight and – height were collected from all participants and their body mass index was calculated (cf. chapter 9.6.4). This index is used to define an age dependent measure for normal weight and to classify weight deviations (Deutsche Gesellschaft für Ernährung, 2006).

It has to be stressed, that interpretation of the body mass index and its significance are critically discussed in scientific literature (Donner, 2005, p. 23; Ditmier, 2006, p. 4), because it is only a coarse reference point and because of its limits of normal weight, that do not comply with the actual knowledge anymore. Moreover is the body mass index not suitable for predications about the individual constitution of the body tissue (muscle mass, fat content) and does not take into account the resulting different constitutional types.

A search in scientific literature about a relation of the body mass index with tone and tension, respectively, remained without results. However, the body mass index was used as aid to document the physical variety of the test persons in spite of these controverses.

The body mass index is calculated by division of bodyweight by the squared body height (cf. the following formula from: Deutsche Gesellschaft für Ernährung, 2006):

$$\textbf{Body mass index } [kg/m^2] = \frac{\text{Bodyweight } [kg]}{\textbf{Bodyheight}^2\ [m]}$$

In the actual case, the body mass index varied from 18 to 30 kg/m². Deviations of normal weight under consideration of age were taken from the guidelines of the Deutsche Gesellschaft für Ernährung (2006). The results for the actual sample of test persons are summarized in the following table:

Interpretation by BMI	underweight	slight underweight	normal weight	slight overweight	overweight
Number of subjects	8	2	16	4	3

TABLE 23: Classification of the test persons by their bodyweight index.

In Table 23 can be observed, that approximately half of all test persons (16) had normal weight and the other half either over- (7) or underweight (10).

Another aspect in the documentation of the different tone and tension conditions is the variation of age. The age distribution in the actual group of test persons is summarized in the following table.

Age group	20-30 years	30-40	40-50	50-60	60-70	> 70
Number of subjects	3	4	11	10	2	3

TABLE 24: Classification of the test persons by age

The test persons cover a wide range of age (minimum 24, maximum 82 years of life) as can also be seen in table 24. Most of the test persons are between 40 and 60 years old (63%), 21% are between 20-40 years and 16% older than 60.

An ideal age distribution with equal proportions of each age group was aspired, but rejections by patients and the restricted patient pool are the reasons, why the sample could not meet the ideal. However, it is obvious that a broad range of age is ensured and each age group is covered by at least two test persons.

The patients were instructed to keep silent during the whole procedure in order to prevent recognition based on their voice. This was necessary to guarantee the blinding of the osteopaths in the second test run. Under consideration of the anonymity of the test persons, the relatively high number of test persons and only two contacts between each osteopath and each test person, a disruption of blinding by acoustic recognition can be rejected.

12.1.3 Conclusion

A broad range of different tone and tension conditions is a prerequisite for the actual study. In order to grant this broad range in an objective way, it would have been necessary to examine the test persons with invasive methods, that could not be applied within the scope of this study. It is not possible and ethical to expect the test persons to put up with the exposure to instrument-based methods for the assessment of the intra-abdominal pressure.

The alternative method was to select patients with known visceral results from the patient pool of our practice. Further criteria for selection were to grant a broad age spectrum (24-82 years of age) and a wide range of nutritional conditions (BMI from 18-30 kg/m^2). According to the actual test results, this method could be successfully used for providing a broad variety of different tone and tension conditions.

Results for the intra-examiner reliability indicate, that blinding by anonymity of the test persons, silence during the whole examination, and the use of sleep masks during the second test run was successful.

The course of the study and the osteopaths were perceived as very comfortable and none of the test persons felt uneasy. The patients listed as main aspects the professionalism of the osteopaths, the presence of the assistants, the good organization and the separate examination rooms in the interviews after the examinations.

12.2 Restrictions Concerning Method

An objectification by instrument-based examinations of the abdominal pressure conditions would be the method of choice for the validation of the tone and tension tests.

However, this study does not judge validity, but examines the concurrence in the results of the palpatory tests (inter-examiner-/intra-examiner reliability).

In order to grant homogenous basic conditions, each patient would have to be examined by all examiners at the same time (cf. chapter 2). Since a synchronous palpation is impossible, test persons were examined sequentially. To what extent a repeated palpation of the abdomen affects tone and tension conditions in the test persons, cannot be assessed. In order to reduce a possible therapeutic effect, the osteopaths were instructed, to palpate as shortly as possible and to use as slight as possible pressure. These demands were essential for the examination, but were a disturbance of the examination conditions for the osteopaths and do not comply with the daily osteopathic practice.

The whole testing procedure lasted 2.5 hours and required high attention and concentration of the osteopaths. In order to grant as equal as possible conditions for each patient, the examination had to be performed continually and constituted an extraordinary stress situation for the osteopaths, they are not exposed to in their normal job. It is not possible to quantify its effect on the results and its seriousness could not be foreseen in advance of the study. Since generally all therapists who take part in a reliability examination are exposed to this form of stress, it is being accepted as a situational condition of this study.

