The Influence of osteopathy on the vegetative nervous system in chronic pain patients

Elke Fürpaß
October 2006

Abstract

Keywords: Vegetative Nervous System, Chronic Pain, Heart Rate Variability, HeartMan, Stress, Age Dependence, Bio cybernetic Connections

In the study at hand, the question had to be clarified, if osteopathic interventions can influence the vegetative nervous system. 12 candidates with chronic disorders passed through an eight week observation period, where they were treated four times generally osteopathic. The evaluation of the objective was made by measuring of the heart rate variability (HRV) with the help of the HeartMan (a portable long term ECG of the HeartBalance Company). The evaluations of this 24-hour measuring, before and after the intervention phase were compared. As an additional evaluation criterion a visual analogous scale (VAS) was used to define the pain intensity before and after the treatment. For the statistic preparation the mean values and the mean errors of the mean values ± SEM were calculated. With help of the t–test the data were checked for possible significances by $p < 0,05$. Connections between two variables were verified by a linear regression analysis.

The final measuring values have all changed in terms of an improvement of the vegetative status. However, changes of the HRV parameters did not show the significance level, since the individual reactions to the treatment turned out differently. Only the results of the VAS by $p < 0,05$ were significant.

A distinct correlation showed, between the age of the test subjects and the ascertained HRV – parameters. In young patients the osteopathic treatment caused a distinct improvement of the HRV parameters, as far as their basic values were within the norm. Only older patients proved considerably more rigid in their reaction.

The study proves that stress situations in daily life have a significant influence on the measuring results. The underlying bio-cybernetic considerations in this connection will be followed up at a further part of this work.

II EMPIRIC PART

1 INTRODUCTION

The physiological connections in our body are an important focal point, with which medicine, inclusively osteopathy, is confronted daily. How one affects the other, what really activates an osteopathic treatment in the organism remains still a fascinating question – even after many years of practice. Already several years before my osteopathic training I was fascinated by the thought of the relativity of all things, the variability – nothing has only one truth; it always depends on the observer's point of view. Every biologic system, therefore also the human organism, relies on information and energy exchange with the environment to enable its existence. Experts from quite different disciplines have dealt at all times with this issue. Bergmann (1993), a general practitioner with great experience in the field of reflex therapies, speaks of open systems, whereby the system, regarded holistically, represents more than the sum of its parts. Heinz von Foerster (2001), physicist and philosopher denotes the human being as a cybernetic system, as a non-trivial machine, and describes this circularity, which is inherent in the human being and identifies him, from the philosophical point of view. My schooling taught me the aim is to maintain the integrity of all these single systems and parts – thus promoting the self-healing power of our organism. Many modern medical concepts speak of **self-healing -** and here a catch phrase emerged, which could easily be misused, but still can't be dismissed from our thoughts. If we are familiar with the laws of nature, consequently also the human being, it cannot be claimed anymore that a physician or therapist can heal the organism only from outside. Something else is happening here - it concerns an approach between the worlds of natural laws, the philosophic way of looking at osteopathy, and the world of the human being as mind-body entity. The osteopath stands somewhere in the area of conflict between science and life itself. But the fact is decisive that the organism carries all knowledge in itself.

This has caused me to observe more closely the effectiveness of osteopathic action on a very significant integrative part of our body, namely the vegetative nervous system (VNS).

Medical science describes numerous effects of therapeutic interventions on the VNS. The literature offers numerous publications, mainly in the field of pain management (Wright 1995), or also regarding the effects of manual therapeutic interventions (Vicenzino 1998). The knowledge that the VNS can be influenced by osteopathic treatment is based largely on empiric experience, and thus rests upon the clinical observation. Recent scientific

findings suggest that the sympathetic and parasympathetic nervous systems can not be seen anymore as the very opponents, but that their synergy effects guarantee stability in the system.

Previous research works dealt in a considerably greater extent with the diverse effects on the sympathetic nervous system, although one could assume that the effects of the parasympathetic nervous system lead to regeneration and healing and should be therefore of primary interest. But as already mentioned, it is not enough to look only at one side of the coin. In doing justice to this demand, a suitable measuring method is available and applied since some time in medicine and in competitive sports. With the measurement of the heart rate variability (HRV) it is possible to make a valid statement about the vagotony (the main nerve of the parasympathetic nervous system). The activity level of the sympathicus defines itself as the ratio of several measurands.
The results of numerous HRV-measurements illustrate the variety of possibilities, which are at the disposal of our organism. Here it can already be assumed, not stabilities guarantee optimum function, but variabilities. “Rhythm instead of beat is a sign of vitality” (Moser 1999).

1.1 Problem Presentation

The osteopathic procedure always aims at the treatment of the entire organism. Of course, specific lesions in single parts of the body are dissolved, but always with the mental reservation, serving with it the whole system. This work is aimed to clarify primary, **if changes in the area of the vegetative nervous system are verifiable by osteopathic influence**. Influencing the VNS could either mean putting it to alert, or to “throttle” it. But eventually an adequate “standby-modus”, which permits acting in both directions at any time, is gainful for the health of a person.
Here the question is unavoidable, does the VNS present an image of the entire situation of the organism? Are conclusions due to the VNS’s vitality condition on the rest of the body allowed? Experiences from practical work with patients suggest also that mainly the mental condition and the degree of stress exposure have a significant influence on the NVS.

For a better understanding and to highlight the complex functionality of biological systems in general, and of the human organism in particular, one has to go into more detail. Also the issue, handling of chronic pain conditions must be taken into account unconditionally. The aim is always to contribute to the improvement of the organism’s vitality. According to my opinion, this attempt fortifies the medical relevance of my objective.

I THEORETICAL PART

2 VEGETATIVE NERVOUS SYSTEM

The vegetative nervous system (VNS) innervates mainly the smooth muscular system of all organs. These functions are extensively protected from direct arbitrary control; therefore this NS is also known as **autonomous nervous system (ANS).**

For the entire function of the human body, the individual functions of the different organs have to be coordinated and adjusted to the prevailing activity condition of the organism. In accomplishing this, the VNS receives, interprets, processes and sends chemical and electrical messages via a well organized central autonomic network (CAN), (Slater 2005).

2.1 Anatomic Bases

The VNS has its anatomic centers in the central nervous system, and also in the periphery. Basically, the separation in central and peripheral NS remains always an artificial separation. The close anatomic connections between these systems demand always the reflection of the mutual inter-correlations.

The vegetative nervous system consists of the sympathetic nervous system, parasympathetic nervous system and enteric nervous system.

2.1.1 Sympathetic Nervous System (SNS)

The cell bodies of the pre-ganglionic neurons of the sympathetic nervous system (SNS) are situated in the intermediary zone of the thoracic and lumbar segment of the spinal cord. The axons of these neurons leave the spinal marrow (RM) over the anterior roots and move from there to the paired para-vertebral ganglions and to the unpaired pre-vertebral abdomen ganglions. The para-vertebral ganglions are organized in the sympathetic trunks (truncus sympathicus),which extend left and right from the spinal column from the base of brain and come down to the sacral bone. From the sympathetic trunks the post ganglionic axons move on the one hand to the effector organs in the periphery of the organism, on the other

hand over special nerves to the organs in the head area, in the bosom, in abdomen and pelvis region. (Duus 1990).

The truncus sympathicus is to be understood as the central contact point, where the VNS can be influenced over spinal manual techniques (SMT). The ganglions are surrounded by a thick connective tissue capsule, which continues in the epineurium of the pre- and post ganglionic neurons. The capsule is strongly innervated and therefore also potentially reactive.

2.1.2 Parasympathetic Nervous System

The pre-ganglionic neurons of the head part of the parasympathetic nervous system (PNS) are situated in the nuclei of the cerebral nerves.

III Occulomotorius

VII Facial nerve

IX Glossopharyngeal nerve and

X Vagus nerve

Thereby the vagus nerve alone contains approximately 75% of the fibers. The pre-ganglionic fibers of the sacral part come from the sacral segments 2 to 4. The divergence from pre-ganglionic to post-ganglionic fibers is less than in the sympathetic nervous system, which probably reflects a more localized and specific function of the parasympathetic nervous system (Duus 1990).

2.1.3 Enteric Nervous System

The enteric nervous system – also called the brain of the gastrointestinal tract – regulates the basic functions of the gastrointestinal tract. All cell bodies lie in the wall of the gastrointestinal tract, whereby the enteric system can function independently from the ZNS (Jaenig 1989, cited after Slater 2005).

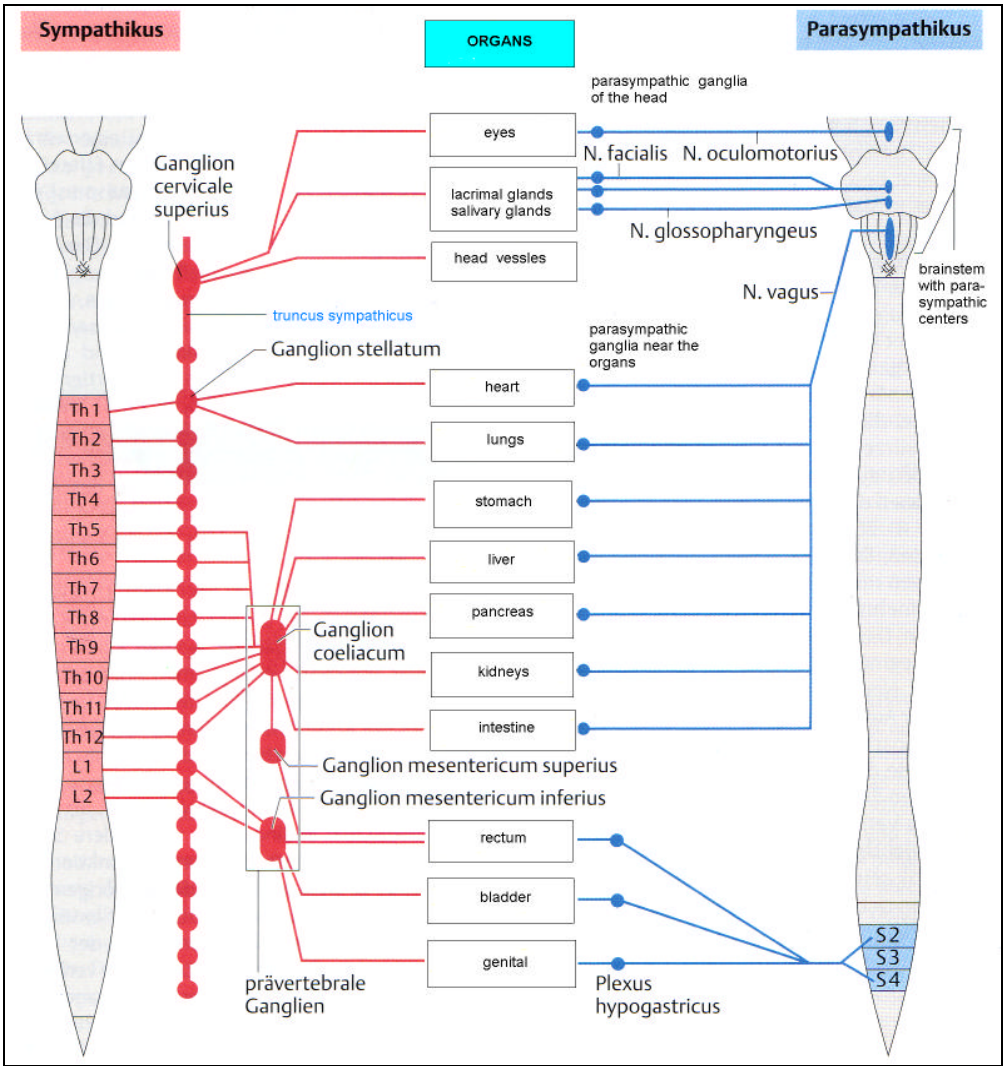


Fig.2 Origin and service areas of the VNS (Slater 2000 after Hamill 1997, Modified after Fürpaß 2006)

Different authors describe slightly divergent illustrations of segmental innervations of the inner organs and therefore these outlines should be seen critically as simplified summary. The problem of the segmental classification of single tissues results among others from the very complex change-over from pre- to post ganglionic neurons. In most vegetative ganglions of larger animals a pre-ganglionic axon diverges on many post-ganglionic cells, and many pre-ganglionic axons converge on a post-ganglionic cell (Jaenig 1996). That means that every single spinal cord segment can influence up to 100.000 post-ganglionic neurons (Hamill 1996, cited after Slater 2005). This fact shows us again the complexity of neuronal circuits on the one hand, and the versatility of the human organism on the other hand. However, many things always resemble one model only, which serves our understanding, but still remains behind reality.

Visceral afferences in the spinal cord are circuited partially to the same neuron, which also relays somatic-sensitive impulses to the brain. Thus, visceral stimulations can be “wrongly interpreted” as somatic ones, and complain about somatic pain occurrence, where in fact visceral stimulations are the reason. The sensitive fibers of those skin regions, called **Head Zones**, circuit in the spinal marrow on the same neurons, as those fibers, which are coming from certain organs. In this context one understands, why visceral osteopathic techniques are such a valuable contribution to the treatment (see chapter 5.4.1 – Importance of visceral techniques).

2.2 Physiologic Foundations

Main task of the VNS is the preservation of the inner milieu, the homeostasis. In this connection a paradigm change takes place, which will be explained as follows.

2.2.1 Homeostasis – Homeodynamic

On the basis of new findings the term of the homeostasis is called into question, and replaced by the concept of **Homeodynamic** (Moser 2004). Emerging from the observations of the HRV, stable health is not achieved when the body is holding all parameters equally, but when he maintains the capability of adjustment to different situations, thus a physiologic oscillation. The measuring of the HRV offers a suitable method in modern system physiology for the visualization of these body rhythms.
All our life our organism is shaped by rhythms. Many research results show that this vibrating is not a vagary by nature, but a condition for health (Klasmann 2005, Emoto 2003).

The osteopathy speaks of the principle of economy. That means the organism endeavors constantly to achieve the best possible regeneration with the least of effort. A very important part of this endeavor on cellular level is the provision of all vital substances in the right dosage, at the right time and place. The body attempts this on its own, as every living organism possesses the inherent property of self healing and regeneration (Moser 2004).

We try to support this effort with our therapy, and so contributing to homeostasis.

The measuring of the HRV has proved especially suitable for the comprehensive definition and representation of the body rhythmic. The heart does not beat quite regularly, it dances. A high variability occurs, especially during the relaxation phase, respectively while sleeping. The phenomenon of the relaxation presents a basic principle of living organisms, which differs them from machines. A well coordinated organism, where all body rhythms cooperate, recovers peculiarly fast and adjusts well. From this point of view the heart seems to be predestined for the representation of homeodynamic processes (Moser 2004).

Practical observations suggest that an osteopathic treatment influences individual functions of the VNS. Nearly always a lower breathing or heart frequency can be registered, often an improved skin profusion, and not seldom the obligatory walk of the patient to the toilet because of increased uriesthesis after treatment. Time and again patients report they have felt a deep tiredness on the day of treatment, and/or that they slept unusually deep in the night following the treatment.
From chrono-biologic examinations it is known that good sleep can only be attained if the organic vitality state during daytime is satisfactory. A strengthening of the circadian rhythmic (ca. 24 hours) should be accompanied by an improved sleeping quality. In the auto-chronic picture (chapter 4.2) changes of the sleeping architecture can be observed.

2.2.2 Neurotransmission in the VNS

The most important transmitters in the VNS are noradrenalin and acetylcholine. All para-sympathetic pre- as well as post-ganglionic neurons are setting free acetylcholine that is why PNS is also called **Cholinergic System.**
All sympathetic pre-ganglionic neurons as well as some post-ganglionic neurons are also cholinergic. The most sympathetic post-ganglionic neurons are setting noradrenalin free as transmitters, therefore the SNS is also known as **Adrenergic System** (Jaenig 1995).

2.2.3 Central Control of the VNS

The most important and combined superior vegetative control centers are, due to their priority, starting with the highest, as follows:

Hypothalamus
Limbic System
Formation reticularis

The **Hypothalamus** contains a system of small nuclei and fiber systems, as well as the hypophysis. In this brain area a multitude of behavior aspects are implemented, which are accompanied by complex vegetative reactions. Also the circadian rhythm is controlled from areas of the hypothalamus (Trepel 2004).

The main tasks of the **Limbic System** consist in the control of the emotional reply, as well as in the ability of the brain to learn and remember. The limbic system lies in the depth of the endbrain and includes the cingulated convolution, the hippocampus, amygdale, fornix, and in a broader sense also fore-thalamic nuclei, the prefrontal cortex, and the hypothalamus (Trepel 2004).

The **Reticular Formation** consists of center zones, which to some extent are difficult to separate, and which are mainly to be found in the center of the brain stem-tegmentum. One of its main duties is to coordinate the circuitry of individual brain stem nuclei for partially vital functions (for instance, breath and metabolism function). Additionally, parasympathetic and sympathetic centers are controlled selectively from the reticular formation (Trepel 2004).

2.3 “Flight-Fight” Reaction

By this, one understands the reaction of the brain in case of illness or injury. Thereby it comes to a stress reaction, which is biologically absolutely reasonable, because it causes physiologic behavior changes, which serve the survival (Gifford 2005).

Often it is attempted to blame the sympathicus alone for causing a “stress situation”, which suggests that only in this part of the VNS stress and excitement situations are activated, **so called “Flight-Fight Reactions”**. But in most cases both parts of both systems are activated in stress situations. The famous stomach ulcers (due to increased gastric secretion) of a stressed manager or the uriesthesis of a nervous examinee are vivid examples for a partial para-sympathetic activity in stress situations.
Nevertheless, the SNS has a special meaning in the interplay of mind-body in health and illness. As a reaction to stress the SNS does not only activate the whole body, but it also inverts immune organs such as thymus, spleen and lymphatic glands, and is therefore involved in the regulation of the inflammation reactions, and consequently contributes also to a big part to the healing process.
Therefore it occurs that an adequate attitude of all parts of the VNS is an inevitable condition for the healing processes. When we speak in osteopathy of self healing mechanisms, we mean to promote exactly these physiological control mechanisms.