One target was, that preferably all osteopaths performed the tests uniformly. This, of course, would be the ideal situation, which cannot be met due to individual differences in the osteopaths' mode of practice. However, I tried to reach an optimal approximation for a homogeneous testing procedure by considering the following aspects:

- The osteopaths had to be practically experienced in the performance of the tone and tension tests and had to use them routinely.
- A consensus training was performed in advance of the tests in order to ensure an as uniform performance as possible.
- There was the opportunity for individual correction by the director of the tests, if the osteopaths felt ambiguous.

In the interviews with the test persons after finalization of the testing procedure, it became obvious, that the osteopaths did not perform the tests uniformly. The subjects described different hand positions and varying pressure. With the current knowledge it would have been meaningful to charge the assistants with the inspection of uniformity. The assistants took part in the consensus training, too, and were assigned to an osteopath, whom they supported for the whole course of the study. Their main tasks were to note the results in a prepared file and to grant a fluent process of the examinations. Due to the steady assignment, the assistants could not notice possible inconsistencies. To fulfill this task, it would have been necessary to assign them to patients instead of osteopaths.

In the second test run, sleep masks were used for blinding the osteopaths against a recognition of the test persons and to ensure an uninfluenced assessment of intra-examiner reliability. That means, conditions for the osteopaths changed compared to the first test run. Furthermore, these blinded conditions are different from daily practice. Since there is no definite trend in the results of the first and second test run, it cannot be assessed, if and to how far, the use of the sleep masks affected the results. The advantage of the mask, the prevention of a visual recognition, is rated higher than the possible disadvantages, mentioned before.

13 Evaluation

13.1 Evaluation of the Results

After the description of the limiting and influencing factors in the last chapter, we will now summarize and interpret and compare the results of this examination.

13.1.1 Raw Data

Variance of the data of all four testing methods is very high (κ= 0.0 to κ= 0.50) and the different experience of the osteopaths does not influence the results. Furthermore it becomes apparent that approximately 16% of all test results of the osteopaths can be compared to a purely random concurrence if all eight tests (one tone test and three tension tests, performed twice) are taken into consideration.

Comparatibly better results can be observed in the tone test than in the tension tests. It was probably more difficult for the examiners to assess abdominal tension (cf. TABLE 25).

	Tone test	Tension 1st leaf	Tension 2nd leaf	Tension 3rd leaf
Inter-examiner reliability 1st test run	0.26	0.09	0.13	0.06
Inter-examiner reliability 2nd test run	0.15	0.11	0.14	0.10
Intra-examiner reliability	0.35	0.24	0.21	0.17
Opposite results	6%	7%	12%	17%

TABLE 25: Comparison of the results by means of the κ-values for intra- and inter-examinerreliability.

On account of the poor to fair concurrence of the results, the examination reveals that sensitivity of the tone and tension tests is low, and the testing procedue therefore not reliable.

13.1.2 Inter-examiner Reliability

Inter-examiner reliability was assessed by comparison of the results of the seven osteopaths during two test runs. Evaluation by Cohen's kappa index proves to be a qualitative means of interpretation. (cf. chapters 10. and 11).

The main results of the examination are: The κ-values for inter-examiner reliability are generally lower than those of intra-examiner reliability (cf. TABLE 27). This difference in inter- and intra-examiner reliability for manual tests is commonly described in scientific literature (examples cf. TABLE 26) and could be observed in this study, too.

Publication	Inter-examiner reliability (κ-index)	Intra-examiner reliability (κ-index)	Object of investigation
French et al. (2000)	0.27	0.47	Mobility of the spine
Gregsen et al. (2000)	0.45 – 0.51	0.59 – 0.64	Muscle tone
Vincent et al. (2002)	0.052	0.46	Flexion test in stance
Christensen et al. (2003)	0.22 – 0.3	0.44 – 0.49	Palpation of breast muscles
Podlesnik (2006)	< 0.01	0.11	Local listening test

TABLE 26: κ-values from different studies about inter-examiner and intra-examiner reliability of manual tests.

It is obvious in this study that intra-examiner reliability is distinctly higher than inter-examiner reliability. (cf. TABLE 27). One possible reason for the lower results of inter-examiner vs. intra-examiner reliability might be caused by the inhomogeneous performance of the osteopaths.

	Tone test	Tension 1st leaf	Tension 2nd leaf	Tension 3rd leaf
Inter-examiner reliability 1st test run	0.26	0.09	0.13	0.06
Inter-examiner reliability 2nd test run	0.15	0.11	0.14	0.10
Mean Inter-examiner reliability	0.20	0.10	0.13	**0.09**
Intra-examiner reliability	**0.35**	**0.24**	**0.21**	**0.17**

TABLE 27: Comparison of the κ-values for intra-examiner and inter-examiner reliability of the tension- and tone tests.

Individual differences in the positioning of the hand for the palpation of the tension of the third leaf was even noticed by the probands and might be one reason, why concurrence is such low compared to the tone test and the tension tests of the other leaves.

κ-values for the inter-examiner reliability of the tone test are distinctly higher during the first test run (mean $\kappa = 0.26$), than during the second one (mean $\kappa = 0.15$) and an independent samples t-test yielded in a statistically significant difference between the reliability in the two test runs ($t = 3.34$, $p = 0.002$).

This raises the question if the use of the sleeping mask is responsible for the worse results during the second test run. As already mentioned in chapter 12.3, the use of the sleeping mask caused a change in examination conditions. It might be possible that visual perception of the person examined could positively affect the reliability of the examinations. In this case, results of visual perception would influence palpatory results. It is not possible to answer the question whether visual impressions cause unconscious expectations on part of the therapist that are only confirmed by the palpatory examination. It is possible that this aspect has a significant impact in the procedure examined here. This question of general interest for manual tests is only poorly treated in scientific research and deserves further investigation.

The variance of the κ-values of the tone test is high. They range between $\kappa=0.00$ and $\kappa=0.50$. Only one of 21 pairs of examiners achieved moderate concurrence. However, after $\kappa=0.50$ in the first test run concurrence is much lower in the second test ($\kappa = 0.11$). All others have to be judged as only “poor” or “fair” (i.e. <0.40) and 7% of all results are not better than purely random concurrence according to the interpretation model of Landis and Koch (1977).

The mean κ-values of all three tone tests are higher in the second test run than in the first one (cf. TABLE 27). Especially the results of the tests on the third leaf are distinctly better (independent samples t-test: $t = 1.467$, $p = 0.15$), even though they are still very low. Since examination conditions were changed in the second test run by using the sleeping mask, it cannot be precluded, that this fact had a (positive) influence on the results.

Another aspect that has to be considered is the growing practical experience in the course of the testing procedure, possibly resulting in increased certainty in the interpretation of the palpatory perceptions. This aspect might be backed by the fact that it is more difficult to definitely interpret tension than tone (cf. chapter 12.1.1) and that reliability of the examination results improved with time. Whether the inconsistent results of the tone and tension tests have to be ascribed to the negative effect of fatigue cannot be conclusively determined due to conflicting data. While results of the tone test became worse in the second test run, results of the tension tests improved. Since tone and tension test were performed consecutively, the aspect of fatigue should be negligible.

Lowest concurrence was observed in the results of the tension test on the third leaf (mean $\kappa = 0.09$, cf. TABLE 27). This is a hint that the third leave is the most difficult to determine for the osteopaths. An average of 26% can be classed as purely random concurrence. In the results of this test a distinct improvement of concurrence can be observed between the results of the first and second test run (independent samples t-test: $t = 1.467$, $p = 0.15$, statistically not significant). However effects on the inter-examiner reliability are low.

The best concurrence can be observed in the results of the tension test on the second leaf. The corresponding mean κ-value equals κ=0.13 (cf. TABLE 27) and approx. 12% of all pairs of examiners reach an concurrence that is not better than purely random concurrence. The mean κ-value calculated for the interexaminer concurrence in the tension tests on the first leaf equals κ=0.10. In this test, 19% of all results do not reach beyond purely random concurrence.

Using the classification of Cohen’s kappa index and the mode of interpretation according to Landis und Koch (1977), inter-examiner reliability of the four tests is “poor” to “fair” and does not comply with the requirements for a valid and reliable manual diagnostic tool (Flynn et al., 2002; Liebenson/Lewit, 2003).

13.1.3 Intra-examiner Reliability:

Intraexaminer reliability is determined from the concurrence of several results of one and the same osteopath in repeated examinations which leads to a qualified statement about the level of his performance(cf. chapter 11.2). As in the previous chapter, concurrence in the repeated tests is quantified by means of Cohen’s kappa index and interpreted according to Landis and Koch (1977) (cf. chapter 10).

The actual results follow the trend described in literature that intra-examiner reliability for manual tests is generally higher than inter-examiner reliability (cf. chapter 13.1.2.). This denotes a tendency that the performance of a manual testing procedure is of more individual value for the individual therapist than a general validity of the test. Furthermore it turns out that concurrence of the results of the tone test is generally higher than of the tension tests. While 6.3% of all results of the tone test were the opposite (hyper- vs. hypotone) in the two test runs, it was 7.1 to 19.2% of the results of the tension tests.

Considering the higher number of opposite results and lower κ-values of tension, it is probably more difficult for osteopaths to assess the abdominal tension than tone (cf. tables 28 and 29).

Osteopath	Years of job practice	Tone test	1st leaf tension	2nd leaf tension	3rd leaf tension	Mean
1	0	9.4%	0.0%	3.1%	40.1%	13.2%
2	0	9.4%	9.4%	28.1%	15.6%	15.6%
4	0	3.1%	6.3%	0.0%	3.1%	3.1%
3	6	3.1%	9.4%	6.3%	21.9%	10.2%
5	4	15.6%	18.8%	25%	28.1%	21.7%
6	6	0.0%	6.3%	3.1%	°	3.1%
7	3	3.1%	0.0%	18.8%	6.3%	7.0%
Mean		6.2%	7.1%	12.0%	19.2%	11.1%

Table 28: Proportion of opposite results of the single osteopaths in the different tests and their individual means.