2.4 Interactions of the VNS with other systems

The following passage describes the interactions of the VNS with other systems – but only aspects, which are relevant for the treatment of chronic pain condition, will be dealt with. This proves that brain, immune system, mind and the VNS as mediators can functionally not be separated from each other. These connections are especially important when the participation of the VNS in lasting pain conditions, thus in chronic pain patients, is discussed.

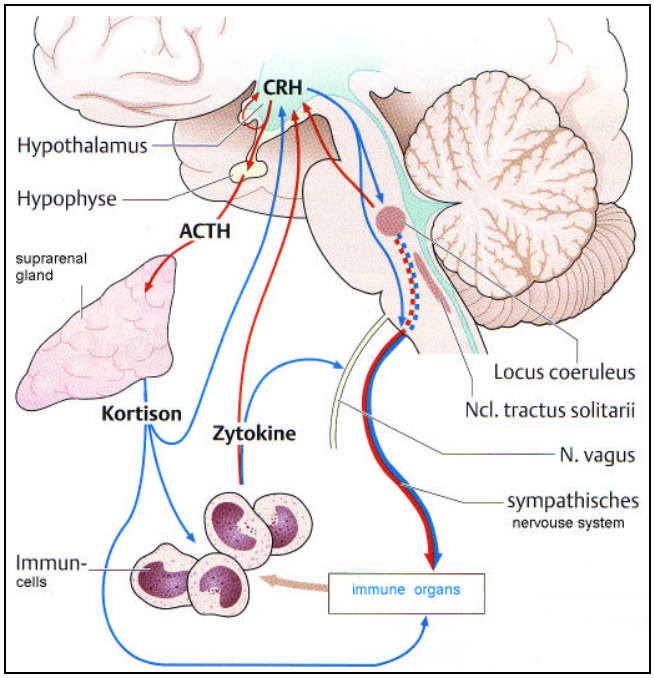


Fig. 3 Interrelations of the VNS with other systems (Slater 2000 from Sternberg und Gold 1997, modified after Fürpaß 2006)

2.4.1 Interaction with the Immune System

One of the most important functions of the VNS is the interaction with the immune system. The SNS innervates the organs of the immune system, and regulates the inflammatory processes in the entire organism. Primary, immune reactions are serving the maintenance of the homeostasis. The interactions of the immune system with neurons in certain brain areas activate a cortisone-conveyed extinction of the immune reaction, and induce behavior patterns, which support recovery from illness and injury (Sternberg and Gold 1997; cited after Slater 2001).

In therapeutic work this interplay with the immune system, regarding physiologic healing processes is especially important. Cytokines from the immune system can signalize the nucleus of solitary tract and the brain regions in connection with it, that specific behavior patterns should be released against the stress reaction. Flight prevention behavior, fear and other symptom typical behavior patterns, which are characteristic for the healing process, belong to it (Slater 2001).

2.4.2 Interaction with the Neuro-Endocrine System

The hypothalamus-hypophysis-adrenal axis corresponds to the control center of the brain, regarding stress reactions. If something stressful happens, or even if a stressful thought turns up, the hypothalamus synthesizes the corticotrophin releasing hormone (CRH), which activates the hypophysis to release adrenocorticotropic hormone (ACTH) into the bloodstream. As a result the adrenal gland produces cortisone, the key hormone in the regulation of a stress situation (Slater 2005).
Since every chronic pain signifies eventually stress for the organism, it is clear that well functioning inter-correlations between brain respectively nervous system on one hand, and organ system on the other hand are indispensable for all repair functions. *Barral* (2004) describes that also visceral manipulations about an increased serotonin synthesis in the peripheral tissues can result in a stimulation of cerebral activity (see chapter 5.4.1 Significance of Visceral Techniques).

2.4.3 Interaction Brain – Immune System – Psyche

The reciprocal connections between VNS and the immune system signify that immune cells are able to respond to the VNS via cytokines. The brain replies with chemical signals, which curb the immune system. The immune reaction serves the preservation of the homeostasis, in identifying and destroying foreign substances, and facilitating healing processes of the tissues. At the same time the stress reaction of the brain is activated too (Slater 2005).

Only recently one has found sampling sites in peripheral nerve endings. Visceral nerve endings, which draw sample from the blood, were discovered in the liver. Then this information arrives over the n.vagus into the CNS. The liver scans the blood and lymph for toxins and inflammation mediators, and transmits the results to the brain, especially to the limbic system (Wattkins et al 1995; cited after Gifford 2005).

Here we have come full circle and it becomes clear that damaging influences to the body are processed in a way, which dictates necessary behavior reactions and emotions.

Especially in chronic pain, when one and the same information reaches the brain repeatedly, further behavior is facilitated accordingly. The next chapter deals with this issue more specifically.

3 CHRONIC PAIN

Several times it was already pointed to the importance of the VNS in connection to the treatment of pain. Dealing with the issue of pain extensively would go beyond the scope of this work. But I would still like to mention significant aspects, which are, according to my opinion necessary for a better understanding, mainly also in view of subsequent study interpretations of this work, particularly as the test subjects are chronic pain patients.
Medicine differs between two “variants” of pain:

Biologic adaptive pain: here an existing damaging agent is one reason

Mal-adaptive pain: here an adequate trauma is missing, and the ailments remain beyond the healing process.

At the daily practice we are dealing mainly with patients, who suffer of mal-adaptive pains, that is to say, symptoms correlate only to some extent with the defined pathologic findings. The participants of the study at hand belong exactly to this last mentioned group. Recently therapeutics and physicians try to do justice to these demands, and have improved and matured their abilities regarding diagnostics and analysis to a large degree. Nevertheless, diagnostic remains often purely centered on the tissue only. From this the necessity of an extension of our view occurs, in order to understand the complexity of biologic systems and those of the human organism.
Still wrote: “The horizons we see in every moment depend on the place where we stand, and from the direction we are looking, and the number of possible horizons is infinite. But the only horizon which opens up is the one we are moving towards, and this also only as long as we move towards it” (WSO-Folder 2006).

New literature proves again and again that the psycho social factors have a much greater influence on the development of a chronicity, respectively a successful treatment, than physical factors (Waddell 2004; cited after Gifford 2005). It is generally known that for instance an ankle joint injury or lumbar back pain does not only activate peripheral nociceptors, but that the conveyance of this information goes to the CNS too. There, these inputs meet again with individual relevant memories, which subsequently results in an individually attuned answer for the concerned person.

3.1 Neurophysiologic Foundations

Basically one can assume that pain, respectively discomfort always produces stress, and therefore releases diverse mechanisms in our organism. The control of the nociceptors and the endogenous analgesia is connected with the stress reactions of the brain. Latest researches suggest that there are no special individual pain routes, but rather a *"nociceptive matrix"* (Peyron et al 2003; cited after Gifford 2005).

But one of the centers of specific interest for the endogenous pain control is the Peri-aqueductal Gray (PAG). The Central Gray includes the region of the midbrain, which surrounds the aqueduct, and corresponds to the important integration place for fear-induced behavior changes. The irritation of the PAG initiates on one hand the feeling of fear, and leads to vegetative reactions and analgesia on the other hand. The significance of the PAG lies probably in the suppression of pain sensation in extremely dangerous anxiety and stress situations (Beck 2002).Within the PAG there are two areas, which impart different forms of the endogenous analgesia:

- Dorsal System (dPAG), non-opioid analgesia
- Ventral System (vPAG) opioid analgesia

Results of precedent studies (Wright and Vicenzino 1995) prove that spinal manual techniques (SMT) are an adequate impulse to activate the dPAG, which procures a sympathetic excitation, and leads therefore to an immediate pain relieving effect. The authors are stating further that after 20 – 45 minutes a vPAG-induced analgesia occurs, which in turn is accompanied by a sympathetic repression. Here it suggests itself that this effect is also influenced by osteopathic interventions.

I will deal with this matter specifically in chapter 5.4 Therapeutic Connections. By stress decrease the effect of the vPAG prevails, which leads to a repression of the sympathetic nervous system. These physiologic changes support the healing attitude and a decline of the heart minute volume and respiratory frequency. The theory of a decreased sympathetic activity in connection with healing processes, following the acute phase, presents at the time only an explanation model. But it is not known exactly which neural vegetative activity exists in disorders in the individual case. Manifested are only clinical observations, which show a certain frequency (Waltl 2003).

3.2 The Significance of Stress in Chronic Pain

Stress can abate pain until the physical danger is over, or also increase, because pain itself is seen as menace.
Clinical, that is to say, the less attention is put to pain, the better it can be controlled. Therefore we cannot see the personality of the patient separated from the therapeutic effects of our interventions. According to this there is no effective therapy without placebo effect.

I believe, stress in present modern cultures differs a lot from the stress of our ancestors. Today stress is mostly long standing and not life threatening, but difficult to fight.

In modern medical science there is the term "**Stress Biology".** This deals with the physiologic mechanisms and behavior strategies, which enable the organism to survive, as well as the maintenance of the homeostasis, and explains the attitude in chronic pain. Pain is a perception quality like seeing colors, whose neuronal correlations exist in the brain/CNS (Edelmann 1992; cited after Gifford 2005). Another component of pain processing is the local value of the **psycho-social structures**, where every single person is embedded. The significance of this influence factor can not be dismissed anymore from mature medicine.
A multitude of research results show that under chronic patho-physiologic stress-conditions the answer of the brain can be wrongly regulated. *Sternberg and Gold* (1997 after Slater 2001) described that emotional disturbances or diseases with state of agitations

can occur as a result. This is a common clinical pattern in the treatment of patients with chronic pain conditions

3.3 Pain Processing

I would like to mention only few aspects of pain processing, making it easier to follow my considerations. I omit consciously chemical reaction patterns and processes and concentrate on the issue *chronic pain.* When we want to understand how far our treatment influences the VNS, and to which extent we thus can contribute to the healing process of our patients, because this is finally the aim of our endeavors, then we may not negate the nature of our biology. We have to look at the processing techniques in a larger context, which the organism uses for the healing.

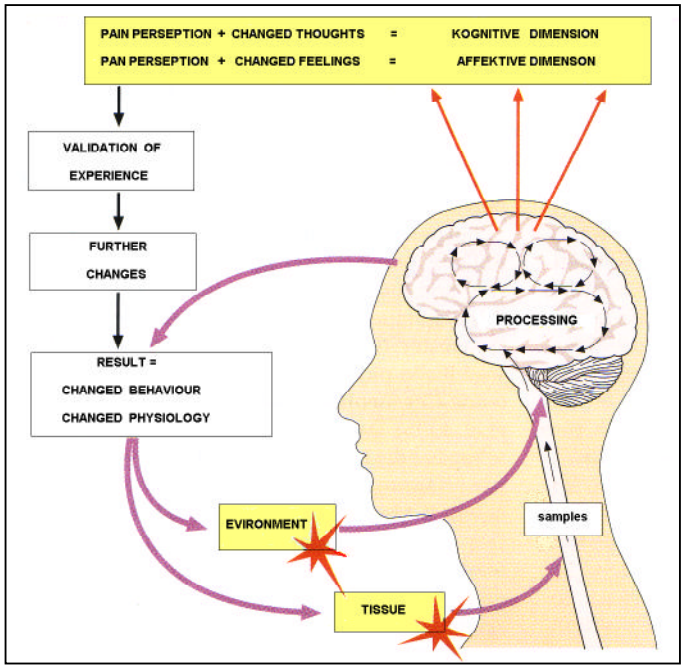


Fig.4 Model of the mature organism by injury
(Gifford 2005, modified after Fuerpass 2006)

According to this, pain processing does not happen linearly. If we consider that every stimulation includes a processing and efference of the brain, the circularity becomes clearly visible. In pain conditions the SNS is stronger activated than in normal circumstances. This happens mainly, because pain is seen as a threat to the organism. Here it is important to emphasize that not the SNS intensifies the pain perception directly, but that mental factors

are decisive what the individual classifies as threatening, what scares him and what causes him stress. The sympathetic activity is therefore closely connected with the thoughts and emotions of a person (Gifford 2005).

A pathologic changed activity of the VNS (hyper activity or suppression) will always have effects on the immunologic neuro-endocrine system. The general health, healing courses, as well as the metabolism and the blood circulation of the tissues can be influenced negatively.

The previous chapters have shown how complex the processes and behavior reactions of the organism are. The presented insights outline only a small segment of the entire matter, the real extent would go beyond the scope of this work.

4 HEART RATE VARIABILITY – HRV

1965 the first time in medicine it was reported about fluctuations of the heart period continuity in connection with fetal stress. *Hon/Lee* (1965, cited after Hottenrott 2002) ascertained that by stress exposure on the fetus in the mother's womb the variation of successive heart periods declines.

During the past years the application fields expanded beyond the clinic-diagnostic area, which among others can be proved on the basis of the exponential increase of HRV publications in scientific professional journals.

These studies show that the HRV is a characteristic of the adaptability of the human organism to endogenous and exogenous stimulations. Contrary to the assumption that a stable, thus a regular beating heart tolerates stress easily, a complex variability of the heartbeat proves as an indicator for a healthy and long living heart (Moser 2004).

Our heart keeps constantly the balance between beating too fast and beating too slow – stability is eased by vibration (Moser 1999). This vibration of the heart frequency is called **Heart Rate Variability (HRV).** Without these light rhythmic irregularities, the physiologic regulation systems could get out of control.

4.1 Physiologic Foundations

The electric stimulation on the heart starts from the sinus node (primary excitation formation center), and extends over the atrium muscular system to the atrio-ventricular node. From there the excitation is relayed via a special conduction system, the His‘bands, the leg of av-bundles and the Purkinje’s fibers, in order to stimulate the ventricular myocardium. But basically every myocardium is able to form stimulations autonomously. Since the sinus node has the highest discharge frequency normally, it is taking over the pace maker-function of the heart. The electrocardiogram (ECG) displays the summation of the total stimulation conditions of the heart in their chronological sequence. The naming of the waves, tines and lines, which are displayed in the ECG, happens alphabetically PQRST). The P-wave shows the stimulation dispersal over the atriums, the QRS-complex represents the stimulation dispersal over the ventricles, whereas the R-tine emerges mostly dominant. The re-polarization of the ventricles reflects itself in the T-wave.

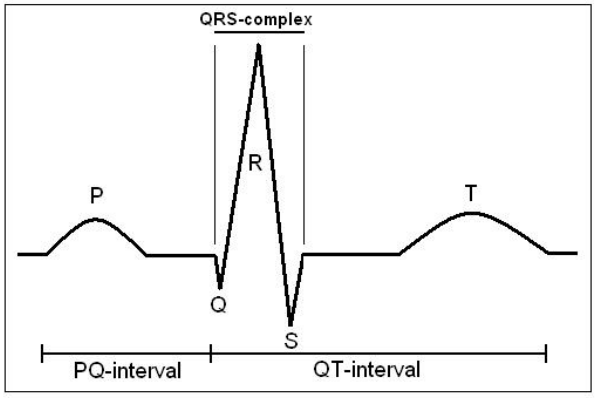


Fig.5 Schematic illustration of the ECG
(HeartBalance 2006)

The R-tine is used to define the duration of the RR-intervals (in fact the heart rate). ECG recordings in resting phases or during sleep show the natural variation of the RR-intervals; this means for instance, that at a repose heart rate of 60 beats/minute not every beat happens exactly after one second, respectively 1000 milliseconds. These variations of the heartbeat sequence are in healthy persons a normal adjustment reaction of the heart to inner and outer exposures and demands. At a corresponding high bodily or mental pressure the variability of the heartbeat is hardly found, it resembles rather a machine pulse.

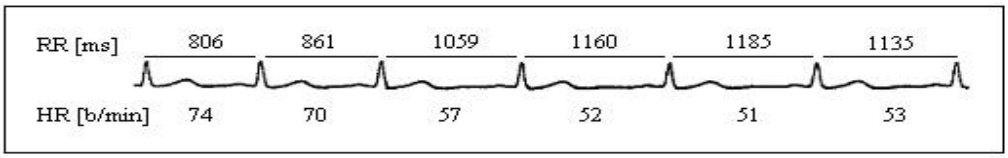


Fig.6 ECG in resting position over six RR-intervals with indication of the heart period duration and heart rate (heart balance).

4.2 Modulators of the Heart Rate Variability

Examinations of the vegetative innervations of the heart show most different combinations at the activity level of sympathicus and para-sympathicus. The Heart Math Research Center in California (Task Force of European Society of Cardiology and the North American Society of Pacing and Electrophysiology 1996), an enterprise which deals with the objectifying of vegetative functions, names the following interaction levels:

- High para-sympathicus/low sympathicus
- High para-synpathicus/normal sympathicus
- High para-sympathicus and sympathicus
- High sympathicus/norma para-sympathicus
- High sympathicus/low para-sympathicus
- Normal sympathicus/low para-sympathicus
- Low sympathicus and para-sympathicus
- Low sympathicus/normal para-sympathicus

These findings were gained by measuring the heart rate variability, and prove the multitude of possibilities, which are at our organism's disposal.

The heart reacts continuously to the signals of the organism and the environment with finely tuned variations of the heart period duration. This adjustment ability is based on an optimal cooperation of the sympathetic and para-sympathetic nervous system. Heart and VNS are embedded in regulatory circuits, and therefore part of a complete network, whose components are in constant interrelation to each other. The repressing vagal high frequent electric impulses of the para-sympathicus are leading to a very fast dropping of the heart

rate. The low-frequent impulses of the sympthicus cause an increase of the heart rate, but need more time for it. Short time HRV fluctuations are activated primary by the variation of the vagotony. The full sympathicus stimulation starts only after 20 – 30 heart beats, the vagus stimulation shows the effects considerably quicker.

The strength of the sympathetic and para-sympathetic stimulations results from different physiologic systems, which form a complex network and are in interrelation with the VNS.