Osteopath	Years of job practice	Tone test	1st leaf tension	2nd leaf tension	3rd leaf tension	Mean kappa index
1	0	0.31	0.18	0.20	0.04	0.18
2	0	0.55	0.39	0.07	0.33	0.34
4	0	0.58	0.26	0.27	0.26	0.34
3	6	0.00	0.13	0.26	0.09	0.12
5	4	0.21	0.15	0.10	0.17	0.16
6	6	0.57	0.35	0.37	°	0.43
7	3	0.24	0.22	0.20	0.13	0.20
Mean kappa index		0.35	0.24	0.21	0.17	0.24

TABLE 29: κ-values of all osteopaths (intra-examiner reliability) and individual mean values.

Intra-examiner reliability of the tension test decreases from top (first leaf) to bottom (third leaf) and the number of opposite results, that means hypotension in one test and hypertension in the other, increases (cf. tables 28 and 29). These opposite results occur at least in the tests on the first leaf (average of all examiners: 7%) and most frequently in the tests on the third leaf (average 19%). Tests on the second leaf delivered 12% of opposite results.The tone test resulted in 6% of opposite results, on average. These results seem to support the initial quote by Fieuw (2001) who describes severe difficulties in the assessment of tension of the third leaf. He explains them with the misinterpretation of hypo- as hypertension.

Tension of the first leaf was assessed most reliably (mean κ = 0.24). The least reliable was the assessment of the tension of the third leaf (mean κ= 0.17). Again, assessment of the second leaf takes a mid-position with a mean κ-index κ=0.21. With the classification according to Landis und Koch (1977), intra-examiner reliability of the tension test on the third leaf can be characterized as “poor”, on the other leaves it is “fair”.

Looking at the individual values of inter-examiner reliability, osteopath O4 (a student) reached the highest κ-value of κ=0.58. The lowest κ-index with κ=0 was calculated for examiner O3, an experienced osteopath with six years of professional experience. Both of these extreme values could be observed in the results of the tone test. Under consideration of the mean intra-examiner agreement in all four kinds of tests, examiners O3 and O5 (six and four years of professional experience) concurred least in their own findings (κ= 0.12 and 0.16, respectively, “poor reliability”) and osteopath O5 additionally showed the highest proportion of opposite results (21.7%). Osteopath O6 with six years of professional experience reached the highest intra-examiner reliability with a mean κ-index of κ =0.43 („moderate reliability“). Due to these tendentially contradictory results, no general statement about differences in the reliability of test results of experienced osteopaths and students can be made.

If mean κ-values are calculated separately for both, students and experienced osteopaths, students perform slightly better than their more experienced colleagues (cf. Table 30).
An independent samples t-test results in t= 1.182 and p=0.25. That means, the difference is not significant. The proportion of opposite results is similar in both groups (10.63% vs. 10.55%). Comparing the data revealed that osteopath 5 (4 years of professional experience) boasting the highest average of contrary results (21,7%) belonged to the group of experienced practitioners. In view of the intended prerequisite of the study , namely to employ only experienced colleagues this result is even more of a surprise.

The test results obtained here that invested the students with a higher intrasubjective reliability have to be confined to this study. Due to the limited number of participating osteopaths (n=7) a qualified and reliable statement is not indicated.One possible explanation for the better performance of the students may be that they are more familiar with the procedure of the test. Since they are still in osteopathic training, they are probably confronted more often and intensely with the performance of tone- and tension tests. The osteopaths with professional experience have left osteopathic school an average of 4.8 years ago and if they really use the test in their everyday practice as they had affirmed in advance of the study cannot be verified. The results obtained give rise to doubt their daily routine of this testing procedure.

	Mean proportion of opposite results	Mean Kappa index intra-examiner reliability
Students in 5th year of osteopathic training	10.63%	$\kappa = 0.29$
Osteopaths with professional experience	10.55%	$\kappa = 0.23$

TABLE 30: Mean proportion of opposite results and mean κ-values for intra-examiner reliability for osteopaths with professional experience and students

14 Conclusion

In this study, reliability of a palpatory test examining abdominal tone and tension of the three leaves was assessed. Cohen's kappa index calculated from the raw data of the test results was applied as well as the arithmetic mean and their 95% confidence interval- a quantifiable measure for the assessment of the inter- and intra-examiner reliability. Finally it was interpreted by the model of Landis and Koch (1977).

The main result of this evaluation of the tone and tension tests reveals only poor to fair ($\kappa<0.40$)marks in inter- and intra-examiner reliability. In consideration of this result, this test seems to be unsuited for diagnosis since no reliable prediction of tone and tension can be expected. Flynn et al. (2002) and Liebenson and Lewit (2003) recommend to use only tests in manual diagnosis which have shown evidence of their reliability in scientific examinations, a reliability that has not be judged as poor($\kappa<0.20$).

Following this recommendation, only the tone test has its justification in the field of manual medicine because the examination resulted in a fair reliability with a mean κ-value of 0.28. The mean κ-value of all three tension tests is κ=0.16, equivalent to poor reliability. We consider testing procedures validated as unreliable as utterly unsuitable for grounding osteopathic medicine in an appropriate scientific framework. However, this statement should be weighed against the following considerations:

The investigated method is used for the assessment of the superficial tone of the abdominal wall and of the intraabdominal pressure. For registering the different pressure gradients of the single leaves it is essential to know and accept Glénard's model of the functional leaves. This model was developed by Glénard (1899) approximately 100 years ago and in the 1980s adopted and integrated in his concept of visceral osteopathy by Weischenk (1982). Twenty years later, this functional tension model was adopted by Helsmoortel et al. (2002) und Fieuw (2005) as a basis for their visceral concept. Until now there is no scientific proof for the existence and the function of the "three functional leaves of Glénard", and probably - based on our research - there will be no interest in examining them in the future.

Since Glénard's model has never been scientifically tested yet, primarily Helsmoortel et al. (2002) shall be referred to who cite numerous scientific investigations that support this visceral model. Helsmoortel et al. (2002) have to be criticized in several points. They draw on scientific studies that investigate the interdependency of tone and changes in tension. In these investigations, intraabdominal changes in tension are induced by activation of the diaphragm. Whether this kind of tension change can be compared to tension changes caused by nutritive or pathologic reasons has yet to be scientifically proved. Moreover, proofs cited by Helsmoortel (2002) are fragmentary and they always represent only partial aspects of the tension model. Under consideration of these aspects, the model of the "three leaves of Glénard" that forms the basis for the examined tests remains a hypothetical construct without any proof of its existence and function.

According to Fieuw (2005, p.3), normotension is higher in the first leaf than in the second leaf and here it is higher than in the third leaf again (cf. chapter 9.7). With this assumption the normotension described by Fieuw (2005) forms the basis used by the osteopaths for the assessment of tension changes.It can be observed in the test results that the first leaf was judged as normotensive in 56% of all examinations. This implies that the highest tension was found in the first leaf in 56% of all cases, which would support Glénard's functional model. The second leaf was judged as hypertensive in most of the cases (47%), indicating an increase in tension. The same applies to the third leaf where tension was rated as hypertensive in most of the tests (46%). These results imply that almost half of them characterized the second as the third leaf as hypertensive whereas the first leaf is assigned normotension.If these results are interpreted on the basis of the concept of visceral osteopathy by Fieuw (2005, p.1 ff), approximately half of all probands ought to be in hypertension processing from caudal to cranial. Knowing the probands' tension conditions and their weight distribution, this condition is not probable. If the entirety of tension ratings is contrasted to the weight distribution of the probands, as in table 31, a possible synchronicity of tension ratings with the weight distribution can be uncovered. It has to be stressed, that a relation between body mass index and increased tension has not been scientifically investigated up until now. Nevertheless, this relation is described in the visceral concept by Helsmoortel (2002) and Fieuw (2005) and forms one of the basis of the foundations of their visceral concept.Assumption the existence of this relation, no accordance between tension ratings and weight distribution can be recognized in the actual data (cf. table 31).

Underweight: 30% of all test persons	Normal weight: 8% of all test persons	Overweight: 21% of all test persons
Hypotension in 24% of all cases	Normotension in 40% of all cases	Hypertension in 36% of all cases

TABLE 31: Comparison of all tension ratings with the weight distribution of the patients.

Since neither the Glénard's „functional model of the leaves" nor Fieuw's description of normotension (Fieuw, 2005), based on it, have been investigated scientifically, the interpretation of the results of this study leads to the following conclusion:
On account of the poor concurrence in most results of the tension tests and of the hypothetical considerations about the comparison of the results with probands weight, we question the measure for assessing tension as described by Fieuw (2005, p. 3). We recommend this definition of normotension to be revised in further studies by means of a comparison with an objectifiable method for the assessment of the intraabdominal pressure.

A further aspect in the assessment of the different pressure gradients is the imagination of the osteopaths which expresses itself in the ability to visualize anatomical conditions and to associate them with the expectable tension conditions. We suggest in a study about inter-examiner reliability of tension tests that it a universal visualization of „Glénard's leaves" should be undertaken by the participating osteopaths. This aim could not have been realized in this study, because according to the probands, the osteopaths differed in performing the test (cf. Chapter 12.1.2). Therefore it can be assumed that the process of visualization depends on a subjective interpretation by the osteopath. The consequence has turned out to be an adverse effect for this study. The lack of a universal visualization might be one responsible factor for the poor inter-examiner reliability.