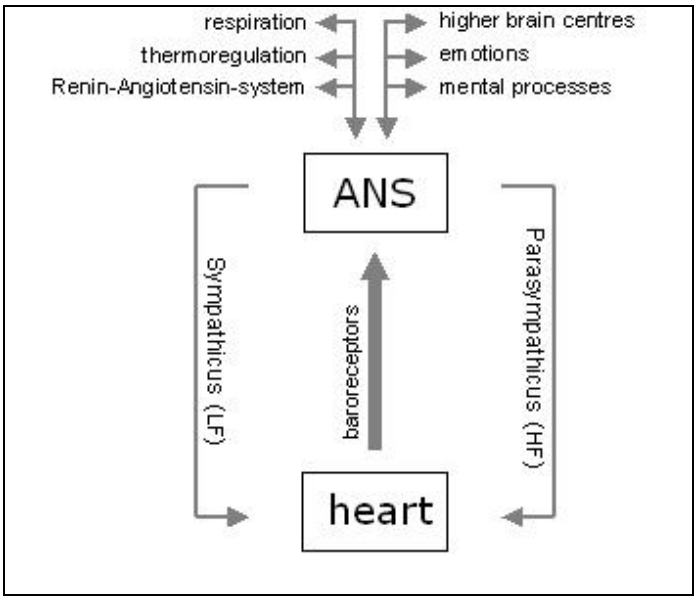


Fig.7 Modulators of the HRV (HeartBalance 2006)

Baroreceptors, which are mainly in the aortic arch in the carotid sinus, react to arterial pressure fluctuations, which influence the VNS. The afferent impulses of the baroreceptors cause a repression of sympathetic structures, and a strengthened stimulation of the para-sympathetic structures.

The **respiration** is exercising direct influence on the HRV, at breathing-in the HR rises, at breathing-out it drops. The influence of the respiration on the HRV is called respiratory sinus arrhythmia (RSA).

Also the **Renin-Angiotensin System**, which is responsible for the volume regulation of the extra-cellular fluid, as well as the thermo regulation, is influencing the HRV.

But the VNS is also influenced by higher brain centers and **mental processes.** Conscious relaxation, concentration or stress, are forming the HRV in a characteristic way.

Besides, the VNS is also influenced by other factors, such as age, gender, the circadian rhythm, the training condition and health conditions (Moser et al.1999)

On examination of the different influence factors on the HRV it becomes obvious that the human organism **is not** a simple linear system, but that we are dealing with complex cybernetic regulatory circuits. In chapter 5 (Bio Cybernetics) the coherences will be outlined in more detail.

4.3 Diagnostic Parameters of the HRV and its Presentation

In order to describe the activity (the tonus) of the individual branches of the VNS, different analysis processes are applied. At all processes the R-tine from the ECG is detected. Error signals and extra systoles are eliminated before further analysis. The individual frequency bands, which are actually part of the auto-chronic picture (chapter 4.4) are, due to more clarity, already illustrated here.

4.3.1 Parameters of the Period Analysis

Heart Rate

HR (heart rate): The heart rate is calculated from the recorded RR-intervals (beats per minute).

$$HR = \frac{60.000}{RR[ms]}$$

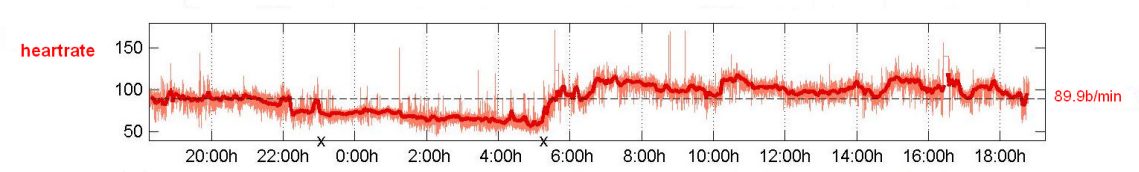


Fig.8 Illustration of the heart rate in autochronic picture

The strain during the working day leads to a considerably higher heart rate, in comparison to the evening leisure time, respectively night sleep.

SDNN / log RSA

SDNN (standard deviation of normal-to-normal intervals): The standard deviation of the mean values of all RR-intervals for 5-minute-segments is a measure for the total variability. Rhythms with a frequency of less than 0,0033 Hz (period duration: 300 secs) are suppressed thereby.

$$SD = \sqrt{\sum_{i=1}^{N} \frac{(RR_i - \overline{RR})^2}{N-1}}$$

logRSA: The median of the absolute differences of consecutive RR-intervals, measures the quick changes caused by the respiration, but without drawing a limit at a certain frequency (Lehofer et al. 1997). The respiratory sinus arrhythmia (RSA) reflects consequently the strength of the modulation of the heart rhythm by respiration, and is a measure for the tonus of the vagus activity.

$$RSA = Median(|RR_i - RR_{i-1}|)$$

To reach a normal distribution of the inter-individual values, these are subjected to a logarithmic transformation.

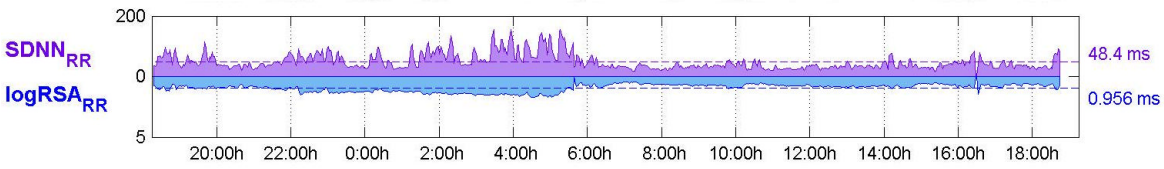


Fig.9 Illustration of the SDNN and LogRSA in autochronic picture

SDNN as a measure for the entire variability of the heartbeat is presented in the color lilac. The respiratory sinus arrhythmia, logRSA, is presented in blue and folded downward. In this example a distinct increase shows in both period parameters during night.

Pulse-Respiration-Quotient

The pulse-respiration-quotient (QPA) registers how often the heart is beating during one breath. During night and in relaxation (trophotropic conditions) a whole-numbered proportion of 4:1 (frequency coordination) is taking place, independent of the quotient under ergotropic conditions in daytime (Hildebrandt et al. 1998).

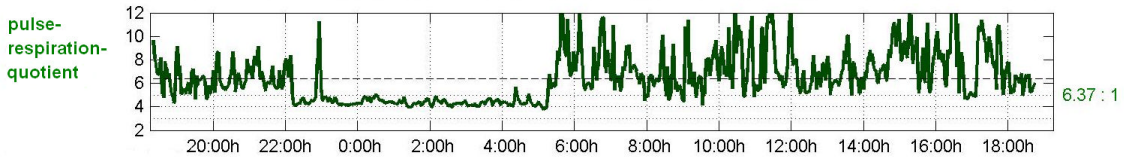


Fig.10 Illustration of the QPA in autochronic picture

The pulse-respiration-quotient is only interpreted during night sleep, respectively during the relaxation phases in daytime, since a reliable registration of the respiration can only be guaranteed during these phases (Bettermann 1996).

4.3.2 Parameters of the Frequency Analysis

Via mathematic frequency analysis processes, additional parameters of the HRV can be gained. The entire time series of the RR-intervals is divided into 5-minute segments and subjected to a Fourier transformation. Thereby the frequency fields, which are contained in the time series are computed, and illustrated with the aid of power spectral densities. A comparable procedure is the spectral splitting of the white light with the aid of a glass prism in the colors of the rainbow.

lnTOT, lnHF, lnLF

TOT (total frequency): This area corresponds to the performance in the frequency region of 0.0033 – 0.4 Hz (periodic duration of 300 – 2.5 seconds).

HF (high frequency): The HF area comprises frequency fluctuations of 0.15 – 0.4 Hz (periodic duration of 7 – 2.5 seconds). The performance in the HF-band corresponds to the activity of the para-sympathetic nervous system, and mirrors mainly heart frequency variations, which are attributed to the respiration.

LF (low frequency): The LF-Band comprises the frequency region of 0.04 – 0.15 Hz (periodic duration between 24 – 7 seconds). The performance in this field is influenced by the sympathicus as well as the para-sympathicus. This region was previously also called baroreceptor region (blood pressure rhythmic), as the activity of this receptor is shown here.

VLF (very low frequency): The VLF-Band corresponds to the performance in the frequency field of 0.0033 – 0.04 Hz (periodic duration between 300 – 24 seconds). This frequency band is subjected mainly to influences of the sympathetic nervous system, whereby a clear physiologic relevance in literature was not yet defined.

The power densities of all bands are recorded in natural logarithm, in order to guarantee the normal distribution of the values.

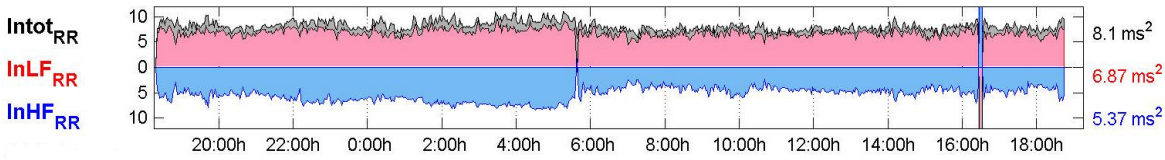


Fig.11 Illustration of the frequency fields TOT, LF, HF in autochronic picture

In Fig.11 the frequency bands are presented TOT (grey), LF (pink) and HF (blue). Because of the better overall view the HF-Bands are folded downward. The quoted values on the right edge of the diagram are mean values during the total measuring duration. Corresponding to the above shown spectrogram, the spectral density of all frequency fields is significantly higher in the evening, respectively at night, than in daytime.

Vegetative Quotient

The quotient from LF and HF (VQ) shows the momentary vegetative activation level of the organism, and is presently the best available measure of the “autonomous balance”. High values represent an active, service-oriented attitude of the organism, low values point to a relaxation-oriented attitude.

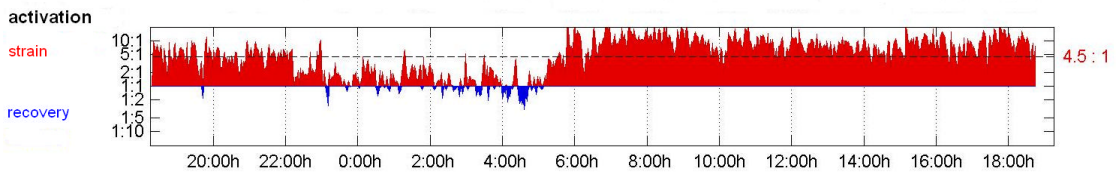


Fig.12 Illustration of the VQ in autochronic picture

The vegetative quotient is also described as sympatho-vagal balance. A prevailing of the sympathicus activity (stress) is represented red. A prevailing para-sympathetic activity (relaxation) is represented blue, folded downward.
The recorded example shows a high VQ over the day, but during night it is dropping significantly. A prevailing of the para-sympathetic activity affects only shorter phases.

4.4 The AutoChronic Picture (ACP)

Autochronic picture: Greek: *auton* (self)
Chronos (time)

The Auto-Chronic picture is an illustration process, which makes results of the heart rate variability over 25 hours visible. Condition for a precise illustration is a measuring process, which measures the interval between the heartbeats much more precise than common ECG-appliances (for instance HeartMan, see 6.2).

The auto-chronic picture shows also the spectrogram and the activity protocol besides the represented bands InTOT, InLF, InHF, VQ, SDNN, logRSA, HR and QPO, in chapter 4.3.

Spectrogram

In the spectrogram, the complex information contained in the HR, is represented in a visually easy understandable way. Thereby the signal is displayed in three dimensions (abscissa = time; ordinates = frequency; color = amplitude)

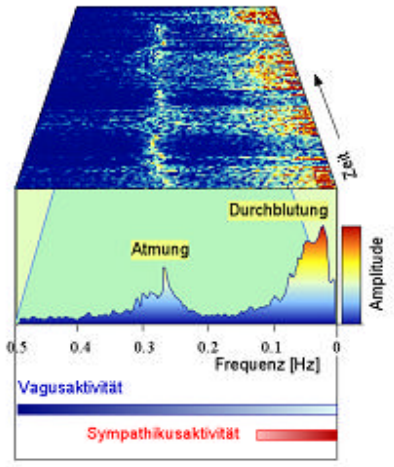


Fig.13 Spectrogram (Moser 2004)

Every line is the result of a frequency analysis of a segment of a periodic series. The amplitude of the signal is programmed thereby in color. Low amplitudes are represented blue, higher ones white, and very high ones red. The picture is composed line by line, and results in a time dependent illustration of all rhythms contained in the heartbeat sequence (Moser 2004).

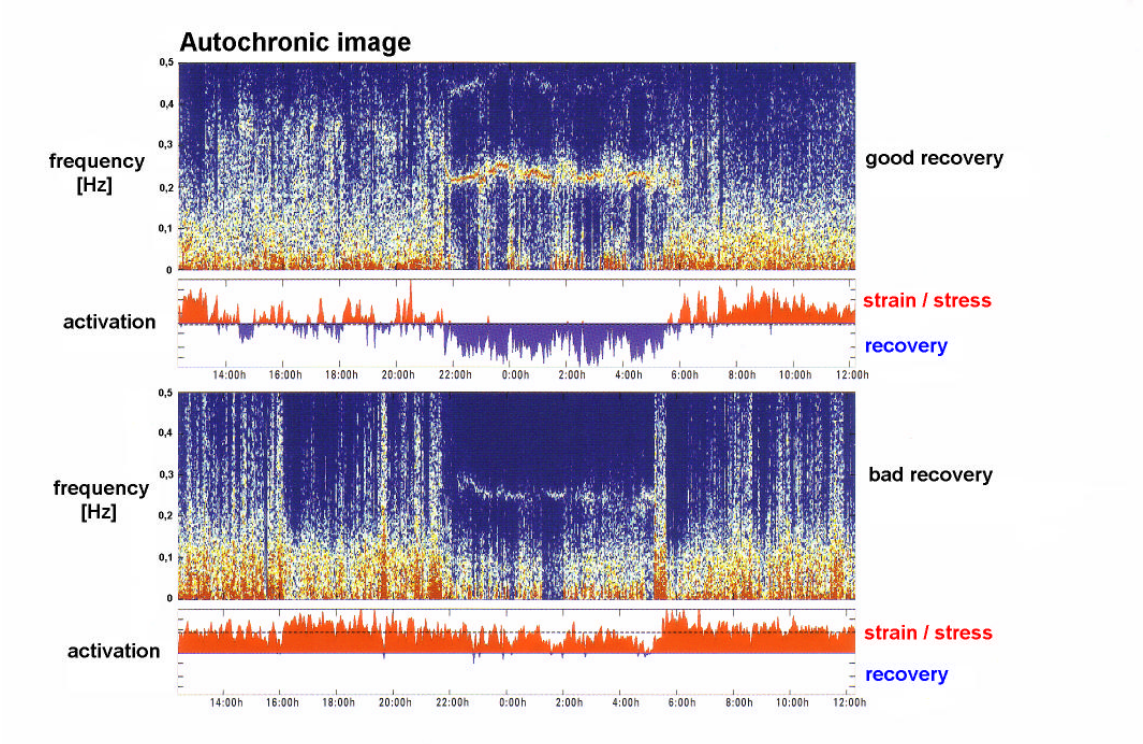


Fig.14 Display of two spectrograms (HeartBalance 2003, modified after Fürpaß 2006)

Diagram 14 shows two spectrograms of different vegetative status. The colorfulness in both displays suggests that very young test persons are involved. In the majority of cases such a strong colorfulness occurs proximately only until the 20th year of one's life. One sees the considerably higher proportion of the para-Sympathicus (blue) on the frequency band under the above spectrogram. This is also reflected in the higher variability in the HF field, whereas the lower spectrogram shows more activity in the LF-field, which is accredited to the sympathetic activity. In the case of "a good recovery" it is also evident that the sleeping cycles (NREM- and REM phases) are becoming more visible. In addition, during the night sleep a distinctive RSA occurs, which suggests restful sleep.

The Activity Protocol

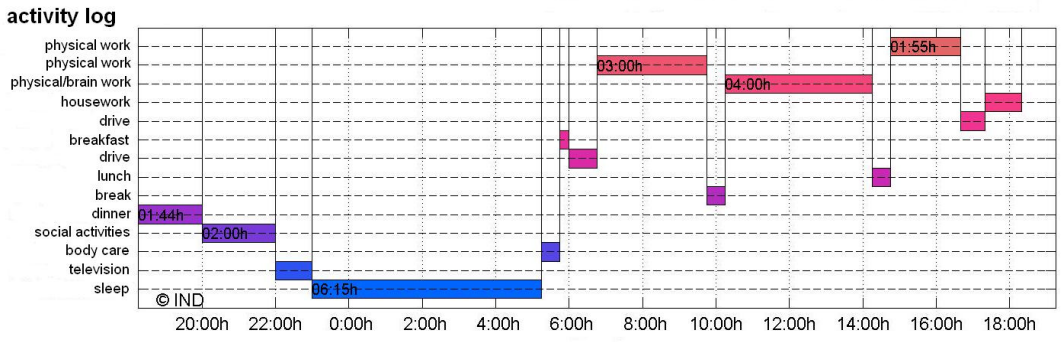


Fig.15 Illustration of the activity protocol in autochronic picture

A precisely recorded activity protocol enables an exact interpretation of the results. The individual activities are displayed according to the level of the mean heart rate and additionally encoded in color.

5 BIOCYBERNETIC CONNECTIONS

The previous chapters have already proved that the organism, due to its anatomic and physiologic conceptions, constitutes a functional network. Only the collaboration of all systems leads to recovery and health. The possibilities at the organism's disposal are manifold. Time and again we have to prove, why a special effect turns up, or why it doesn't. At complex systems, such as the human organism, it is often difficult to find simple replies.

Nature teaches us that there is no second identical result (in any form) – and there lies also the problem of the reproduction (Emoto 2003).
For this very reason I feel the need to grant this issue a certain place in my work, and also to show the problem of scientific working in osteopathy. With this I do not want to excuse my inability, but to present, to some extent, connections, which due to my opinion should not be disregarded.
In many biologic disciplines system-oriented thinking is granted a lot of space. In order to understand the effective mechanisms in osteopathy better it is exceedingly helpful to use thinking models from the system theory. Clever people before and after *Dr. Still* have already philosophized about this matter. In my case the texts of *Heinz von Forster* confronted me for the first time with this theme, and are holding me captive since.

5.1 The Smallest Cybernetic Unit

Every biologic system, starting from the unicellular organism up to the human organism, depends on information and energy exchange with its environment, and is therefore to be evaluated as an **open system**. This is characterized by the set-up from sub systems, whereby the system, holistically seen, is more than the sum of its parts. This “more of the whole” is conditioned by the functional-regulatory networking of the sub systems in connection with their ability to auto regulation. But the latter determines also that there are no absolute lesion chains, but of course often very distinct ones. It corresponds to the human desire to concentrate on a single causality, but it does not correspond to the functionality of biologic systems – one can only talk of frequency (Bergmann 1993).

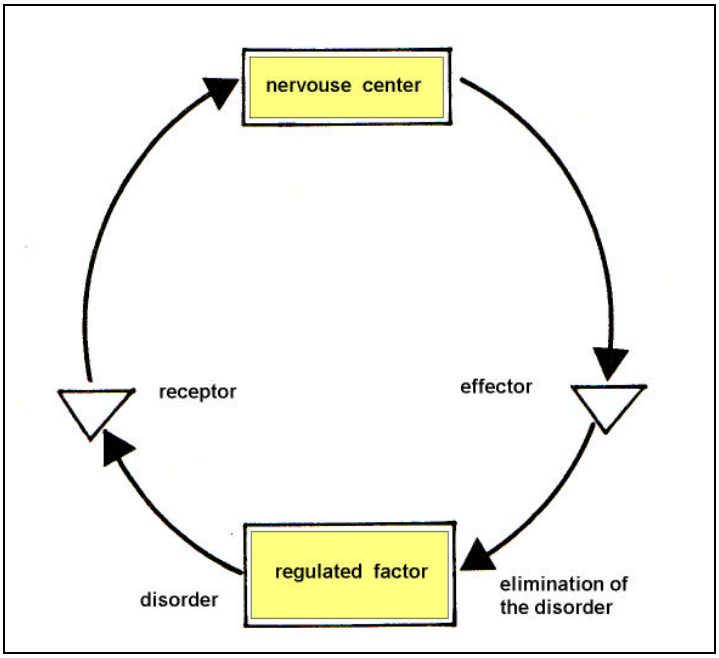


Fig.16 The regulatory circuit (Bergsmann 1993, modified after Fürpaß 2006)

The illustration of diagram 16 serves only as a thought model for the basic description of the regulation mechanisms. In medical clinics we will never find the function of an isolated regulatory circuit, but certainly sub systems, which can be observed very well. Important is that the entire system reacts to the same principles. In this case the circle construction is not necessary, only the circle function (Bergsmann 1993).

Back to the question in the introduction, here it is obvious that our osteopathic interventions, adequately applied, always influence the entire system. But the effectiveness depends on a consistent anamnestic approach, together with careful therapeutic work, and last but not least on exogenic influences, to which our patients are subjected.

The target of biologic systems is to always preserve the homeostasis of the regulatory circuit, respectively to correct one by dysfunction triggered derivation with least loss of energy. Latter also matches the optimal coverage with least energy loss, therefore a principle of economy.

The underlying circular reflector is not a one-way-system, but presents a network, whose outmost part is the symptom. Special importance belongs to the chronic syndromes, whereby bio-cybernetic considerations are always advisable (Bergsmann 1993).

Adaptation Model after Bergsmann

(Bergsmann 1993)

The human organism adapts itself constantly to inner and outer influences. So a **chronic irritation** always means a long term strain, which is accompanied by a change of the initial value. Therefore, every additional irritation in this strained tissue will find other conditions as in the non-strained area. This explains many continuous forms and distinctive features of the reaction of chronic ill persons. This also shows the difficulty to assign a certain effect to a particular intervention.

5.2 The Principle of Open Biologic Systems

A system and its function can only be understood and described, if the functions of the subsystems, which participate in its composition, are known. But since it is never possible to verify all influence factors, all our problem evaluations always remain just models, coming closer to the truth. But this should not disaffect us it only shows us that the human being is not trivial. After *Heinz von Foerster* (2001, p 55) „... is the human being a "possibility being", whose reactions and ways of behavior are principally unforeseeable…". But this assumption of unpredictability contradicts the ordinary observation at the daily therapeutic practice. *Heinz von Foerster* calls the just described, the principle of the organizational closure.

Principle of the Organizational Closure

(Foerster 2001)

When a biologic organism (human being) has produced something as an output, and then re-uses it as an input, then a circular figure develops. If this circularity remains some time, stable values are forming.

A positive therapeutic intervention changes therefore the initial position of the organism. The effect of the treatment, for instance reduced pain, thus the output of our intervention, is used again as input, as a new assumption. This way we can adopt assumptions, but their coming into being can not be explained clearly.

Herein consists the problematic of clear cause – effect – statements, to which science partially tries to force us.

This shows that a standardized treatment will never really lead to the goal, but it is absolutely useful for private studies. Now, after conclusion of the practical part of my work I know, for making a statistically valid statement it had been more sensible to examine only the effect of single techniques, and not an entire individual osteopathic treatment. Then the measurement of variation would have been less.

But it corresponds however to the osteopathic approach not to infer from a symptom or effect produced by the organism principally to the same cause. Important is to respect the individuality of the system and to meet a therapeutic decision in every individual case. This is a course of action, which proves itself in practical work, but is less suitable in statistic review.

5.3 Biocybernetic Science Model

The bio-cybernetic science model describes that linear-causal thinking is always successful, where simple cause and effect mechanisms are concerned. But bio-systems are complex cybernetic regulation mechanisms, where no one-way streets exist. The prevailing number of patients at an average osteopathy practice shows functional disturbances, and sometimes even a malfunction of bio-cybernetic regulatory circuits. If sufficient biologic energy is available, regulation therapies, as osteopathy too, are leading to the activation of self healing powers, and thus to the return of the distressed system into the autonomous regulatory circuits.

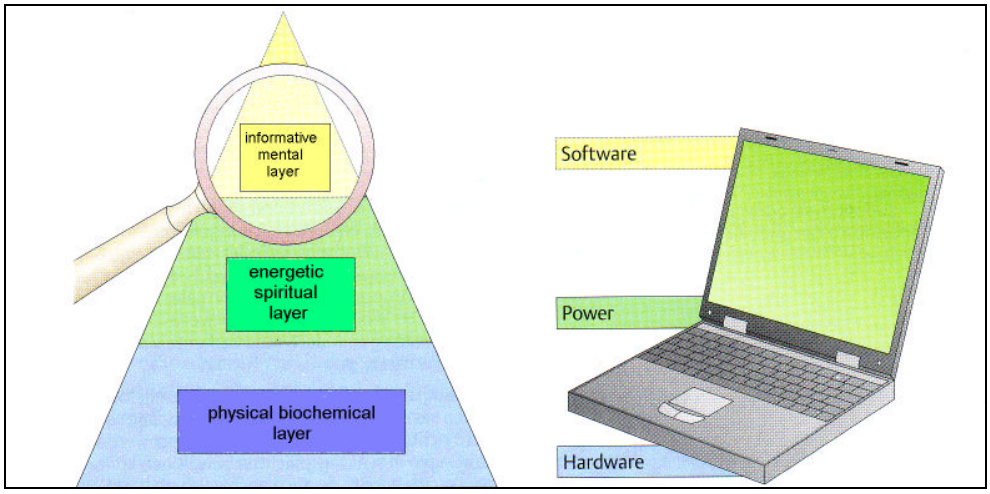


Fig.17 Model introduction – levels of the bio system (Oettmeier 2005, modified after Fürpaß 2006)

Here it is obvious that we can not limit ourselves on a purely physical-biochemical level, if we consider reality. The development of illness and also the recovery process are always passing all three levels, and the process starts often in the informative area (Oettmeier 2004). A multitude of biologic effective processes settles in this energetic effective area, and can often be made measurable and visible only indirectly. In this therapeutic grey zone, where no proofs due to present scientific measures can be brought forward, it's not always easy for an osteopath to meet the need for explanations. But *University Professor DI Gerhard Fasching* phrased it very aptly in an Austrian daily newspaper (Kleine Zeitung 2005): "If I can't catch fish in a net of 3 cm meshes, which are smaller, does that mean there are no smaller fish?"

Energy in the Bio System

The previously mentioned scientific model dealt with the existence of biologic energy. A frequent issue in osteopathy is energetic techniques that we induce an energetic balance, or with the aid of focused attention we are able to discharge energy cysts again. Here inevitably the question turns up, what actually is energy? Physics teaches us, energy can be neither produced nor destroyed, but it can change its form. From college we know energy is the capability to perform a service from matter or radiation. Concerning the bio system, energy is necessary to form and maintain matter, and further, matter is energy in a different form.

1984 the atom physicist Dr. Carlo Rubbia received the Novel Price for a mathematical computable natural constant, which shows the ratio of matter to energy: this formula says, in order to create 1 part of matter in visible, concrete form, approximately 1 billion more energy units are necessary (Oettmeier 2005).

Therefore that means science deals with the billionth part of reality, whereby we restrict our perception to a minimum of the reality. Time and again the therapeutic practice proves to me that especially in chronic resistant ailments, subtle techniques of the craniosacral therapy are the most effective. Therefore, there is a point in extending our perception and grant these techniques their justified place. *LAO-TSE*: “This is the rule: The material harbors usefulness, the immaterial imparts the true essence” (cited after Lauterwasser 2002).

5.4 Osteopathic Connections

During the treatment of my candidates I did not use a certain procedure, but intervened, corresponding to my anamnesis and diagnosis, as is the case in the practical osteopathic work. Our approach depends less on an analytic isolated consideration of the distressing symptoms, but on the question, under which conditions the organism maintains its order and integrity autonomously. Without the knowledge about the significance of health and healing, a therapist can contribute nothing to the healing of an illness.

For an easier understanding it is useful to comment on the mode of action of individual branches. In therapeutic daily life they are only a foundation for diagnostics and special applications. The individual therapy concepts of the osteopathy can not be separated functionally from each other. Following is an exemplary outline, how individual techniques can influence the VNS.

5.4.1 Significance of the Fascia

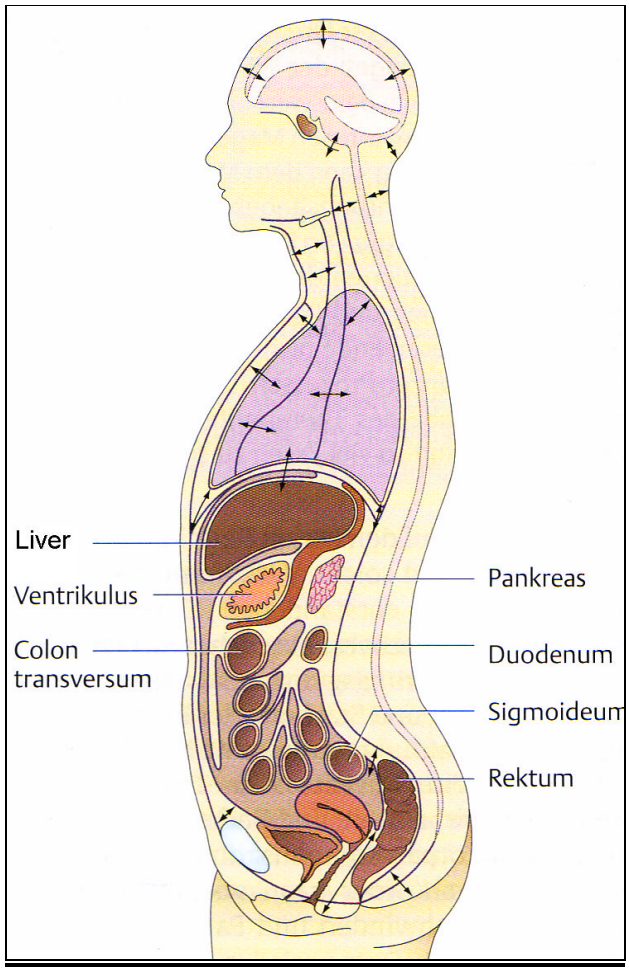


Fig.18 Schematic fascia illustration (Kwackman 2005, modified by Fürpaß 2006)

One of the most significant substrates, wherefrom all our techniques start is the tissue, especially all fasciae in the organism. The term "*the fascia*" is preferable here, because it is **an** organ, which spreads through the entire body in form of duplications.

Connective tissue consists of ground substance and tissue fibers. The ground system, due to *Pischinger* (cited after Bergsmann 1993) is to be seen as the primary information system of all oxygen-depending organisms. Ground system is the complex, consisting of organ cell, neuron and vascular system, whose all-embracing combination is the "soft connective tissue", which due to modern terminology is called matrix (Bergsmann 1993).

The common activity and information field of this triad is the ground substance, the extra-cellular matrix. It is the largest system, spread through the entire organism. Therefore, this "cell-milieu-system" is responsible for all basic functions of life (Oettmeier 2005).
Ultimately, within this milieu every information transmission takes place. *Eppinger* claims (cited after Paoletti 2001) that illness starts in the ground substance, and spreads from there into the parenchyma cells. Therein consists also the similarity of all injuries. Irritations at the connective tissue, thus in the area of the fasciae, can transmit disturbed information, and keep the regulation systems of the cells, tissue and nerves in a state of tension (Paoletti 2001). In the end, in all fields of osteopathy we work with fascial structures.
Here we have come full circle again and we osteopaths with our therapeutic possibilities can contribute to the improvement of the regulation.

5.4.2 Significance of Visceral Techniques

According to *Barral* (2002) the following rhythms have an affect on the viscera:

- Respiratory rhythm
- Cardiovascular rhythm
- Peristaltic

Inversely, a good functionality of the viscera harmonizes the above mentioned rhythms. For example, adhesions in visceral structures can result in constrictions on vessels which are leading to the heart. Therefore, as a result of heightened peripheral pressure an impairment of the venous reflux could occur, which again demands an increased pumping performance of the heart. An impaired motility of the diaphragm can again cause a reduced respiratory function.
Barral (2004) describes connections between visceral and musculo-scelettal, as well as mental disturbances. Due to that, chronic joint pains are often observed as an expression of liver function disturbances. It is also known that liver diseases can lead to depressions and fatigue syndromes. The Chinese medicine knows these inter-correlations already since long (Stux 2003).

The significance of stress in chronic pain syndromes was already sufficiently indicated. In this connection it is to note that the release of serotonin as neurotransmitter inhibits the arousal system, which is leading to a normalization of the situation (Ulmer 1995).

Due to latest scientific knowledge, part of the serotonin synthesis possibly happens in the gastrointestinal tract, thus in that tissue, where it is also detected. An increased serotonin synthesis leads to the stimulation of cerebral activity, as well as to the relaxation of the vascular muscles in the gastrointestinal tract, and in the respiratory system. Visceral manipulations heighten the metabolic turnover of the tissues, which again stimulates the metabolism of the entire organism via an increased serotonin synthesis. This is possibly also an explanation for the therapeutic success in migraine by visceral therapy (Barral 2002).

According to *Chapman* (2004) vegetative stress symptoms very often cause a deterioration of the trophic of those metabolic organs, which serve the regeneration and the build-up. There are, among others thymus, spleen, liver, pancreas, thyroid and adrenal gland. Thus it appears that by the treatment of corresponding Chapman-points the functional dysregulations can be influenced.

5.4.3 Significance of Cranial Techniques

Starting point for diagnosis and therapy in the cranio-sacral therapy (CST) is the cranio-sacral rhythm (CSR), which constitutes an independent body rhythm, just as the heartbeat and the respiration. The frequency of this undulation lies between 6 – 14 beats/min. It is interesting that already in the 1930's the psychologist *Rohracher* has proven a constant, strong stochastic superimposed, mechanic 7-12 hertz undulation of the human body, which he referred to as micro undulation (Moser 1999).
Hildebrandt et al (1998) shows the importance of body rhythmic for a healthy organism. Also in osteopathy, especially in the cranio-sacral therapy, one deals with rhythms. Maybe an osteopathic treatment leads to a strengthening, respectively harmonization of longer rhythms, such as the sleep-wake rhythm, by harmonizing shorter rhythms like the cranio-

sacral rhythm. *Moser* (2004) defined similar effects at a study, concerning the effectiveness of eurhythmia on the human organism.

The cranio-sacral system (CSS) is in a very close mutual relation with the following systems (Liem 1998):

Nervous system
Neuro-vegetative System
Muscle fasciae skeletal system
Arteriovenous System
Lymphatic System
Respiratory System
Endocrinic System
Immune System
Visceral System

The CSS poses an inner milieu between these systems, which coordinates all activities. In accordance with other authors (Liem 1998, Upledeger 1994, Becker 2001) my personal practice experience has proven that the CV-4 technique (treatment method of the 4th ventricle) offers a good support at the treatment of chronic pains. Due to Upledeger this technique can produce a hypotony of the sympathetic nervous system.

5.4.3 Significance of Structural Techniques

The first diagnostic criterion in osteopathy is the assessment of the mobility, whose impairment can cause an osteopathic lesion. *Still* observed 1874 that for instance a poor mobility of the osseous thorax structure can cause an impairment of the lung function (Ligner and Van Asche 1993). Of special significance are the foramina vertebralia. Even least structural or functional changes can influence the issuing nerves and vessels. If there is a vertebra in lesion, a permanent nervous hyperexcitability consists, which on the one hand causes the persistence of the lesion, and in case of continuity can also lead to long term effects. Again, no clear parting line can be drawn between the individual organs, but rather one causes the other.

Clinical observations have proved that patients with indications of a vegetative component can achieve pain palliation and a normalization of sympathetic epi-phenomena by manual treatment of the thoracolumbar region. Chiropractic manipulations of the vertebral joints in the Th1-L3 area causes a decline of the skin temperature in the finger area, corresponding to a sympathicus increase (on base of the pre-ganglionic origin in the intermediary zone of the spinal cord-segments Th1-L3). Manipulation in the area C1-C7 and L4-L5 lead to an increase of the skin temperature and infer to a repression of the sympathicus (Harris and Wagnon 1987, cited after Waltl 2003).

II EMPIRIC PART

6 METHODIC

6.1 Test Persons

Test subjects of the age 37,25 ± 8,65 were chosen for the study. The group consisted of 6 women and 6 men.

Inclusion criteria: Disorders in the area of the mobility apparatus since at least three months.

Elimination criteria: Cardiac disturbances, psycho-somatic diseases

List of Test Persons

	Female	Male	Ailment Duration	Pain Intensity at outset due to VAS
TP 1	48		4 years	4
TP 2		30	2 months	3
TP 3	29		4 months	6,5
TP 4		40	5 years	3
TP 5	35		10 years	5
TP 6	33		4 months	5
TP 7	48		3 months	6,5
TP 8		50	10 years	4
TP 9	35		4 months	3
TP 10		28	3 months	4
TP 11		26	3 months	3,5
TP 12		45	15 years	5

Table 1 List of Test Persons

6.2 Measuring Device

The measurements at the study at hand were carried out with the HeartMan. The **HeartMan 301 (**fig.19) is a long-term ECG device, developed by Heart Balance company in cooperation with the IND (Institute for Non-Invasive Diagnostics, Joanneum Research Weiz, under guidance of Prof. Dr. Maximilian Moser).

Fig. 19 HeartMan 301 (HeartBalance 2006)

The device enables a worldwide unique precise measuring of the HRV with a scanning rate up to 5.000/sec, that is to say, the measuring is to 0.2 ms exact. To give the HRV a concrete form for the practitioner, the IND developed a method, which submits a heartbeat series of 5 minute intervals to a frequency analysis. The resulting specters are converted into colors, and put together again to a picture (chapter 4.2, auto chronic picture). The HeartMan is a device of iPod size, which can be carried easily on the waistband, while three chest wall electrodes are taking care of the signal recording. The device is equipped with a memory card, the HeartMedia Card, which has a recording capacity of 48 hours. By a mark scanner the user can mark the time, and additionally protocol the day's activities, which are shedding light on the daily routine. These are synchronized with the body measuring, and facilitate the interpretation of the auto chronic picture.

6.3 Visual Analogue Scale – VAS

In addition to the parameters of the HRV an investigation of the pain intensity according to visual analogue scale was carried out. The test subjects quantified their pain level before the first treatment, and after the last treatment due to a provided 10-step intensity scale.

6.4 Study Design and Test Procedure

A “within subject design” was used in the study, where the test subjects acted as their own control group. At the beginning they were enlightened about the target of the study and also about the device.

1. Two 24 hour measurements as initial value, within maximum 2 weeks; quantification of the pain level after VAS
2. Subsequent intervention phase of six weeks, where the participants were each treated 4 times osteopathic
3. During the last treatment a 24 hour measurement was started again
4. Another final measuring the following week, after conclusion of the intervention phase

The measurements after the fourth treatment, as well as the final ones where then compared with the initial values.
The treatments took place in my practice, in a quiet and well tempered room. Before every treatment an osteopathic anamnesis was done, the therapy was individually adjusted to the ailment picture of the individual test subject. According to this it was a common practice-related treatment situation. Also during simultaneous measuring, the therapy was carried out similarly.

6.5 Statistic Methods

For the statistic preparation the mean values $\pm$ SEM were calculated. With the aid of the T-test the data were examined for possible significances. The significance level was fixed to $p<0,05$.
Connections between two variables were examined with a linear regression analysis.

7 RESULTS

The subsequent analyses were based on the following evaluation parameters:

HR	Heart rate
SDNN	Standard derivation of the RR-intervals
	= total variability of the heartbeat
LogRSA	Respiratory sinus arrhythmia (vagus activity)
VQ	Vegetative quotient
InLF	Activity of the low frequency field (sympathicus and vagus)
InHF	Activity of the high frequency field (vagus)
VAS	Pain evaluation due to visual analogue scale

7.1 Results of the immediate pictures

In the course of the second treatment a short measuring of each person was carried out, which is illustrated by the following recording. It shows the immediate osteopathic influence on the nervous system.

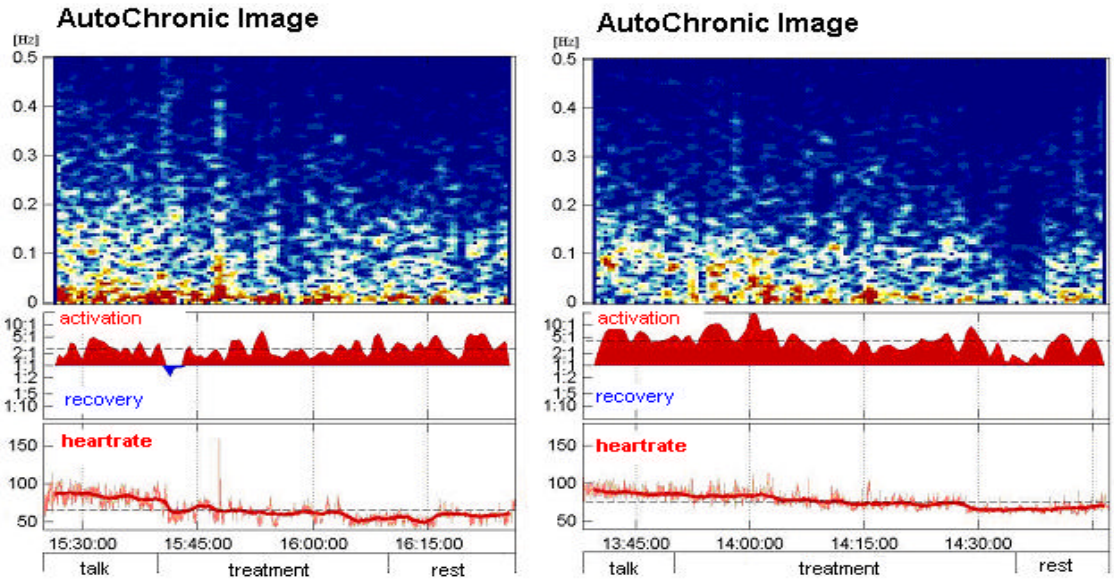


Fig. 20 Immediate Pictures

Fig. 20 shows that the heart rate drops distinctly during the treatment. The vegetative quotient (VQ) is therefore also falling. HRV is mainly to be attributed to the influences of

the VNS, especially those of the para-sympathetic portion. Due to this, at the predomination of para-sympathetic influences the HRV increases, and the HR drops. This proves that the osteopathic treatment causes a rise of the para-sympathetic activity, and suggests the conclusion that the increased sympathicus activity at chronic pain patients can be influenced positively. However, this depends on the initial condition of each test subject, respectively on his/her reaction ability

7.2 Comparison of the Mean Values of all Parameters before, respectively after the treatment

Table 2 Illustration of the mean values of all parameters ± SEM

	before	after	
HR (b/min)	70,42 ± 1,43	69,87 ± 1,79	n.s.
SDNN (ms)	80,49 ± 5,06	83,68 ± 7,46	n.s.
LogRSA (ms)	1,35 ± 0,04	1,38 ± 0,06	n.s.
VQ	3,12 ± 0,60	3,07 ± 0,66	n.s.
InLF (ms²)	7,65 ± 0,17	7,71 ± 0,19	n.s.
InHF (ms²)	6,67 ± 0,23	6,85 ± 0,29	n.s.
VAS (scale units)	4,38 ± 0,36	2,04 ± 0,32	p < 0,05

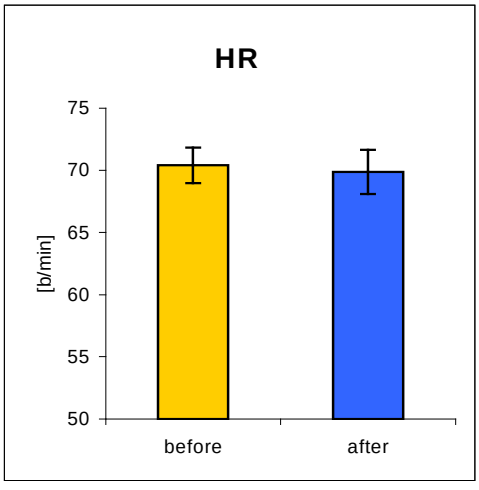


Fig. 21

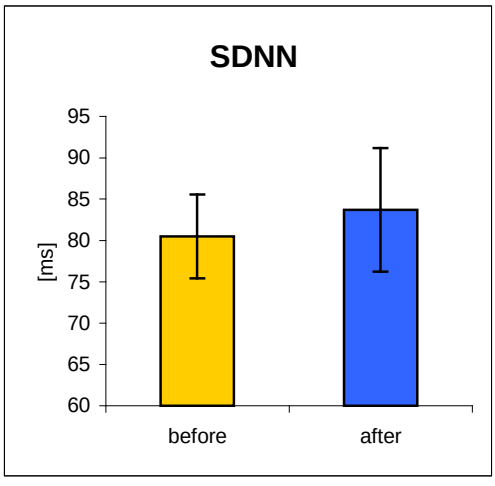


Fig. 22

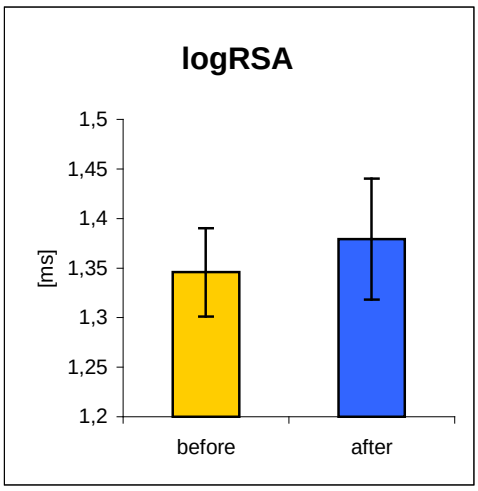


Fig. 23

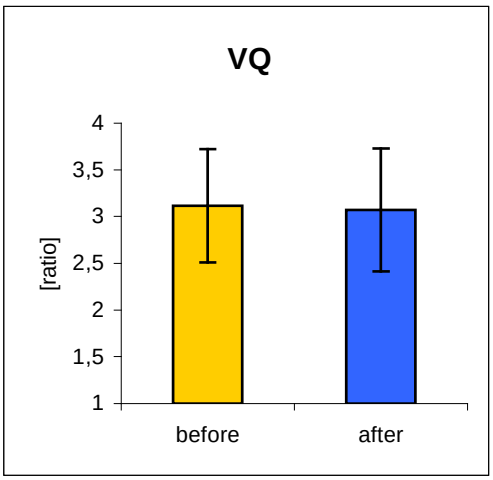


Fig. 24

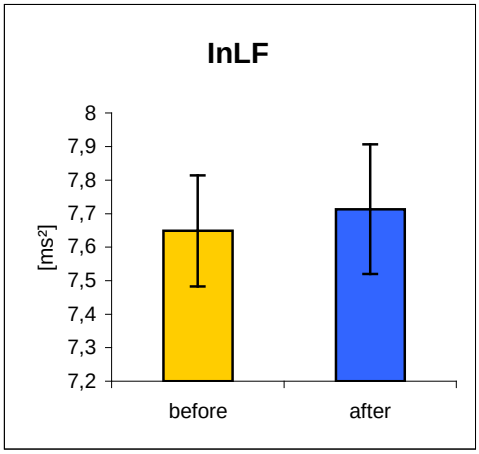


Fig. 25

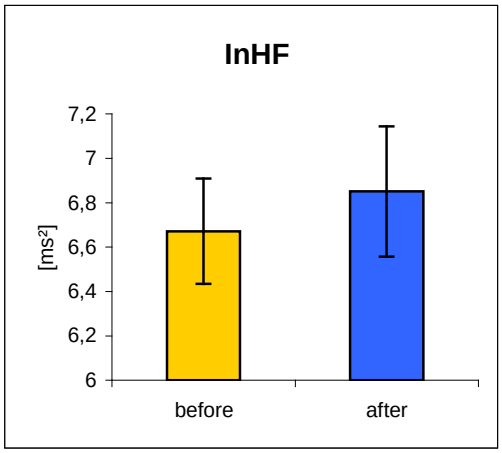


Fig. 26

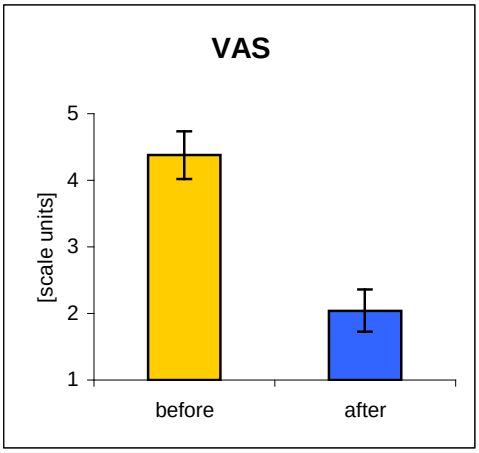


Fig. 27

Fig. 21 – 27 Illustration of the mean values of the evaluated HRV-parameters, as well as the results of the VAS before and after the treatment ± SEM

The comparison of the measuring values of the HRV parameters (Fig. 21 – 26) shows in all parameters positive tendencies. The values of the final measuring have all changed toward an improvement of the vegetative status. However, these changes show no significance in the result.

The results of the VAS (fig.27) were significant at $p < 0,05$.

7.3 Individual changes of all parameters before respectively after the treatment

In order to assess why no significance materialized when the entire group was taken as a unit, the individual changes (before/after differences) are presented as follows:

Differences of all parameter before/after in absolute values							
	HR	**SDNN**	**logRSA**	**VQ**	**lnLF**	**lnHF**	**VAS**
	b/min	ms	ms	Ratio	ms²	ms²	scale units
TP 1	1,35	-3,65	-0,02	-0,25	-0,07	-0,01	-2
TP 2	-7,84	16,5	0,17	-0,55	0,04	0,45	-1
TP 3	-6,9	9,6	0,15	-0,35	0,21	0,6	-3
TP 4	4,85	-5,05	-0,05	1	-0,04	-0,18	-1,5
TP 5	4,6	-12,2	-0,08	-0,1	-0,27	-0,2	-4
TP 6	-8	20,15	0,17	-0,5	0,4	0,65	-2
TP 7	0,1	-2,5	0	-0,3	-0,16	0,13	-2
TP 8	-3,2	-4,65	0,03	-0,45	0,08	0,18	-2,5
TP 9	7,55	1,85	-0,04	0,4	0,33	0,1	-2
TP 10	5,85	-10,9	-0,08	1,21	-0,26	-0,29	-3
TP 11	-3,5	27	0,12	-0,1	0,46	0,54	-2
TP 12	-1,45	2,2	0,03	-0,55	0,06	0,18	-3

Table 3 Illustration of the changes of the mean values of all collected parameters before and after the treatment

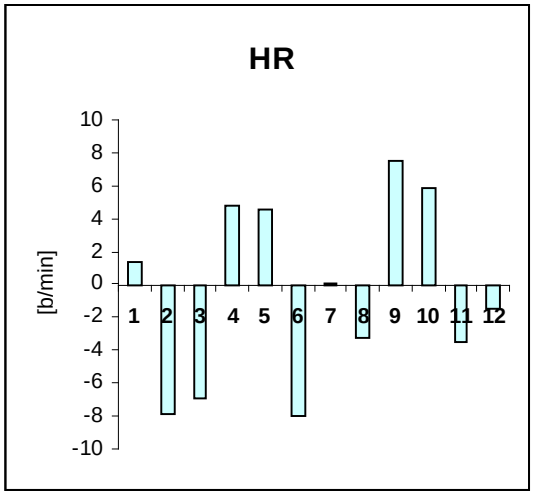


Fig. 28

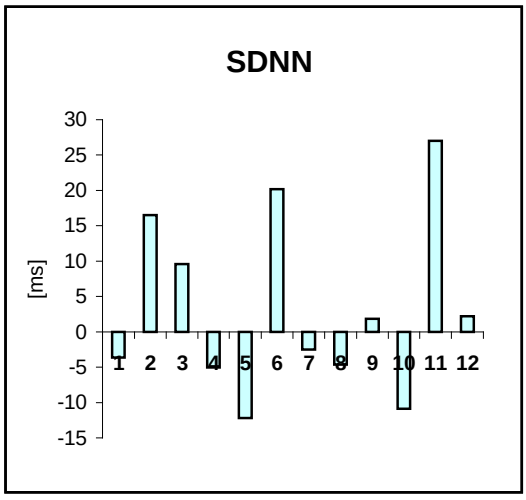


Fig. 29

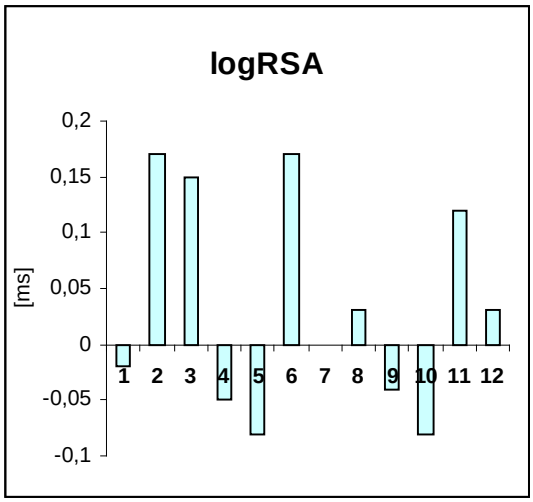


Fig. 30

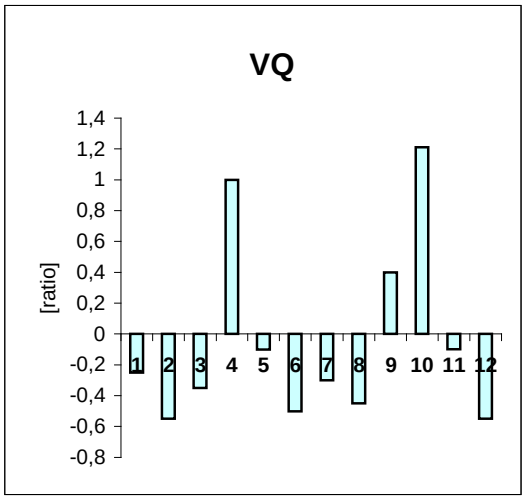


Fig. 31

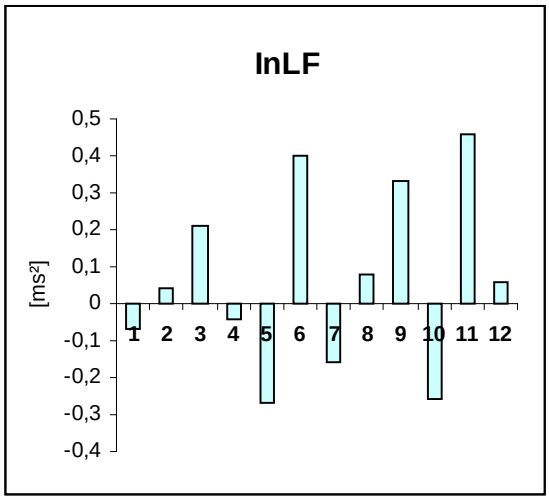


Fig. 32

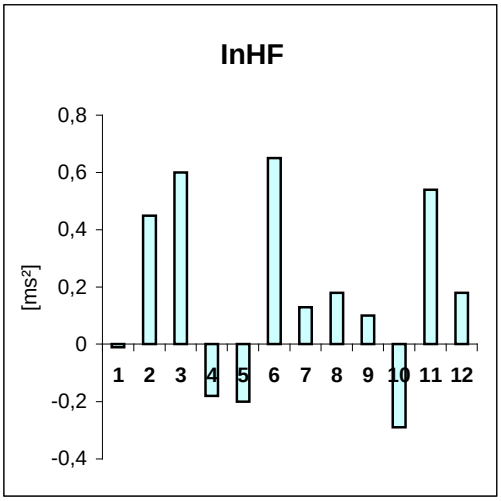


Fig. 33

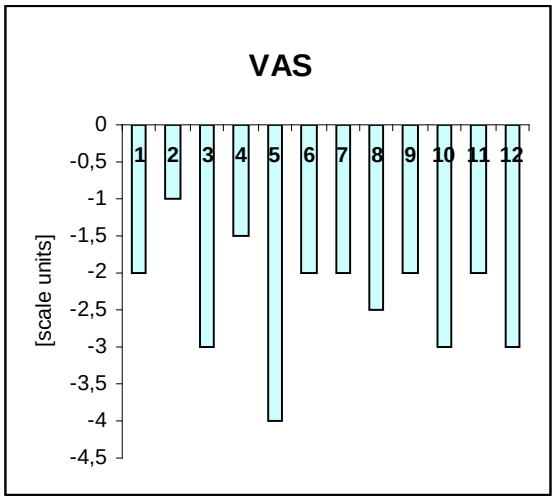


Fig. 34

Fig. 28 – 34 Illustration of the individual changes of all collected parameters before, respectively after the treatment

The figs. 28 – 34 show that the test subjects reacted very differently in the individual parameters. TP 2 and 6 for instance, reflect an “improvement” of the values of all evaluation criteria. However, the values of the TP 4 illustrate a “deterioration” of all HRV parameters, but an “improvement” at the pain evaluation. But the results together are continuously consistent, only depending on the individuality of each test subject.

At TP 2, the activity in the HF-field increases considerably more than in the LF-field, which is leading to a dropping of the VQ. Corresponding to the changes in the HF and LF area, the SDNN increases clearly after the osteopathic treatment. Due to this, the HF decreases for instance at TP 2, which leads to a lowering of the vegetative quotient. After HF and LF rises, the entire variability (SDNN) increases.

At TP 5 LF and HF decline, but latter only to a slight extent, which leads again to a lowering of the VQ (caused by the relatively higher para-sympathicus effect). The changes from the frequency analytic methods are also mirrored in the time domain methods, where the entire variability (SDNN) declines slightly. But since both frequency areas (HF and LF) decline, the entire variability (SDNN) declines too.

All in all, the changes in the different test subjects differ a lot, only in some test subjects distinct improvements are showing. A clear tendency shows only at the VAS. Here all test subjects are showing a change in the sense of pain reduction.

7.4 Correlation of the defined parameters before respectively after the treatment with the age of the test subjects

Since the individual changes did not result in a unified tendency, a further data analysis was carried out, where an interesting connection between the age of the test subjects and the HRV parameters turned up.

The following illustrations confirm:

The age of the test subjects corresponds to the: independent variable

The individual parameters correspond to the: dependant variable

- Corresponds to the values before the treatment
- Corresponds to the values after the treatment

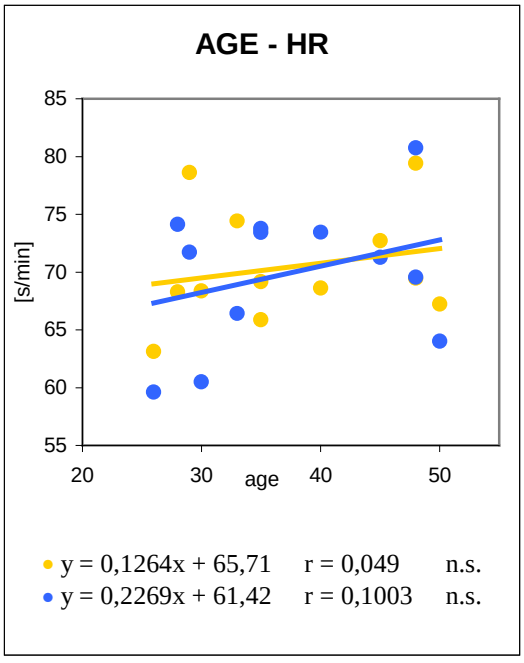


Fig. 35

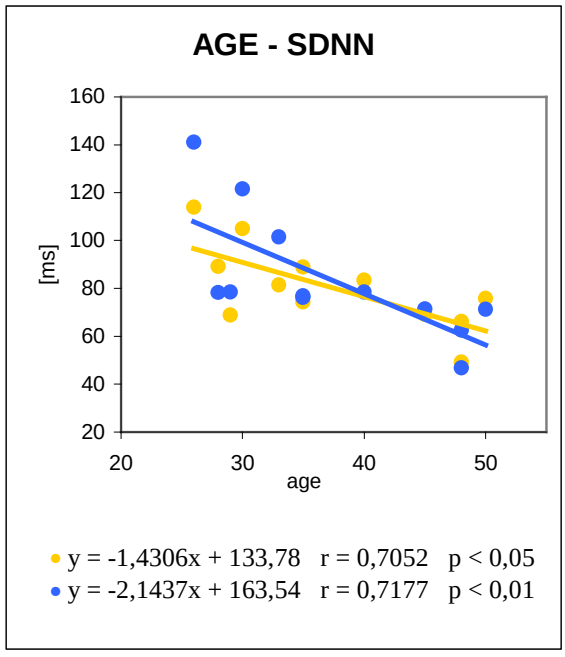


Fig. 36

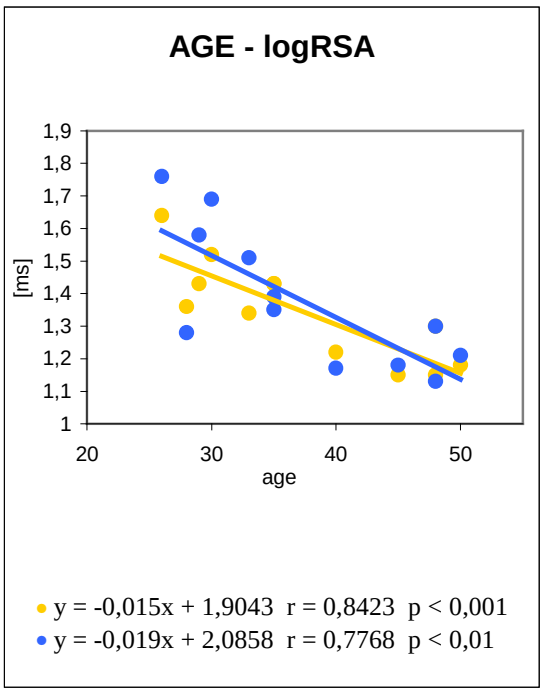


Fig. 37

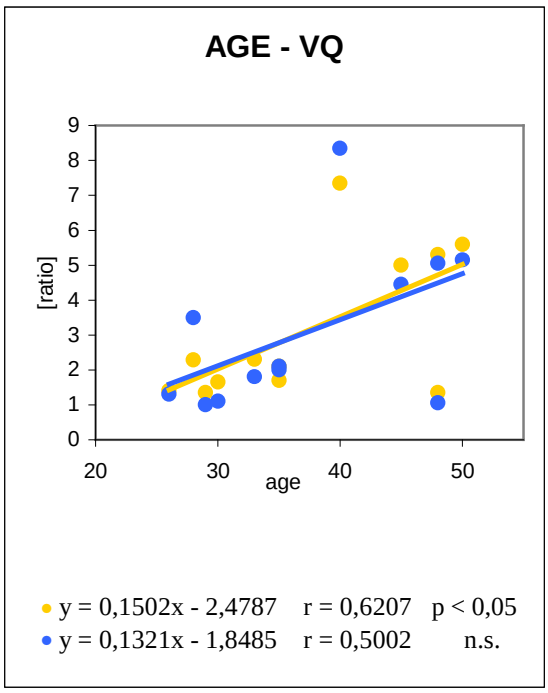


Fig. 38

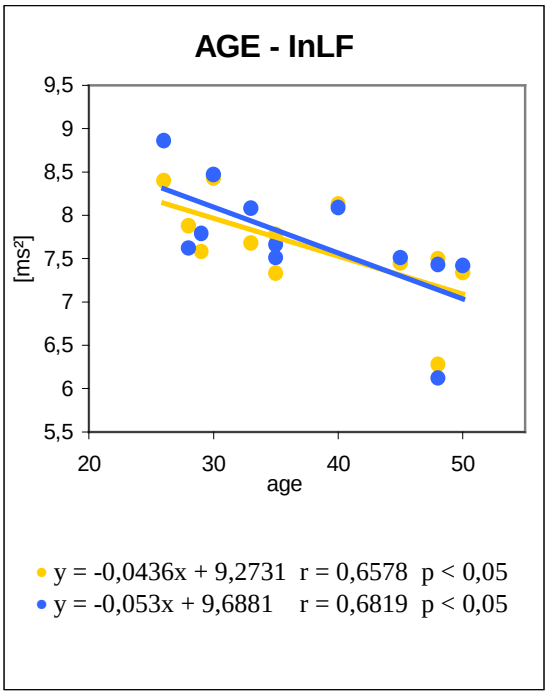


Fig. 39

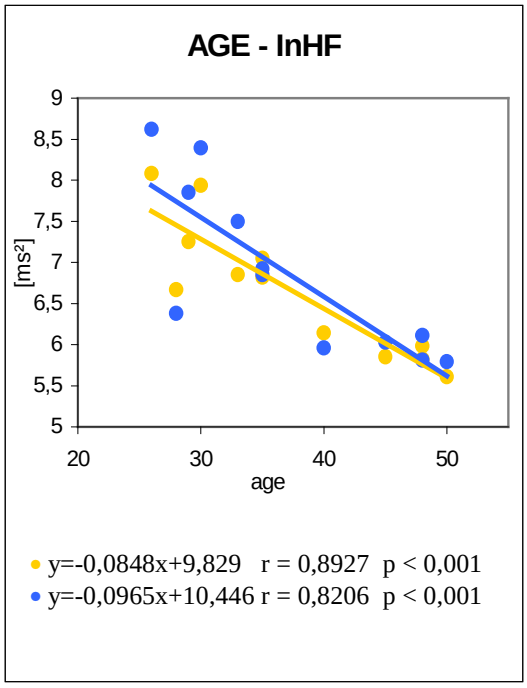


Fig. 40

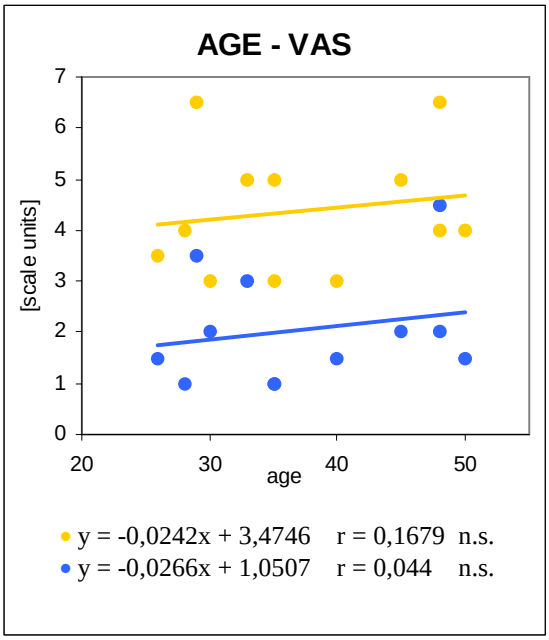


Fig. 41

Fig. 35 – 41 Illustration of the correlation of all defined parameters with the age of the test subjects before and after the treatment with the aid of linear regression.

As frequently described in scientific literature, (for example Task Force 1996) the HRV declines with age. The previous diagrams show that also the initial values of the examined test subjects showed these typical changes. Therefore logRSA, SDNN, LF and HF decline with age, whereby the decline of the HF area is considerably higher than the one of the LF area. That results in an increase of the VQ with advancing age.

Contrary to that, there are some younger test subjects, whose values are clearly in the lower level. This concerns partly the initial value, and partly the result after the treatment. Possible reasons of this impaired HRV can be stress, lacking relaxation abilities, respectively illness.

Only the HR shows no connection with age, although this parameter changes itself negatively too, thus in the sense of an increase.

The results of the confrontation between pain and age show no statistic proven connection. After the osteopathic treatment similar connections turn up, but it shows clearly that there are consistent larger changes in younger test subjects. The younger organism, based on the initial situation of the VNS is able to react quicker to the treatment. Younger persons, whose initial values do not correspond to the norm, do not show this behavior. Older test subjects are considerably more rigid in their reaction ability. Therefore it can be assumed that the treatment changes are less.

7.5 Demonstration of two individual examples

The evaluations have proved that in one and the same test subject, several parameters have often changed for the better, while others stayed the same, respectively deteriorated. Even so, tendencies could be derived. In this sense two adequate examples are introduced here.

Example 1 – "Improvement"

TP 6 Age 33 years, female

Anamnesis:

July 5th: St.p. operative removal of an endrometriosis node in the descending duodenum, fistulization after 4 days, then OP anus praeter for two months.

Sept.5th: Follow-up operation

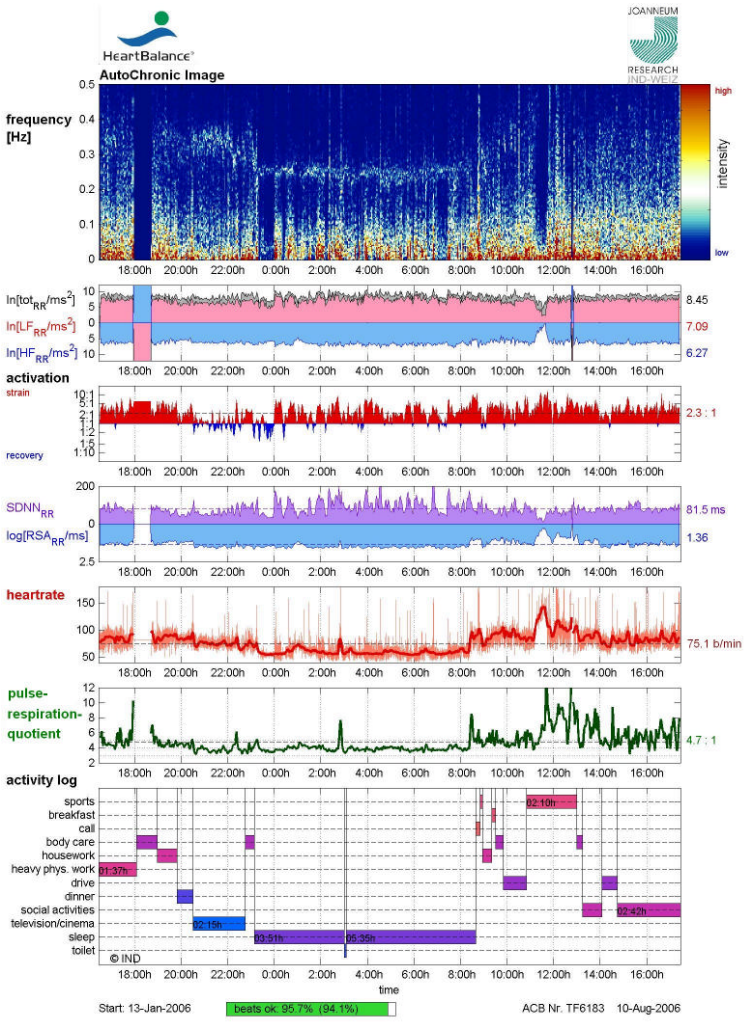
Irregular digestion, migraine, pains in the area of BWS with radiation to ventral, partial difficulty in raising the upper part of the body, general fatigue and little resilience.

Therapy: Structural techniques in thoracal area
Visceral relaxation techniques
Relaxation of fascial para structures, and the CSS

Final result:

The patient was nearly free of pain and felt considerably more flexible and more resilient.

Autochronic Picture “before”



ACP-number	6183
Measuring start	
13,1,2006	
16.30	
Measuring end	14.1.2006
17.30	
Measuring duration	
(h:min)	25.00
Day activity (h:min):	16.00
Evaluation (day):	95%
Evaluation (night):	98%

Total Evaluation

Vitality
Good
Regulation Capability
Very good
Sleep recreation
Good
Day course
Good

Fig. 42 ACP 6183

Evaluation of the Vegetative Nervous System

Spectrogram:

In the state of wakefulness the spectrogram shows activities in all three frequency fields. Structural changes based on different activities are clearly discernable. The night sleep is distinctly to differ from the state of wakefulness. During the entire duration of the sleep a RSA is existent. NREM – and REM phases can not always be explicitly differed.

InLF/InHF-Bands

LF- and HF bands correspond very well to the age. A circadian rhythm can be identified in both bands.

Vegetative Quotient

The VQ moves on an optimal level. However, during night sleep it could distinctly drop.

SDNN / logRSA

For the SDNN, as well as also the logRSA optimal values are seen. From the course of the SDNN results a clear circadian rhythm.

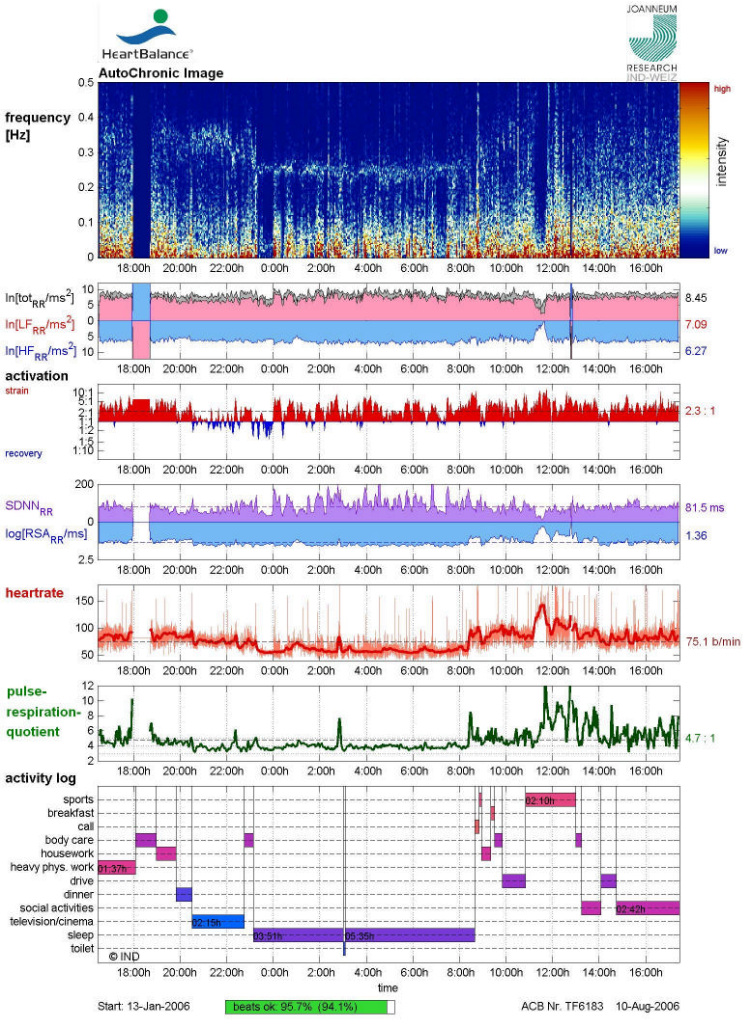
Heart Rate

Structural changes result from the course of the heart rate, corresponding to the activities. The sleep interruption is clearly visible, but seems not to affect the further sleeping course negatively.

Pulse-Respiration-Quotient

In the evening (watching TV) already a relatively quiet course of the QPA starts. The proportion of 4:1 during the night sleep can be attributed to an optimum coordination of heartbeat and respiration.

Auto Chronic Picture "after"



ACB number	6185
Start of measuring	3.3.2006 16:50
End of measuring	3.3.2006 17:50
Measuring duration (h:min)	25:00
Day activity (h:min)	19.05
Evaluation ability (day)	98 %
Evaluation ability (night)	100%

Total Evaluation

Vitality
Very good
Regulation capability
Good
Sleep recreation
Good
Course of the day
Good

Fig.43 ACP 6185

Assessment of the Vegetative Status

Spectrogram

A significant variability shows in all frequency fields. Several structural changes exist in the state of wakefulness. The sleeping architecture is not quite optimal, only the first NREM phase can be defined clearly. During the night sleep a RSA shows, and additionally also during short day-sleep phases.

InLF / InHF-Bands

LF and HF bands show optimal activity. The day-night difference is at least indicated**.**

Vegetative Quotient

Corresponding to the activities in LF and HF bands, an optimal VQ arises from the measuring course.

SDNN / logRSA

Both parameters show, corresponding to the age, optimal values**.** Structural changes exist, and a circadian rhythm shows at least to some extent in the SDNN course.

Heart Rate

A distinct night-day difference results from the HR. Sleeping phases during the day are clearly to make out. Additionally, many structural changes in the state of wakefulness are recognizable.

Pulse-Respiration Quotient

The QPA shows a smooth course. During the night sleep the QPA is not stable and whole-numbered in the entire course, which suggests an optimal sleep recovery.

Comparison of the two Pictures

By comparison of the two measurements the considerably shorter night sleep term in the auto-chronic picture (ACP) 6185 is conspicuous. The sleep quality, all in all, has to be assessed as non-optimal. The possibly occurring sleep deficit is compensated by short sleeping terms during the day. Nevertheless, compared with the first measuring, an improvement in all parameters has been reached. The methods, defined by frequency analytic values show a distinct increase, whereby the para-sympathetic activity rises stronger than the sympathetic one, which leads to a lowering of the vegetative quotient.

The values of the SDNN, respectively the logRSA, defined by time domain methods, also rise distinctly. The heart rate drops on an average of 75,1 S/min to 70 s/min, which is a cardiac work deduction of a solid 7500 beats during 25-hours of measuring time.

Example 2 – "Deterioration"

TP 4 Age 40 years, male

Anamnesis:

1983: Skull fracture, cheekbone and ethmoid fracture left

2001: Rear-end collision accident

a number of smaller cerebral concussions by climbing plunge.

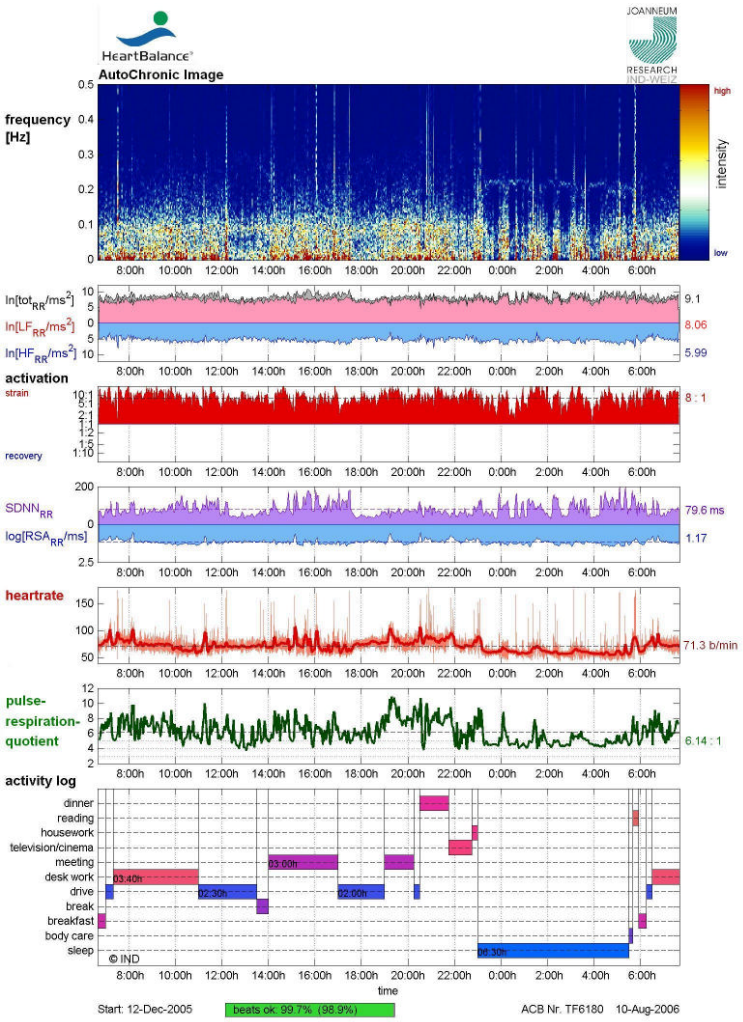
Deg. BS changes of the cervical spine, partly numbness in left hand, sleep disturbances. Patient momentary under stress, since he changed to occupational independence

Therapy: Thoracal manipulations and soft tissue techniques
LBT cervical spine, Mob. CO/C1 both sides
Release of a torsion left SSB
CV-4 technique
Release of a sacrum lesion
Treatment of left kidney, inclusive fasciae

Final Result:

A pain reduction of 50% was reached after the therapy. But the patient reports still a return of symptoms, even though less intensive after extended strain. The sleep quality could not be influenced considerably, and due to the patient's statement, is related directly to his professional stress.

Auto-Chronic Picture “before”



ACP-number	6180
Measuring start:	12.12.2005 6:40
Measuring end:	13.12.2005 7:40
Measuring duration (h:min:)	25:00
Day activity (h:min)	18:30
Assessment day:	98%
Assessment night:	98%

Total Assessment

Vitality
Slightly impaired
Regulation ability:
Impaired
Sleep recreation
Impaired
Course of the day
Slightly impaired

Fig. 44 ACP 6180

Assessment of the Vegetative Status

Spectrogram

At the state of wakefulness the variability in the spectrogram is mainly restricted to the LF and VLF area. Additionally an e 0,1-Hz-Band occurs, which has to be evaluated as a sign of certain mental stress. The night sleep can be clearly differed from the state of wakefulness. However, a RSA is only hinted, the sleeping architecture could, all in all, be indicated more distinctly.

InLF / InHF bands

During the course of the day both values are below the norm**.** A day and night difference is not clearly defined. The second phase of the long car drives is marked by a distinct activity decline at the LF and HF area.

Vegetative Quotient

The quotient increases strongly, which suggests a strong prevalence of the sympathicus tonus. Furthermore a distinct lowering during the night sleep is missing, which suggests an impaired sleep quality. Structural changes are only indicated.

SDNN / logRSA

SDNN and logRSA correspond to the age, however no circadian rhythm is clearly recognizable. But at least SDNN structural changes are detectable in the day course.

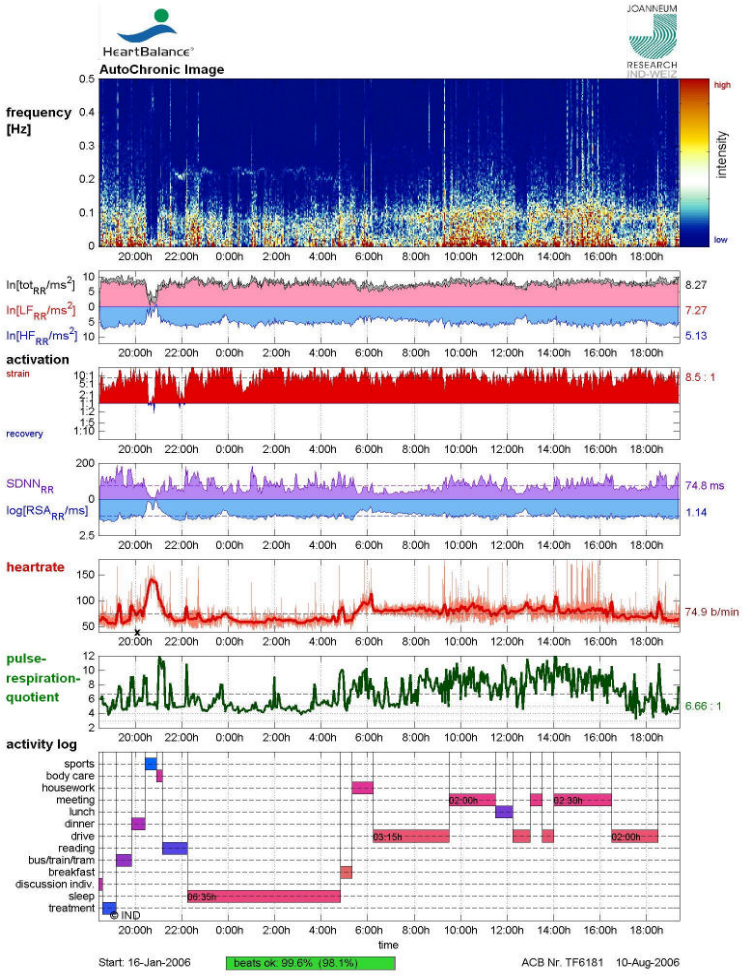
Heart Rate

Structural changes show in the heart rate in the state of wakefulness, the night sleep can be clearly defined. From the course of the HR at night, it can be concluded on the sleeping cycles.

Pulse-Respiration-Quotient

The course of the QPA during the night sleep is generally too restless. Whole numbering is only reached in short phases, which is contrary to a good recreation during the night sleep.

Autochronic Picture “after”



ACP-number	6181
Measuring start:	16.1.2006 18:25
End of measuring:	17.1.2006 19:25
Measuring duration (h:min)	25:00
Day activity (h:min)	18:25
Night sleep (h:min)	6.35
Assessment (day)	98%
Assessment (night)	98%

Total Assessment

Vitality:
Slightly impaired
Regulation Ability:
Impaired
Sleep recreation:
Strongly impaired
Circadian Rhythm
Impaired

Fig. 45 ACP 6181

Assessment of the Vegetative Status

Spectrogram

The variability in the state of wakefulness is mainly restricted to the LF respectively VLF area. A distinct 0,1-Hz-band evolves. The apparent high activity during the conversation in the afternoon is attributed to technical artifacts. The sportive activity is clearly visible in the spectrogram by the drop of the HRV. Contrary to this, the night sleep can be recognized only to some extent, since a separation of NREM and REM phases is not possible. During the reading phase in the evening, the sleep shows an intensive RSA-band, as it does not occur anymore during the following night sleep.

InLF / InHF- Band

The values for the activity of the LF area are lying in the upper normal range, the values of the HF area in the lower normal range. Structural changes show by the sportive activity, respectively the car drives, while the night sleep can not be differed definitively from the state of wakefulness. The osteopathic treatment at the beginning of the measuring leads to a distinct increase of the HF-Band.

Vegetative Quotient

Attributable to the slightly increased values for the LF area and the slightly lowered values for the HF area, unfavorable values occur for the VQ. A lowering of the VQ shows in the sleeping phase during reading, during the night sleep towards 1 o'clock in the morning, respectively during the treatment.

SDNN / logRSA

From the course of the SDNN values in the mean of the normal range, and the logRSA no definitive circadian rhythm can be seen. The highest logRSA values are reached during the osteopathic treatment.

Heart Rate

The day-night-difference can be recognized clearly from the HR. Low HR values show during the osteopathic treatment. Relatively high values occur during car driving in the morning.

Pulse-Respiration-Quotient

Because of the missing coordination of heartbeat and respiration the QPA is neither stable nor whole numbered in the course of the night sleep.

Comparison of the two Pictures

In comparing the two measurements, the values, defined by the frequency analytic methods are lowering in a dimension that the proportion between sympathicus and para-sympathicus (VQ) becomes still more unfavorable. Also SDNN and logRSA decrease, which shows a lowered HRV in the ACP 6181, compared to ACP 6180. In the course of the day, long car drives and meetings dominate in both measurements. Consciously planned and consumed breaks are missing, could however only be an initial attempt to improvement, in order to balance the strongly sympathico-tonic prevalence somehow. A structured day routine with absolutely needed recreation phases could be at the same time a first step to the improvement of the sleep quality.

One, at least in a slight extent, existing reaction ability of the VNS shows during the osteopathic treatment in ACP 6181 at the beginning of the measuring. In this phase a distinct increase of the para-sympathetic activity occurs (InHF, logRSA).

8 DISCUSSION

8.1 Interpretation of the Immediate Pictures

At this point we return to the beginning of the work of answering the initial question, whether the VNS can be influenced by an osteopathic treatment. No statistical proven connection could be established in this work, yet the assumption suggests itself that osteopathic interventions help to shape the vegetative status.

Engel (2002) investigated in his study the influence of cranial osteopathy on the state of consciousness of the patient, based on several parameters. The lowering of the HR during the experiment was significantly higher in the treated group as in the test groups. *Engel* (2002) sees therein important consequences for the patient before and after an osteopathic treatment. Further he finds therein justified clues that osteopathy can be defined as a holistic method.

From these short measurements it is obvious that the previously higher sympathetic activity status clearly drops during the treatment. Naturally this depends on the treatment methods

which were indicated just then. Thus, Dog-techniques reflect themselves differently in the auto-chronic picture than myofascial techniques. In most cases I finished the treatment session with cranial techniques, or at least with an examination of the cranial system. The distinct decrease of the heart rate in these cases was clearly visible. I think it can be assumed that we have therapeutic measures at our disposal, which distinctly steady the organism – quasi to find its "still point", and direct its inner power to the healing processes.

8.2 Interpretation of the Results of the MV-Comparisons

In comparing the MV of all HRV-parameters, **an improvement in all parameters is shown,** but the results were not significant.

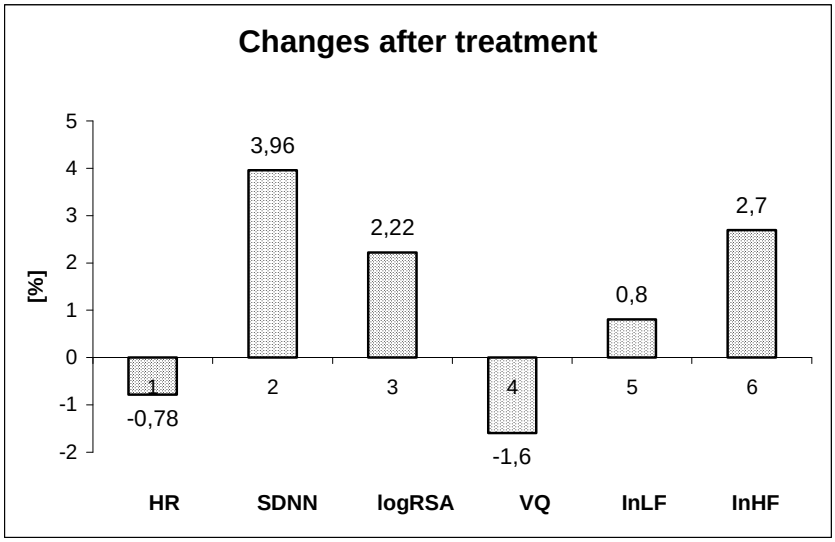


Fig.46 Compilation of the changes of all MV of the HRV-Parameters before, respectively after the treatment

The results permit the conclusion that an influence on the VNS by osteopathy was possible. But the question remains still unexplained, which other influencing factors might have favored, or also impaired this result.

It can be assumed that at a quite long observation time, many endogenic- and exogenic incidents are taking part in the result of this study. Only a considerable larger number of test subjects could have delivered a better average and minimized the artifacts. With the benefit of hindsight, I should also have restricted the age of my test subjects, respectively also defined the type of the "pain picture" more precise. Today, in order to choose study-relevant test subjects, I would limit the age to $\pm$ 10 years, and define more exact pain duration and pain level. So I have allowed too broad a distribution, which, with my small number of participants, could not deliver significant results. Basically it would probably be simpler to evaluate the effect of only one certain technique within a study, instead of a general osteopathic treatment. But if I would act in this sense I could only make a statement about the technique itself, but would not considerate the individuality of the treated persons, because not every patient needs the same intervention to contribute to his recovery process. I would like to remind here again of the remarks in chapter 5 (bio-cybernetic connections).

Presently there is the model of the so called translational medicine. This complies with the wish for integration of best research results with our clinical experiences, in consideration of the individuality of our patients. Illness is seen here as a part of life, and not as an actual state. In finding the solution, the entire person with her/his interactions between genes, environment and lifestyle is incorporated. It remains vital to find an adequate balance between scientific perception and the unique values and life circumstances of a patient (McGovern 2006).

In this sense I would like my work to be understood, namely having contributed to the comprehension of illness and health, of self-healing and recovery.

The MW comparison with the VNS before and after the treatment shows a distinct improvement regarding pain reduction. But the study results do not show a direct connection between pain abatement and positive changes of the HRV parameters. However, the VNS participates in every pain process, but only in few patients exist a direct connection between sympathetic activity and the symptoms. *Yelland and Wright (*1994, cited after Wright 1995) confirm this fact in their study on the basis of patients with chronic shoulder pains. The treatment consisted in a cervical posterior-anterior mobilization of the corresponding segments.

This effected a distinct increase of the skin conductivity, which again is only attributed to an enhancement of the sympathicus activity, but showed no change whatsoever in the perception of pain. When we assume that pain is an individual perception quality of our brain (as already mentioned in previous chapters) a possible explanation could be found therein.

8.3 Interpretation of Age Dependence and Changeability of the HRV-Parameters

My clinical experience taught me that the time factor and the influence duration of the damage are playing a considerable role at the spread of disturbances in the whole organism. The earlier we intervene to cure dysfunctions, the greater are the chances of success. Constant stress can lead to functional disturbances, which changes the synthesis of the ground substance, and so aids the development of chronic illnesses. The practical osteopathic experience shows that the treatment of infants achieves very fast changes. We can assume that such a young organism shows few adaptation lesions, and thus can be supported easier in its healing process. The older our patients are, the more their organism had to adjust to the most different stimulations. Consequently, it had to change its initial position (in this place I remind of my explanations in chapter 5.3). The cell metabolism and therefore also the reaction ability of all our structures slow down the older we are. The older person does not only walk slower, his/her biologic functions are slowing down too. The question is, whether more frequent osteopathic treatments with shorter intervals would be more successful here. The results of the HRV measurements suggest this and give rise to verify it in a further study.

Interesting is the fact that no significant connection has come up between the age of the test subjects and the HR. *Moser* (2006) analyzed the changes of the HRV-Parameters in healthy test persons, compared to those with isolated tumor diseases, respectively after the carried out operation. Typical significant changes showed, depending on the health condition. Only the change of the HR did not follow this typical model. This suggests that the HR as sole

criterion for the vegetative status does not show important results in this connection, but is only significant in the context of the auto-chronic picture.

The data material was also examined towards further correlations, but between the evaluated parameters and the duration of the illness, as well as the gender of the patient, no significant connections could be found.

8.4 Interpretation of the Individual Examples

The measurement of the variations of the HRV can fluctuate strongly from individual to individual. Therefore comparisons between persons are limited. Individual comparisons before/after (Hottenrott 2002) are more sensible.
This suggests that the significance of mean values is only conditionally sensible with a relatively low number of test subjects. Preferably in this case might be an analysis of individual cases.
Already in the basic part I have tried to demonstrate the significant influence of stress exposure on a person's recovery process. Also the cases dealt with in the study make this component clearly visible. We have to be aware that we can only improve the conditions – what the organism makes of them is very much up to the individual. If essential psychical incriminating factors can not be minimized sufficiently, the patient can not tap his healing potential fully. On the other hand I can see here again, a certain chance, that also patients with clinical manifested bodily dysfunctions, have the possibility of recovery if they are also mentally able to deal with these strains. In my opinion this capability shows mostly already in a basically improved initial position of the VNS. Naturally, also this is subjected to certain fluctuations, but would definitely show a significant picture at a long term evaluation of one and the same test person. Therefore, a positive exertion of influence on test subjects with low SDNN at the start, respectively with a 0,1 Hz-Band, which is frequently found in psychical stress situations, was more difficult.
Here it also shows clearly that a relatively small number of test persons, as in the study at hand, make it difficult to indicate a real representative cross section, regarding the exertion of influence on the VNS. Every organism finds other ways and possibilities to deal with the

situation and to react on interventions. However, the success of osteopathic treatments proves that we can make an effective contribution to the healing process of our patients.

8.5 Significance of the AutoChronic Picture for the Diagnosis Process

The results show quite clearly that an interpretation of the measuring values is only meaningful in relation to the history of a person. However, in this sense the presentation process of the auto-chronic picture proves to be a valuable completion to visualize the momentary reaction situation of the organism. These pictures are for the patient like a feedback process, which permits a reflection of his life habits. There was always an indisputable connection between the individual activities and the variation of the values. Often it was like a confirmation of something the patient knew already, and which in a certain form became finally visible – a fact, which all test persons accepted gratefully.

Osteopathic treatments do not show only short term effects. Very often mid term and long term changes can be expected. There is still enough room for further studies in order to observe the regulation mechanisms of our organism in greater intervals. I believe the presentation process of the auto-chronic picture provides good alternatives in return.

Unfortunately, the time frame was too short for me; therefore I confined myself to an observation time of six weeks.

9 SUMMARY

The work at hand deals with the question whether the vegetative nervous system (VNS) can be influenced by osteopathic treatments. The main task of the VNS is the maintenance of the inner milieu, the homeostasis. Based on new findings, the term homeostasis is put into question today, and substituted by the concept of homeo-dynamics (Moser 2004). It shows that a dynamic behavior of all body systems, which permits a continuous adjustment to inner and outer influences, is the condition for stable health.
The test persons of this study are chronic pain patients, which are subjected already to a relative long-term strain. Anamnesis, treatment and result evaluations prove that stress plays a significant role in these cases. Every chronic pain occurrence induces for every person individual behavior patterns of stress processing. Inversely, the acquired strategies dictate the further handling of the disease, respectively the pains. This work tries to bestow consideration upon the here underlying bio-cybernetic connections, and follows thereby the observations of the system theory.

At the beginning of this work stands the hypothesis that osteopathic treatments can contribute to improved auto-regulation. In order to evaluate this, the study avails itself of the auto-chronic picture (ACP), which enables a sight on the vegetative status of a person. The ACP is a presentation process which makes the results of the heart rate variability (HRV-measuring) over 25 hours visible. These precise recordings were carried out by a portable ECG device, the HeartMan (Heart Balance Graz).
All 12 candidates (age 37,25 $\pm$ 8,65 years) passed through an eight week observation time, in which they received osteopathic treatment 4 times. During this time four HRV measurements took place to enable a before / after comparison. Evaluated were the HRV-parameters, SDNN, logRSA, LF, HF and VQ. Additionally, for the evaluation of the pain level a Visual Analogue Scale (VAS) was consulted.

The comparison of the mean values of the individual parameters before, respectively after the treatment showed, all in all, changes in the sense of an improvement of the vegetative status. However, the changes of the individual HRV-parameters show no significance in the final result. Only the results of the VAS are significant at $p < 0,05$ and prove therewith a significant pain reduction after the treatment. But the results do not indicate a distinct

connection between pain reduction and positive change of the HRV-parameter. *Yelland and Wright* (1994, cited after Wright 1995) confirm this in their study on the basis of patients with chronic shoulder pains.

An unambiguous correlation shows between the age of the candidates and the determined HRV-parameters, as already described in the literature. The osteopathic treatments effected a clear improvement in young patients, while in older patients, respectively in young candidates with impaired VNS function only small to no effects were noticed.
The results permit the assumption that a younger organism has still the better possibilities for auto-regulation, that is to say, it reacts also more effective to therapeutic interventions.

Furthermore, there are still two individual examples to focus on the above mentioned individuality of each candidate. The example of the particular case shows the complexity of each pain occurrence distinctly and displays the symptoms in context with the history of a patient. By these insights the therapist as well as the patient, are gaining a valuable reflexion of the body reactions to endogenic and exogenic influences.

10 LITERATURE INDEX

Arvay S.: HRV und Trainingssteuerung in: Spectrum der Sportwissenschaften (Hrsg.), Jg. 13, WGLS-Verlag, supplement 2001

Barral J.P., Mercier P., in: Lehrbuch der Viszeralen Osteopathie, Band 1, München, Urban & Fischer Verlag 2002, 27-28

Beck H., Martin E., Motsch J., Schulte am Esch J.: Schmerztherapie, Stuttgart/New York, Thieme Verlag 2002, 24

Becker R.E.: in: Life in Motion, Brooks R.E. (Hrsg.), Rudra Press 2001, 3. Aufl., 203

Bettermann DD., Engelke P., van Leeuwen P., Heckmann C.: Die Bestimmung der Atemfrequenz aus der respiratorischen Sinusarrythmie (RSA) in: Biomedizinische Technik, Berlin 1996, 41/11, 319-323

Bergsmann O.: Projektionssyndrome, Facultas-Universitätsverlag Ges.m.b.H. Wien 1993, 3. Auflage, 58-65

Duus P.: in: Neurologisch-topische Diagnostik, 5. Aufl., Thieme Verlag, 1990, 290-297

Emoto M.: Wasserkristalle, KOHA-Verlag GmbH Burgrain 2003, 4. Aufl., p 78

Engel R.A.: « Cranial » State of Mind – Does Cranial Osteopathy influence the patient's state of consciousness?, Dipl.Arbeit an der WSO, Wien 2002

Foerster v.H.: Wahrheit ist die Erfindung eines Lügners, Fischer H.R. (Hrsg.), Carl-Auer-Systeme Verlag Ges.m.H., Heidelberg 2001, 54-63, 105-107

Gifford L.: Schmerzphysiologie in: Van den Berg, F (Hrsg): Angewandte Physiologie, Band 2, Stuttgart/New York, Thieme Verlag, 2005, 481-528

Hildebrandt G., Moser M., Lehofer M.: Chronobiologie und Chronomedizin: kurzgefasstes Lehr- und Arbeitsbuch, Hippokrates 1998

Hottenrott K.: Grundlagen zur Herzfrequenzvariabilität und Anwendungsmöglichkeiten im Sport in: Hottenrott K.: Herzfrequenzvariabilität im Sport, Hamburg, Czwalina Verlag 2002, 9-26

Jänig W.: Vegetatives Nervensystem in: Schmid R.F., Thews G. (Hrsg.): Physiologie des Menschen, Springer Verlag Berlin Heidelberg 1995, N.Y., 26. Aufl., 340-369

Klasmann J.K.: Gesundes Schwingen in: Psychologie Heute 2005/7, 20-25

Kwakman R.: Reflextherapien – Osteopathie in: Angewandte Physiologie, Band 5, Thieme Verlag, Stuttgart/New York 2005, Van den Berg F. (Hrsg), 487-502

Lauterwasser A.: (Hrsg.) in: Wasserklangbilder, AT Verlag, Aarau, Schweiz 2002, 56

Lehofer M., Moser M., Hoehn-Saric R., McLeod D., Liebmann P., Drnovsek B., Egner S., Hildebrandt G., Zapotoczky HG.: Major Depression and Cardiac Autonomic Control in: Biological Psychiatry, 1997, 42, 914-919

Liem T.: (Hrsg.), Der primär respiratorische Mechanismus in: Kraniale Osteopathie, Hippokrates Verlag GmbH, Stuttgart 1998, 2. Aufl. 21; 16

Ligner B., Van Asche R., (Hrsg.) in: Gelenke der Unteren Extremität-Mobilisation und Korrektur, Verlag für Osteopathie Dr. Erich Wühr 1993, Kötzing/Bayer Wald, 16-19

McGovern R.J.: Altern und Osteopathie: Die Rolle von Beweisen in:Deutsche Zeitschrift für Osteopathie, Hippokrates-Verlag, Stuttgart 2006, 2/06, 9

Moser M., Lehofer M., Hildebrandt G., Voica M. Egner S., Kenner T.: Phase- and Frequency Coordination of Cardiac and Respiratory Funktion, in: Biological Rhythm Research, Vol 26 No 1, Swets & Zeitlinger 1995, 100-111

Moser M.: Zwischen Chaos und Ordnung – Überlegungen zur Entstehung von Form und Gestalt in: Chaostheorie und medizin. Selbstorganisation im komplexen System Mensch, Toifl K. (Hrsg.), Wilhelm Maudrich Verlag, Wien München Bern 1999, 29-40

Moser M., Bonin D., Frühwirth M., Lackner H.: Jede Krankheit ein musikalisches Problem in: Die Drei 8-9, 2004

Moser M.: Stabilität durch Variabilität in: Sichere Arbeit 5/1999

Moser M., Frühwirth M., Penter R., Winker R.: Why life oscillates – from a topographical towards a functional chronobiology, in Cancer Causes Control, 2006/17, 591-599

Oettmeier R.: Grundlagen der ganzheitlich-biologischen Therapie in:Angewandte Physiologie, Band 5, Thieme Verlag, Stuttgart/New York 2005, Van den Berg F.(Hrsg),1-9

Paoletti S.: in: Faszien, München Urban & Fischer Verlag 2001, 1. Auflage, 114, 143

Schmidt R.F.: H.-V.: Wachen und Schlafen in: Schmid R.F., Thews G. (Hrsg.) Physiologie Des Menschen, Springer Verlag Berlin Heidelberg 1995, N.Y., 26. Aufl, 155

Slater H.: Vegetatives Nervensystem, in: Van den Berg F. (Hrsg): Angewandte Physiologie, Band 2, Thieme Verlag, 2005, Stuttgart/New York, 2. Aufl, 401-423

Slater H.: Vegetatives Nervensystem, in: Van den Berg F. (Hrsg): Angewandte Physiologie, Band 3, Thieme Verlag, Stuttgart/N.Y., 2001, 1. Aufl., 497-500

Sternberg E. M., Gold P. W.: The mind-body interaction in disease. Mysteries of the Mind, Scientific American Special Issue 1997, in Vegetatives Nervensystem, in: Van den Berg F. (Hrsg): Angewandte Physiologie, Band 2, Stuttgart/New York, Thieme Verlag, 2000, 401-423

Task Force of European Society of Cardiology and the North American Society of Pacing and Electophysiology: Heart Rate Variability. Standards of Measurements, Physiological Interpretation, and Clinical Use. Circulation 1996, Volume 93, 1043-1065

Trepel M.: (Hrsg.), Neuroanatomie, Urban & Fischer Verlag, 2004, 3. Auflage, 279-292

Upledeger J.E..: in: Lehrbuch der Kraniosakraltherapie, Weingart J. (Hrsg.), Haug Verlag GmbH & Co, Heidelberg 1994 2. Aufl., 281

Vincenzino B.,Collins D.,Benson H.,Wrigt A.: An Investigation of Interrelationship between Manipulative Therapy-Induced Hypoalgesia and Sympathoexcitation, in: Journal of Manipulative and Physiological Therapeutics, Vol. 21(7), 1998, 448-453

Waltl J.: Veränderung der vegetativen Efferenz durch die Mobilisation der vierten Rippe, Dipl.Arbeit Akad. f. Physiotherapie Graz 2003, 44-45

Wright A.,Vizencino B.: Cervical mobilisation techniques, sympathetic nervous system effects and their Relationship to analgesia, in: Shacklock M. O. (Hrsg.): Moving in on Pain, Melbourne, Butterworth-Heinemann, 1995, 164-171

Wrigt A.: Hypoalgesia post-manipulative therapy: a review of a potential neurophysiological Mechanism, in: Manual Therapie, Vol. 1, 1995, 11-16

WSO Wiener Schule für Osteopathie, Aktueller Folder 2006

11 Image Index