Foccusing on the interpretation of palpatory results, one has to wonder which criteria are used by the osteopath. We think it is a prerequisite for the assessment of the tissue condition that palpatory results are set in relation to a neutral and an ideal one, thus facilitating the assessment of the tissue condition at hand. This cognitive capacity is derived from regular professional experience about this normal/ideal situation and the knowledge about deviations from this state. This internalized knowledge forms the basis for osteopath to assess subtle tissue conditions. This study shows that the background of professional experience alone is not sufficient to reach optimal results in the palpation of body tissues. An accurate and practiced application of an examination method is at least as important for optimal palpatory diagnosis.

The term „clinical reasoning" is used in medical diagnosis and describes the process of clinical evidence/argumentation. Its methodological procedure is a diagnosis of exclusion with the aim to make the best diagnosis for the patient (Higgs, 2000). As one element, multifactorial examination methods comprising several tests for diagnosis of exclusion or for verification of a diagnosis are used. This kind of multifactorial diagnosis is used in osteopathic medicine, too. That means, that test methods are not used separately, but are always combined with other examinations. This aspect is supported by the examination by Henry et al. (2006) who could demonstrate that a multitest system adds to the optimization of the reliability of examination results. It can be deduced that a selective examination of a single test method delivers no objectifiable clue which describes the benefit an osteopath has by integrating this test in his diagnostic process. Considering the higher intra- than inter-examiner reliability, it follows that the individual use of a palpatory test can be of benefit for the osteopath. That means, that an integration of the tone and tension test in visceral diagnostic examination can be a useful decision. However, it is recommended, that the results yielded by this test are used deliberately and combined with other test results.

15 Summary

Literature data show that reliability of test methods in the field of manual medicine is moderate to poor (cf. chapters 8.2.1. and 8.2.2.). From a scientific point of view it might be said that examination methods used in manual medicine are the „Achilles tendon of manual medicine“.

Summing up the results of this study, the tone and tension test is no reliable testing procedure because reliability is only poor to fair. This is no exceptional result in the field of manual diagnosis and reflects a tendency, that can be described with a moderate to poor reliability of examination results (Flynn et al., 2002; Liebenson/Lewit, 2003).

Moreover, Glénard's (1899) „functional model of the leaves“, has not been investigated in a scientific examination and obviously there is no scientific interest in this model. Fieuw(2005) who used Gléndard's tension model as basis for his visceral concept, describes the normotension as a tension gradient progrediently descending from cranial to caudal. This normotension forms the basis for the osteopaths to interpret their palpatory results. The results of this study do not support the tension model described by Fieuw (2005), as was described in our hypothetical considerations (cf. chapter 14).

Visceral diagnostics and therapy are integral elements of osteopathy, and „Glénard's tension model“ is the basis for many osteopathic concepts and visceral osteopathic textbooks. Due to the results gained in this study, we would recommend a scientifical investigation into Glénard's tension model in further studies to determine if this model meets the contemporary scientific standarts.

This methodological study did not aim at the investigation of the whole tension model, but was restricted to the palpatory examination of tension. We would be obliged to have instilled motivation for further investigations in this interesting field of osteopathy.

16. References

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16 Appendix

Appendix 1 - Data Sheet for the Examination

Appendix 2 - Results of the Tests – Raw Data

Methodologische Intra-und Interreliabilitätsstudie zum osteopathischen Test der Tension und des Tonus des Abdomens

Studienleiter: Normen Wolke

Befundbogen zur Erfassung der Tension und des Tonus

Ort der Befundaufnahme:
Praxis für Physiotherapie J. Suchardt, Wismarerstr. 44, 12207 Berlin

Datum: 29.März 2008

Osteopath/in : ________________________ Asistentin ________________________

	Tonus			**Tension**								
				1.Blatt v. Glenard			**2.Blatt** v Glenard			**3. Blatt** v Glenard		
Patient	Hyper	Normo	Hypo	Hyper	Normo	Hypo	Hyper	Normo	Hypo	Hyper	Normo	Hypo
1												
2												
3												
4												
5												
6												
7												
8												
9												
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11												
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33												

Appendix 2 - Results of the Tests – Raw Data:

Tension Test 1st Leaf	1st Test							2nd Test						
Test Person	**O1_1**	**O2_1**	**O3_1**	**O4_1**	**O5_1**	**O6_1**	**O7_1**	**O1_2**	**O2_2**	**O3_2**	**O4_2**	**O5_2**	**O6_2**	**O7_2**
1	1	3	2	3	1	2	2	2	3	3	3	1	3	2
2	2	3	2	2	1	3	2	2	3	2	2	1	3	2
3	1	1	1	1	3	1	2	2	1	2	1	1	3	2
4	2	2	2	3	2	3	2	2	2	2	2	2	3	2
5	2	1	2	3	3	3	2	2	2	2	3	1	2	2
6	2	1	1	2	2	1	3	2	3	3	2	3	3	2
7	2	2	1	3	3	3	2	2	3	3	2	3	3	2
8	2	2	3	3	3	2	2	2	2	3	3	2	2	2
9	2	2	2	1	3	2	2	1	1	2	2	1	1	1
10	2	1	1	1	3	2	1	1	1	1	1	3	2	2
11	3	2	1	3	3	3	2	2	2	2	2	3	3	2
12	2	1	2	2	2	3	2	2	2	2	2	3	3	2
13	2	3	3	3	3	3	2	2	3	3	3	2	3	2
14	2	3	2	2	2	3	2	2	2	2	2	1	3	2
15	2	3	2	1	1	3	2	2	3	3	3	2	3	3
16	2	3	1	2	2	2	2	2	3	2	2	1	3	2
17	2	1	2	3	3	3	2	2	3	1	1	1	2	2
18	2	2	2	3	2	2	2	2	2	2	2	2	2	2
19	2	2	3	3	3	3	2	2	3	1	3	3	2	2
20	2	1	2	2	1	2	2	2	1	3	2	2	2	2
21	3	3	1	1	3	3	3	3	3	1	2	3	3	2
22	2	2	3	3	3	1	2	2	3	2	2	2	2	2
23	2	2	2	3	3	1	1	2	3	1	2	1	2	1
24	2	2	2	3	2	2	2	2	2	2	2	2	3	2
25	2	2	2	2	3	3	2	2	3	3	2	2	3	2
26	2	2	3	2	2	2	2	2	2	3	3	2	2	2
27	2	1	3	2		3	2	2	1	2	2		3	2
28		3	2	2	2	2	2		3	3	2	1	2	2
29	2	2	2		3	2	2	2	1	2		1	1	2
30	2	3	2	1	2		2	2	1	2	2	1		2
31	1		1	1	1	2	2	2		2	2	1	2	2
32	2	3		2	3	2	2	2	3		2	2	2	2
33	2	2	3	2	2	3		2	2	2	3	2	3	

1... Hypertension, 2... Normotension, 3... Hypotension

Tension Test 2nd Leaf	1st Test							2nd Test						
Test Person	**O1_1**	**O2_1**	**O3_1**	**O4_1**	**O5_1**	**O6_1**	**O7_1**	**O1_2**	**O2_2**	**O3_2**	**O4_2**	**O5_2**	**O6_2**	**O7_2**
1	2	2	2	1	1	2	1	3	2	3	2	1	1	2
2	3	1	2	1	1	1	1	3	1	2	2	1	1	2
3	2	1	1	1	1	1	1	1	1	2	1	1	1	1
4	1	2	1	1	1	2	1	1	2	2	2	1	2	1
5	2	1	1	1	3	1	1	2	1	1	2	1	2	1
6	2	2	3	2	2	2	2	1	3	3	3	1	1	1
7	3	1	3	2	1	3	3	2	3	3	2	3	3	1
8	2	1	3	2	1	2	3	1	2	3	2	2	2	1
9	1	1	1	1	3	1	1	1	1	1	1	1	1	1
10	3	1	1	1	3	1	2	2	2	1	1	3	1	1
11	2	3	3	3	3	3	3	2	1	3	3	3	3	3
12	2	1	2	2	1	2	2	2	3	2	2	2	1	2
13	3	3	2	2	3	1	3	2	1	1	1	1	1	1
14	2	3	1	2	2	1	2	1	1	2	2	1	2	1
15	2	2	3	2	1	2	1	2	1	1	2	1	2	1
16	1	2	1	1	1	1	1	1	2	1	1	1	1	1
17	2	2	2	2	3	1	3	2	2	2	2	1	2	1
18	2	1	2	1	1	2	1	1	2	2	1	1	2	1
19	3	2	2	2	3	1	1	2	3	2	3	3	2	1
20	2	1	2	1	1	2	3	2	1	3	2	1	2	1
21	3	3	1	2	3	3	3	3	3	3	2	3	3	3
22	2	1	1	1	3	1	3	1	3	2	1	1	2	3
23	3	1	2	2	3	2	2	2	3	2	2	1	2	1
24	2	1	2	1	1	1	2	1	1	2	2	1	2	1
25	2	3	2	1	3	3	2	3	3	1	2	1	1	1
26	1	1	2	1	1	2	1	1	2	1	2	2	2	1
27	2	2	2	1		1	1	1	1	2	2		1	1
28		1	3	1	2	2	1		3	2	1	1	1	1
29	1	1	2		2	1	1	1	1	1		1	1	1
30	2	3	2	2	1		1	2	1	2	2	1		1
31	2		2	1	1	2	3	1		3	2	1	2	1
32	1	1		1	2	2	1	1	2		1	1	2	1
33	3	1	2	1	1	2		1	2	1	2	1	1	

1... Hypertension, 2... Normotension, 3... Hypotension

Tension Test 3rd Leaf	1st Test							2nd Test						
Test Person	O1_1	O2_1	O3_1	O4_1	O5_1	O6_1	O7_1	O1_2	O2_2	O3_2	O4_2	O5_2	O6_2	O7_2
1	3	1	1	1	1	2	3	1	1	3	2	1	1	1
2	3	3	1	1	1	1	1	1	3	2	1	1	1	1
3	3	3	1	1	2	1	3	1	1	2	2	1	2	2
4	3	2	1	1	1	1	3	1	2	2	2	1	2	2
5	3	3	1	1	3	1	3	3	1	1	1	1	2	1
6	2	3	3	2	2	2	1	1	3	3	2	1	2	1
7	3	1	3	2	1	2	3	1	2	3	3	3	3	2
8	3	1	1	1	2	2	1	1	1	2	2	1	2	2
9	2	1	2	2	3	1	1	3	3	2	2	1	1	2
10	3	3	1	2	1	1	2	3	2	2	2	3	1	2
11	2	3	3	1	3	1	3	2	3	1	1	3	1	3
12	2	1	2	1	1	1	1	1	2	3	2	1	2	1
13	3	3	1	1	3	1	3	3	1	2	1	1	1	3
14	3	3	1	2	1	2	1	3	2	2	1	1	2	2
15	3	2	1	2	1	1	3	3	3	3	2	1	1	2
16	2	1	1	1	1	1		1	1	1	1	1	1	
17	3	1	2	1	3	1	3	1	1	2	1	1	2	2
18	3	2	3	1	2	1	2	1	3	2	2	1	2	1
19	3	3	1	1	3	1	1	3	3	3	2	3	2	2
20	3	1	1	1	1	2	3	1	1	3	1	1	2	2
21	2	3	3	1	3	1	3	3	3	3	1	3	1	3
22	3	3	3	1	3	1	3	1	3	1	1	1	2	3
23	3	2	2	1	3	1	2	3	2	2	2	1	2	2
24	3	1	2	1	1	2	3	2	1	2	1	1	1	2
25	3	1	3	1	3	2	1	3	2	1	1	1	2	1
26	1	2	2	3	2	2	1	2	1	2	2	2	2	2
27	1	3	1	1		1	1	1	1	2	1		1	1
28		3	3	1	1	2	2		3	2	1	1	2	1
29	3	1	2		2	1	1	1	2	1		1	1	2
30	1	3	2	1	1		2	3	3	1	1	1		2
31	1		3	1	1	2	2	1		3	1	1	2	1
32	2	2		1	2	2	2	1	2		1	1	2	3
33	3	1	1	1	1	2		1	1	1	3	1	1	

1... Hypertension, 2... Normotension, 3... Hypotension

Tone Test	1st Test							2nd Test						
Test Person	**O1_1**	**O2_1**	**O3_1**	**O4_1**	**O5_1**	**O6_1**	**O7_1**	**O1_2**	**O2_2**	**O3_2**	**O4_2**	**O5_2**	**O6_2**	**O7_2**
1	3	3	2	2	3	2	3	2	3	3	2	2	2	2
2	1	3	2	1	3	2	2	1	3	1	2	1	2	1
3	3	3	1	1	1	1	2	3	1	2	1	1	2	3
4	3	2	2	2	2	2	2	3	2	2	3	3	2	2
5	3	2	2	2	2	2	1	1	2	2	2	3	2	2
6	3	3	3	2	2	2	2	3	3	3	2	3	2	2
7	3	3	2	2	3	3	2	3	3	3	2	3	3	2
8	2	2	2	2	2	2	2	2	3	3	2	3	3	2
9	1	1	1	1	1	1	1	1	1	2	1	1	1	1
10	1	3	1	1	1	1	3	1	3	1	1	3	1	2
11	3	3	3	2	3	3	3	2	3	3	2	3	3	3
12	2	2	2	2	1	2	2	1	3	2	2	1	2	2
13	3	3	1	3	3	2	3	3	3	2	3	2	2	3
14	2	2	2	2	2	2	1	2	1	2	2	3	2	2
15	3	3	2	3	2	2	3	2	3	2	3	2	2	2
16	1	1	1	1	1	1	1	2	1	2	1	1	1	2
17	3	1	2	2	3	1	3	1	1	2	2	3	2	3
18	2	1	2	2	2	2	2	2	2	2	1	2	2	2
19	3	3	3	2	1	2	2	3	3	3	2	3	2	2
20	2	1	2	1	1	1	3	2	3	3	2	1	2	1
21	3	3	1	2	3	1	3	3	3	3	2	3	1	3
22	3	3	1	1	3	1	3	2	3	2	1	2	2	3
23	1	2	2	1	1	2	3	2	3	2	1	3	2	2
24	2	2	2	2	2	2	2	2	2	2	2	2	2	1
25	2	3	2	2	1	1	2	1	1	1	2	1	1	2
26	2	2	3	1	2	1	2	1	1	2	2	1	2	2
27	1	3	3	2		2	2	2	3	2	1		1	3
28		2	2	2	2	2	3		2	3	2	3	2	2
29	1	1	2		2	1	2	3	1	1		1	1	1
30	1	1	1	2	3		2	1	1	2	2	3		1
31	1		3	1	1	2	3	1		2	3	1	2	3
32	3	3		2	1	2	3	2	3		2	3	2	3
33	2	2	2	2	1	2		3	2	1	2	2	2	

1... Hypertone 2... Normotone 3... Hypotone

17 List of Figures and Tables: