# Examination of Refraction in Myopia - An Osteopathic Treatment Approach

The Orbit – Fluid - Drive

## A Clinical Study

Master Thesis for obtaining the degree

Master of Science in Osteopathy

at the **Donau Universität Krems**

submitted by

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Translated by Mag. Barbara Schnürch

# DECLARATION

Hereby I declare that I have written the present thesis on my own.

I have clearly marked as quotes all parts of the text that I have copied literally or rephrased from published or unpublished works of other authors. All sources and references I have used in writing this thesis are listed in the bibliography. No thesis with the same content was submitted to any other examination board before.

Date

Signature

## Abstract

### Introduction

The objective of this clinical study is to examine myopia (short-sightedness) from the perspective of the cranial concept.

I have already gained positive experiences in treating patients of all ages with ametropia. Based on this experience I have set myself the goal to examine the effectiveness of specific osteopathic techniques for the orbit.

In conventional medicine ophthalmologists traditionally prescribe visual aids to correct amblyopia.

But glasses are just an artificial compensation. The cause for amblyopia itself is not treated. Once short-sightedness has developed the only thing that is undertaken is the correction with optic lenses. Patients wear their prescribed glasses and usually arrange themselves with the fact that their vision will deteriorate further.

If you consider this more closely you could come to the conclusion that visual dysfunctions are incurable, for the conventional methods merely offer glasses as visual aids but do not take into account the actual causes.

Thus I want to put forward the following considerations:

If you consider impaired vision as incurable disease you can only apply the current conventional “treatment” methods.

But if you look at the impairment in the context of osteopathic dysfunction you can achieve a change with the aid of osteopathic treatment.

Despite the fact that there are numerous kinds of visual impairment this paper will be confined to one of the most frequent forms: short-sightedness (myopia). Another frequent form is an irregular curvature of the cornea (astigmatism) which often occurs hand in hand with myopia.

### Research question

Is it possible by means of an orbit fluid drive to achieve a change in and or improvement of refraction with regard to myopia?

**Relevance for the osteopathic concept**

If you look at treatment of myopia under the aspects of the osteopathic cranial concept, the examination and treatment focuses on structures, which have a functional relationship with the orbit and its content.

These aspects are the arterial and venous supply and the nerves of the eyes on a sensomotor and vegetative level along their course of the visual pathway to the visual cortex. The bony framework and the interaction of the cranial bones, especially of those which form the orbit, as well as the relationship of the dural structures to each other and also their continuity with the sclera of the eye are also essential in this approach.

Taking into account all these aspects I have come to the conclusion that visual acuity in patients with myopia can be influenced to such an extent that they need less or even no external visual aids like glasses anymore.

In contrast to the “treatment” with glasses, this treatment approach takes into account the self-healing powers of the body and thus respects the human being in its totality.

**My hypothesis is that a significant improvement of vision in myopia can be achieved through treatment with an orbit fluid drive according to the cranial concept.**

**Study design**

My study was designed as controlled clinical study:

A total of 54 patients agreed to participate in the study. In the end 42 test persons were included in it because some patients did not return the questionnaire or did not fulfil the inclusion criteria. One test person was excluded because of hyperopia. One female test person indicated a dog’s bite in the face as accident in the questionnaire and was therefore excluded from the study.

I treated 20 of the 42 test persons with the technique I will describe later on in this paper. The other 22 test persons formed the control group. They did not receive any treatment, but their visual function was measured before a period of rest and a control measurement was carried out after this period of rest.

An independent optician who was called in as expert carried out the measurements of vision by means of a subjective determination of refraction with the trial frame. The optician did not know whether the patients belonged to the treatment or the control group. This guaranteed his neutrality and independence.

A table of the detailed results of the measurements is included in the annex.

**Selection of the test persons**

The overall number of 42 test persons is made up of many of my patients and a number of recruited volunteers. Unfortunately, it was not possible within the scope of my private osteopathic practice to obtain x-rays of the spines and skulls of the majority of theses patients. None of my test persons was willing to undergo several x-ray examinations for the participation in my study, mostly due to concerns regarding the physical stress which the exposure to x-ray radiation represents.

This is understandable but nevertheless I regret that I had to do without this important means of diagnosis, i.e. x-ray photographs in two planes of the cervical spine and skull.

The patients were randomly attributed to the treatment and the control group: they had to draw lots and were attributed to the two groups according to the number they had drawn.

Together with the completed questionnaire I received a written declaration of consent from the patients in which they declared they agreed to participate in the study.

This declaration of consent can be found in the annex.

**Target parameter**

The target parameter of this study is a change and/or improvement of vision with regard to the myopic condition.

**Secondary target parameters are:** The development of vision within the two groups as well as a comparison of the vision between the two eyes of each individual patient. Further the measurement results within the treatment group were analysed with regard to the age of the respective test persons. In the treatment group also the patients who received their first glasses during childhood were compared with those who received their visual aid later in life.

In order to be able to analyse the results with regard to the target parameter and the secondary parameters I have developed a questionnaire for this study.

**Inclusion criteria**

The primary precondition for inclusion in the study was: myopia of different intensity. Patients with problems of the cervical spine, birth complications like Caesarean section, use of forceps or vacuum extraction and patients with problems of the TMJ were accepted as test persons.

**Exclusion criteria**

Patients who specified injuries in the region of the face, structural or systemic diseases also on a neurological level, cranial malformations, surgical interventions, as well as accidents or tumours in the region of the head and face were excluded from the study. Also patients with hyperopia could not be included in the study.

**Variables**

**The dependent variable** is the measurement of refraction in dioptres (dpt.).

**The independent variables** are the age of the test persons, their habits of wearing their glasses, the age at which they received their first glasses, possible birth traumas, and secondary complaints like headaches and problems affecting the cervical spine.

**Validity and reliability (gold standard) of the variables**

The validity and reliability of the dependent variables was guaranteed through the **subjective determination of refraction with the aid of a trial frame** by an independent optician.

The validity and reliability of the independent variables was established through a questionnaire that I had developed and that can be found in the annex of this paper.

**The treatment technique**

The treatment techniques I applied was a fluid drive of the orbit, a technique in the style of V. Fryman (1998: 38f), H.I. Magoun (1951: 162f) und R. Becker (1997: 71f) which I have developed myself inspired by Nusselein.

This technique serves the purpose of diagnosis as well as that of treatment and can have a far-reaching effect on the whole eye.

**Test arrangement and execution of the study**

Before the treatment the test persons went to an optician, who was called in to support the study, to have their vision measured.

After the measurement they had to walk 500 m to reach the treatment room. The average time of treatment was 20 minutes.

During this period the patients of the treatment group were treated with a fluid drive of the orbit.

The control group did not receive any treatment. All test persons in this group observed a 20-minute period of rest after the refraction measurement.

After the treatment or the period of rest the test persons went back to the optician, who did not know who belonged to the treatment group or the control group and carried out a control measurement.

Exactly four weeks later the test persons visited the optician again, who carried out a second control measurement.

This second control measurement was to reveal long-term stability in comparison with the control group. The interval of four weeks was estimated to be an adequate period to document eventual trends and changes.

A second treatment was not carried out because:

This study was carried out with the objective to find out what happens if a one-time decisive impulse is given to structures that primarily have to do with vision.

I wanted to examine to what extent the body can accept and process this impulse within a period of four weeks. This was verified through the second control measurement which was carried out after the period of four weeks without previous treatment.

A second treatment would represent a new impulse for the re-organization of the body, which would have to be processed again. This processing of the new input would be a variable that would be difficult to calculate and make the results more intransparent.

Therefore, I deliberately renounced a second treatment within the framework of this study.

## Table of contents

**“The true voyage of discovery lies not in seeking new landscapes, but in having new eyes.”**

**Monroe (1997: 49)**

# 1. Introduction

## 1.1 Overview

This thesis deals with the question whether cranial work represents a possibility to improve short-sightedness (myopia). A number of surprising results I could achieve in my practice have prompted me to examine this issue more closely. Therefore I have carried out a clinical study.

Before I will discuss the study as such I would like to provide some insights in the processes and structures which are primarily responsible for the physiological function of seeing: I will thus describe the process of vision and look in detail at the path of light rays in the good (emmetropic) eye as well as in the short-sighted (myopic) eye.

The interrelations and connections between the brain and the eye are very important in the cranial concept and will be discussed in chapter 4 “The eye: a projection of the brain“.

A correct process of vision is depending on several structures, which are interrelated with regard to their anatomical position but also with regard to their function. These structures will be presented individually according to their anatomical organization. However, when it comes to the function of vision, these structures cannot be seen separately.

Nevertheless, to emphasize their various possible influences on the process of seeing the structural and functional components are presented separately with the respective dysfunctions and their possible consequences.

Finally, also the possible corrections offered by conventional medicine are represented. For means of comparison I will then present the treatment technique that was applied in this study as a possibility of correction from an osteopathic point of view.

Afterwards, I will present and explain the results of the study. The statistic analysis and critical evaluation of the results is also included. At the end of the chapter I will come back to my initial hypothesis and evaluate it critically.

In the discussion I will put he results in an osteopathic context and offer an overview as to the different perspectives from which vision can be looked at.

## 1.2 An osteopathic treatment approach

Still writes about the body in perfect health: "We look at it in perfect health which means perfection and harmony not in part, but of the whole body. So far we are only filled with love, wonder and admiration."

http://www.meridianinstitute.com/eamt/files/still2/st2ch2.html

Every living body strives for comfort, painlessness and wants to move as economical as possible.

Pain and restrictions use more power and energy that it would be the case if the body is healthy. The people concerned often feel overstrained and tired. This holds in particular for the eyes: if certain structures of the eyes are restricted, seeing becomes particularly exhausting and less economical for the person concerned.

Anything that restricts or limits mobility will impair the adaptability of a structure and thus its health.

Mc. Govern describes how Still saw the connection between structure and function: "Accordingly Still used the concept of structure and function to explain how neural, vascular and lymphatic structures have to be freed from restrictions (e.g. through manipulations) to facilitate an appropriate function of all related organs." (2003, 51)

From this point of view also myopia and astigmatism can be seen as osteopathic lesions. Anatomical structures which contribute to normal vision are restricted in their function. From an osteopathic point of view they are not ill they just suffer from a loss of function.

An osteopathic treatment works on the underlying causes which are at the bottom of a "defect" – in the sense of loss of function. From this perspective all dysfunctions of the body which have a disturbing influence on the eyes can have a visceral, structural/parietal or other origin.

Through osteopathic treatment it is possible to release the restrictions of the affected structures on a fascial, muscular, neural, circulatory and endocrine level. Through this the structures get back their ability to move comfortably, economical and without pain.

The cranial concept enables the therapist to develop an understanding of the patient's visual problems, which goes beyond the mere symptoms. The functionality of the structures and their interrelations facilitates a deep understanding of the complexity of the process of seeing and its underlying conditions.

The understanding of the physiological conditions provides the basis to work on the causes of the impaired function – the ametropia.

The body can re-organize after the treatment. The self-healing forces become active. And it is these self-healing forces which help the treated structures to regain their full function.

Still said: "He [the osteopath] seeks the cause, removes the obstruction and lets Nature's remedy – arterial blood – be the doctor." (Still, 1992: 6)

In this paper I will discuss the individual structures which surround the eye. They are governed by a special force, which I will describe more in detail in the chapter "Discussion and outlook". I mean the fluids which act upon every structure in the body. Within them lies a force which has the effect that full function can be re-established on all levels.

Through this the cranial concept enables the body (or in this case the eye) to find its health again.

"He who is able to reason will see that this great river of life must be tapped and the withering field irrigated at once, or the harvest of health be forever lost." (Still quoted by Sutherland, 1 948: 1)

### 1.3 The eye: the organ of vision

**The lamp of the body is the eye. If your eye is sound, your whole body will be filled with light.**

Math. 6, 22

If we look at the eye in the course of history, we find ourselves today at a decisive turning point: The demands on the eye have changed during the past century. These new demands have to be discussed and certainly also redefined. New technologies, computers, artificial light, traffic and television and the change in human life towards being more machine-oriented requires a new consideration of the organ of vision and a new look at eyesight as such.

In addition, the people themselves increasingly regard their body no longer isolated and in individual parts.
An increasing number of people recognize that the human being is more than “the sum of its individual parts” and that the most important thing for its existence is the interaction of all its organs and tissues right down to the most minuscule cell structure.
Only within the framework of a highly complicated interaction between all these structures complex tasks like seeing can be accomplished.
In this sense an osteopathic treatment approach can only be applied effectively if important relationships and interrelations which are linked to the process of seeing in the widest sense are considered and integrated.

Therefore the process of seeing can be regarded as “seeing with the whole body “. It is not only important how the light that comes from outside is absorbed but also in how far the body is ready to receive light.
Jacques Lusseyran, a blind philosopher illustrates this with the following words:

**“Joy does not come from outside for whatever happens to us it is within. Light does not come to us from without. Light is within us, even if we have no eyes.”**
(Lusseyran, 1984: 286)

It is undoubtedly right that seeing is only possible in the presence of light. But the eye sees with the whole body; its task is to perceive and to pass on sensations to the whole organism.

## 2. The method of measurement: subjective determination of refraction with the trial frame

**Standardization of the measurement**

To minimize measurement errors the measurement was always carried out the same way. In addition, it was carried out by the optician himself by means of a subjective determination of refraction with a trial frame. Since the measured values depend on the subjective perception of the individual patient, the optician pointed out, that variations of up to 0.25 dpt. might occur.

**To limit inaccuracies as much as possible the measurements were carried out approximately at the same time of the day, plus/minus and hour.**

**This also helped to reduce measurement variations due to tiredness in the evening. But since these sorts of variations concern both groups, we can assume that the initial situation is equal for both groups.**

The measurement is based on the following principle: the optician tries systematically to find the best corrective lenses by holding different glasses in front of the eyes of the patient and asking the patient for each eye precisely how the test person's eyesight changes.

This procedure presupposes a certain participation of the patient.

For the determination of the right glasses a special room is necessary: the refraction room.

The distance from the eye of the test person and the front surface of the test chart (i.e. the projection screen) is set with 5 m.

Since the values in the determination process have to be reproducible a constant artificial light is used.

DIN EN 8596 "Ophthalmic optics - visual acuity testing – standard optotype and its presentation" requires among other things that:

The environment of the test field (test room) has to be darker than the test field. Within an angle of 10° diameter, however, the luminance of the environment must not be less than 1/10 and not more than ¼ of the luminance of the test field.

Within the field of sight of the test person no direct or indirect source of glare (e.g. source of light, reflected source of light, shiny or very bright matt surfaces) must be found.

Light with a colour temperature between 2 500 and 7 000 K has to be used.

The luminance of the test field has to lie between 80 and 320 cd/m.

Taking into account the lighting of the room the luminance of the optotype must not have more than 15 percent of the luminance of the test field. In order to determine anomalies and to double-check correct application a second set of refraction glasses must be at hand.

The refraction glasses have to correspond to the standards defined in DIN EN ISO 9001 “Ophthalmic instruments – refraction glasses”. This guarantees that they fit in the trial frame which is standardised according to DIN EN 12867.

According to DIN EN ISO 9801 refraction glasses have to have the following dimensions:

- external diameter of the frame 38 (plus/ minus 0.2) mm
- edge radius of the frame 1.4 mm maximum
- thickness including frame 2.8 mm maximum – not for prismatic glasses.

The following things are also required:

- a confirmation rule (sph plus 0.5, plus 0.25; minus 0.5, minus 0.25)
- cross cylinder with handle plus/minus 0.25 and plus/minus 0.5
- an expanded set of refraction glasses – for a more sophisticated measurement

To test the vision we use a sight test projector (according to Diepes, 1999).

The standard optotype according to DIN EN ISO 8596 is the Landolt ring.

The standard optotype can also be replaced by other letters and numerals.


1st line: Landolt rings (3 positions of eight possible ones)

2nd line: Pflüger optotype and Snellen optotypes (2 positions)

3rd line: Snellen letters

4th line: DIN 1451 font (Schober)

**Fig.1**

# 3. The function of visual perception: image formation, processing and recognition

This chapter describes how the eye receives light. The processes which facilitate that a sharp picture of the observed object is formed clearly show the enormous work the eye has to perform. This becomes even clearer if we compare a good (emmetropic) eye with an impaired (myopic) eye.

## 3.1 Normal eyesight (emmetropia):

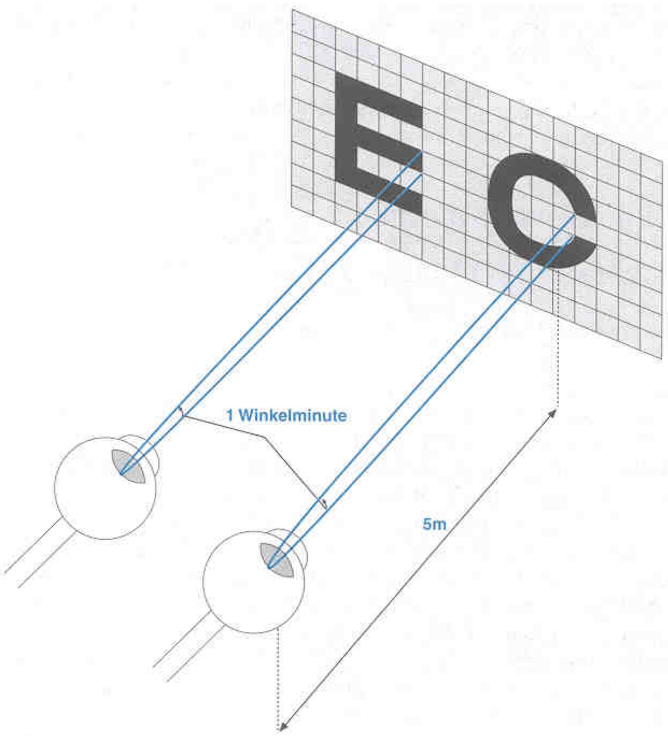
According to Liebsch (1999) normal eyesight is defined through **visual faculty:** This means the overall performance of vision including visual acuity, visual field, colour perception and dark adaptation. It is achieved by the dioptric apparatus: cornea, lens, aqueous fluid, vitreous body and iris.

The maximum ability of optic resolution of the fovea centralis is called **visual acuity** (Hollwich, 1988).

This means the ability to perceive two adjacent points as separate from a certain distance. Usually points which are 1.5 mm apart from each other can be perceived as separate from a distance of 5 m.

Instead of indicating two distances (distance of the two points and observation distance) the **smallest** angle of vision (alpha), under which the two points can still be perceived as separate is used to characterize visual acuity. For the centre of the eye’s sharpest vision, i.e. for the fovea centralis, this angle of vision usually equals 1 angular minute (1/60 degrees), (Hollwich 1988).

This concept is illustrated by figure 2:




Winkelminute = angular minute

**Fig 2**

The visual acuity for foveal vision is called **visus**.

The visual acuity at the fovea centralis usually decreases towards the periphery of the retina due to the increasing distance between the receptors. (Hollwich, 1988)

To test a person's visus the patient is usually asked to read symbols on a visual acuity chart with one eye closed from a standardized distance, usually 5 m (Diepes, 1999).

The visus is determined by first showing the test person a line with as many optotypes as possible in the indicated distance. The symbols are chosen so that the test person can recognize them with some probability.

If the test person cannot recognize the optotypes against all expectation, you move on to a line with a lower visual acuity value until the test person is able to read all symbols in the line. The decisive line is the line in which the test person is able to recognize just above 50% of the symbols.

The smaller the distance between two points the higher the visual acuity. (Diepes, 1999).

### 3.2 Optic properties of the eye

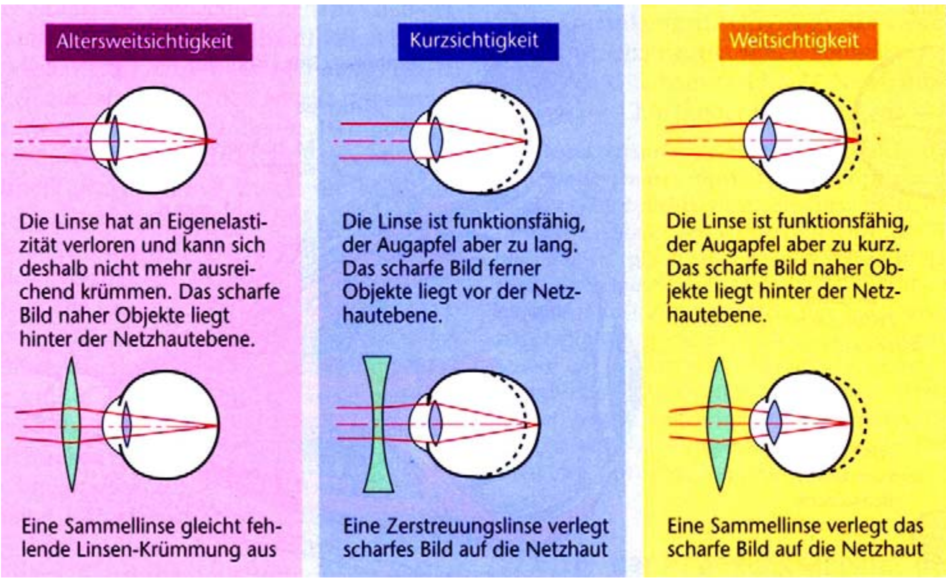
According to Diepes (1999) the **refractive power** is the ability of the optic system (cornea, aqueous fluid, lens and vitreous body) to bend light as it passes through it.

The refractive power is indicated in **dioptres**. 1 dioptre corresponds to a refractive power of a lens which can focus the incident light one metre behind the lens (focal point). According to Prometheus (2006) the cornea has the greatest refractive power. Its curvature is more pronounced than that of the sclera and ensures a refractive power of 43dpt, which corresponds to 2/3 of the overall refractive power.

The system of image formation (dioptric apparatus) creates a real but upside-down picture of the observed object on the retina. This effect is caused by rays of light passing through curved surfaces, which separate the rays because of the different optical density of the medium. Since several surfaces with this property can be found in the refractive eye bulb (retina, aqueous fluid, lens and vitreous body), the image is the result of a complex optic system. This projection of the image is called **refraction**.

The **axis length** indicates the distance between the central point of the retina to the posterior pole of the eye. In normal eyesight this is the point where the incident light is focused on the retina. The axis length usually lies around a normal value of 24 mm. If the axis length increases by 1 mm to a length of 25 mm, e.g. in myopia, refraction changes by -3 dioptres (dpt), (Hollwich 1988).

A balanced ratio between refractive power and axis length enables normal eyesight, which is illustrated by the following figure:




**Magenta: PRESBYOPIA**

The lens has lost its elasticity an thus cannot sufficiently adopt its curvature. The sharp image of near object ist formed behind the retina.

A convex lens compensates for the lacking curvature of the eye´s lens.

**Blue: MYOPIA**

The lens functions well but the eyeball is too long. A sharp image of objects in a distance is formed in front of the retina.

A dispersing lens facilitates that a sharp image is formed on the retina.

**Yellow: HYPEROPIA**

The lens functions well but the eyeball ist too short. A sharp image of near objects is formed behind the retina.

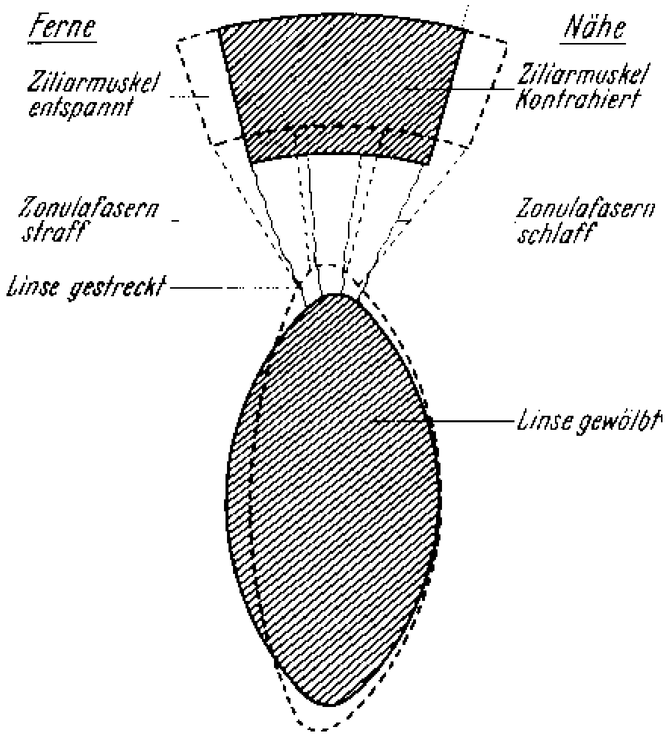
A convex lens facilitates that a sharp image is formed on the retina.

**Fig. 3**

### 3.3 Accommodation

Depending on the distance from which the incident rays of light hit the retina the curvature of the lens is adjusted to the necessary refractive power by the suspensory apparatus of the zonula fibres which exert a pull on the lens. The resilience of the zonula fibres

depends on the ciliary muscles which have their insertion anteriorly at the sclera close to the canal of Schlemm. This process is called **accommodation**. Figure 4 illustrates the change in the tension of the zonula fibres during the process of accommodation.
According to Hollwich (1988) the accommodation is closely linked to the intact innervation by the parasympathetic fibres of the oculmotor nerve and to the pliability of the lens. Any stimulus from the outside within the visual field causes the muscles of both eyes to react in order to focus the image on the centre of sharpest vision.
In order to be able to focus with both eyes Waldeyer (2003) says that both Mm. recti mediales are innervated equally by the Nn. oculomotori. This convergence ensures that the picture of the object is depicted on corresponding sections of the retina.




Ferne = far
Ziliarmuskel entspannt = ciliar muscle relaxed
Zonulafasern straff = zonula fibres tight
Linse gestreckt = lens stretched

Nähe = near
Ziliarmuskel kontrahiert = ciliar muscle contracted
Zonulafasern schlaff = zonula fibres loose
Linse gewölbt = lens spherical

**Fig. 4**

According to Waldeyer (2003) a sharp picture of near objects on the retina is achieved through the contraction of the M. ciliares after receiving an impulse from the parasympathetic N. oculomotorius.
This effectuates that that the zonula fibres can relax and the lens can become more sphere-shaped due to its elasticity, i.e. it can accommodate by increasing its refractive power (Hollwich, 1988).
Simultaneously, this near accommodation is coupled with a constriction of the pupils which is effectuated through the M. sphincter pupillae which is innervated by the parasympathetic N. oculomotorius (Hollwich, 1988).

When we look in the far distance (Waldeyer, 2003) the M. ciliares relaxes and the lens is flattened through the pull of the elastic Bruch's membrane.

The far accommodation goes hand in hand with a dilatation of the pupils through the sympathetically innervated M. dillatator pupillae (Hollwich, 1988).

This short overview clearly shows how complicated the process of only generating a picture is and how many structures have to work together harmoniously to achieve a sharp image.

For means of comparison we will now look at what happens in a myopic eye which often is coupled with astigmatism.

### 3.4 Myopia

In an emmetropic eye the eye has precisely the length that is necessary to guarantee that parallel rays of light from infinity form a sharp picture on the retina (Liebsch, 1999).

But if the ratio between the length of the eye and the refractive power of its dioptric system is mismatched the far point lies no longer in infinity.

The cause for this can either be the lens or the shape of the eye bulb (Liebsch 1999).

If the eye bulb is longer than normal the rays of light do not hit the retina's point of sharpest vision. Gray (1989) indicates deviations from the normal within a range of 24 mm to 29 mm in the case of myopia. The focal point of the optic system lies in front of the retina (Hollwich, 1988). Under these circumstances objects which are far away cannot be seen clearly. The physiological flattening of the lens is limited thus it cannot compensate enough.

No matter how flat the lens is, it is too convex in relation to the eye bulb.

The tension on the sclera is increased due to the longer eye bulb and according to Liebsch the ciliar muscles become thinner. Thus the ciliar muscles cannot adopt their relaxed position, which usually allows for the flattening of the lens.

If, however, the lens is the main problem, the situation presents slightly differently: the lens becomes hyper-convex because of the increasing tension in the tone of the ciliar muscles. In other words: the hypertone muscles around the lens will not enable the flattening of the lens which is so important for seeing objects in a distance clearly.

Liebsch (1999) also mentions that if the bulb grows longer than normally, the internal membranes of the eye, in particular the retina and the choroids membrane cannot keep up with the growth of the sclera.
According to this author this impairs the vascular supply of the eye.

### 3.4.1 Astigmatisms

In this condition the different meridians of the lens have different refractive powers, i.e. that a punctual projection on the retina is not possible. (a-stigmatism).
Astigmatism usually is due to problems of the cornea (i.e. an abnormal curvature of the cornea); more rarely it is caused by the lens.
For the correction it is important whether the caustic lines lie in front or behind the retina. In this context variations can be observed (according to Diepes 1999).
Usually the cornea has different refractive powers due to a defective development.
In astigmatism a point is always seen as line.
Based on these considerations it seems useful to look at the individual structures which are involved in this kind of impaired vision.

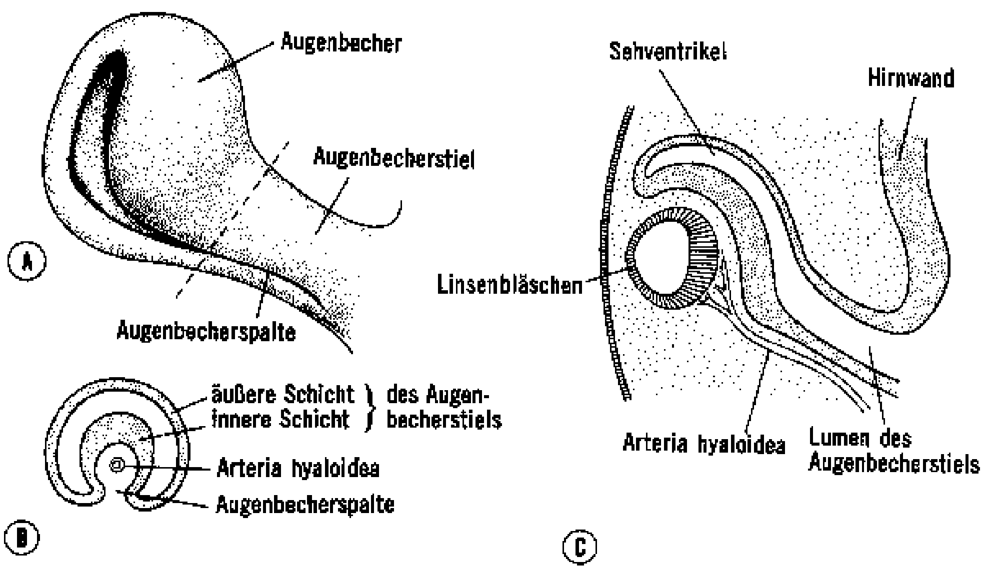
## 4. The eye in a cranial context

This chapter will describe the development and initial interrelations and connections of the eye.

### 4.1 The eye: a projection of the brain

The “container” of the orbit and its content can be compared to the totality of the skull. The orbit contains the eye bulb, ocular muscles, blood vessels, cranial nerves and fascial layers.

**Embryologically** the eye is an evagination of the brain:
The eyes develop at the cranial end of the embryo on both sides of the neural groove (Blechschmidt). According to Tackmann the eye is “[...] a derivative of the brain and thus essentially of ectodermal origin.” (1991:131)
“At first two flat grooves form on each side of the not yet closed forebrain of the 25-day old embryo.” (Langmann, 1985:346)
After the neural groove is closed to form the neural tube the vesicle of the telencephalon is formed at its end (Rohen, 2002). The optic vesicles approach the ectoderm at the sides of the head and according to Blechschmidt (2003) evaginate from it like cups. Blechschmidt writes: “In the embryo the eyes can be found laterally at first” (1989:114). He also says that there is a “[...] simultaneous development of the eyes and telencephalon” (1989:113).
According to Langmann the development of the inner layer of the optic cups corresponds to the principle of the development of the brain. “The space between the inner and outer layer of the optic cups, the optic ventricle, originally is a part of the ventricular system.” (Langmann, 1985: 346)




| | |
|---|---|
| Augenbecher = optic cup | des Augenbecherstiels = of the optic stalk |
| Augenbecherstiel = optic stalk | Sehventrikel = optic ventricle |
| Augenbecherspalte = optic fissure | Linsenbläschen = lens vesicle |
| äußere Schicht = external layer | Hirnwand = wall of the brain |
| innere Schicht = internal layer | Lumen des Augenbecherstiels = lumen of the optic stalk |

**Fig. 5**

A. Ventro-lateral view of the optic cup and the optic stalk in a six-week old embryo. The optic fissure runs at the undersurface of the optic stalk and becomes ever more shallow at the end until it terminates

B. Cross-section of the optic stalk in the region of the dashed line in picture A with the A. hyloidea in the optic fissure

C. Longitudinal section through the lens vesicle, the optic cup and optic stalk in the plane of the optic fissure

Regarding the optic cup Langmann writes: “The inner and outer layers of the optic cup are separated by a lumen, the optic ventricle, in the beginning. When the eye develops further this lumen disappears and both layers have direct contact.” (1985: 346)
Additional interrelations of the eye and the ventricular system will be discussed in detail in chapter 4.2 “The eye is a fluid organ”.
The sclera, fascia, blood vessels and ocular muscles are of mesodermal origin (Tackmann, 1991).

If we look at the development of the retina we can also draw parallels between the eye and the brain.
According to Rohen (2002) the axons of the ganglia cells of the optic nerve, which grow out of the retina, gradually fill the optic nerve completely until they reach the floor of the diencephalon.

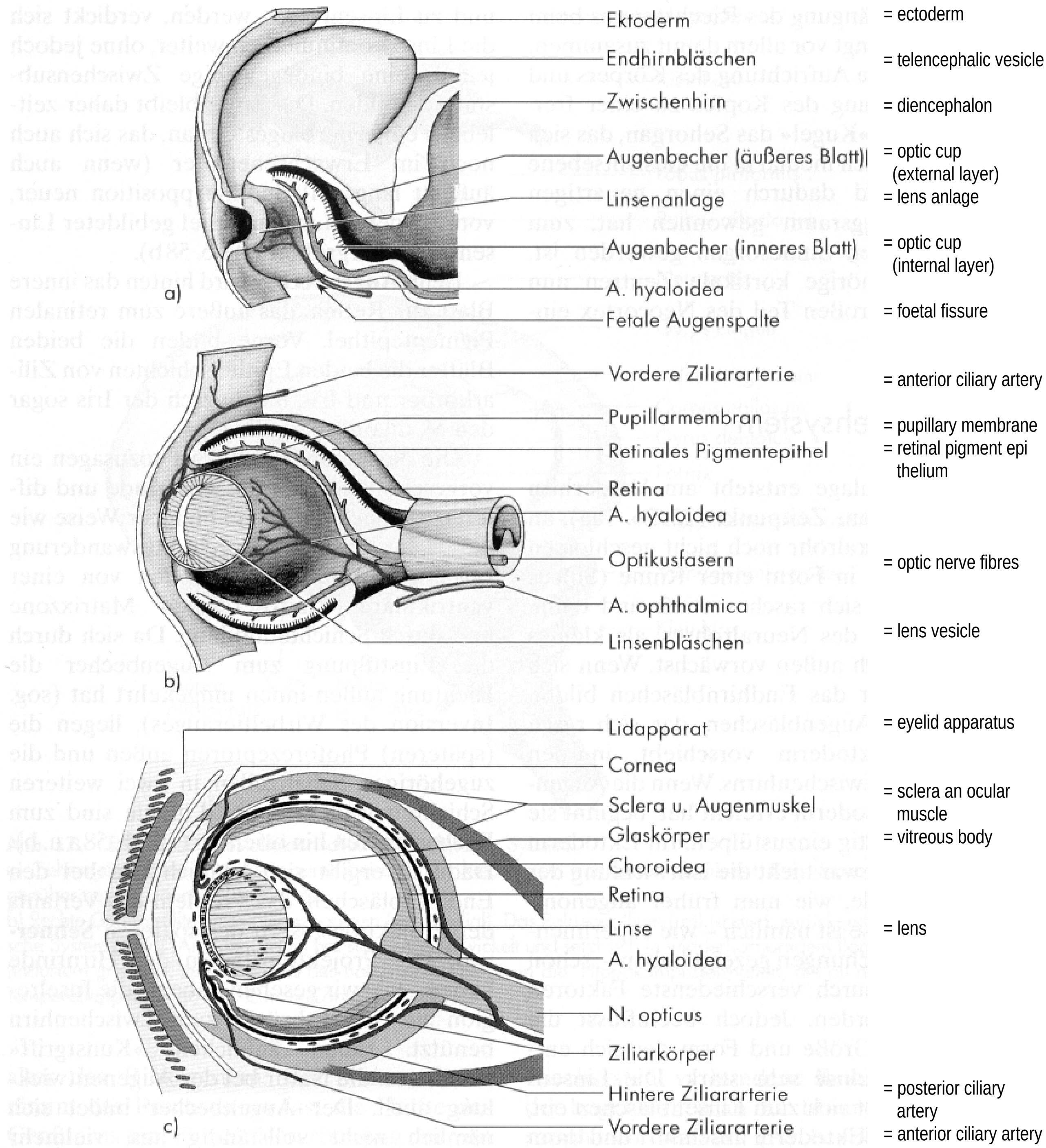



**Fig. 5a**

a) Early stage (about day 32). The optic cup with the foetal optic fissure grows out of the diencephalon towards the ectoderm. The lens vesicle starts to separate from the ectoderm by forming a fold.

b) Later stage (about day 40). The optic cup has almost completely enclosed the lens vesicle which is supplied by the A. hyloidea and the papillary membrane. The optic fibres of the retina grow into the optic nerve via the foetal optic fissure.

c) The various layers of the fully developed eye which is covered by the (still clotted) eye lids.

Also on a vascular level there is a connection:
According to Schulz -Zehden (1986) the optic cup initially is linked with the brain via the optic stalk which also carries the Vasa hyloidea. Gradually it develops to form the N. opticus, which carries the A. centralis retinae in its centre.
From that Schulz–Zehden (1986) concludes that with the optic cups the brain has sort of extended antennas which maintain a close relationship with the brain throughout the whole individual development.
Another continuous relationship with the brain can be found in the eye. According to Gray (1989) the Pia mater finds its continuation in the substance of the N.opticus.
Schulz–Zehden explains that the arrangement of the meninges in the eye corresponds to that of the brain, which can be put down to the embryologic development:
“The loose layer of mesenchyme, which envelops the eye from the end of the fifth embryologic week onwards, forms the eye’s anterior chamber with the ciliar muscle and the Mm. sphincter et dillatator pupillae. It also forms an inner layer (similar to the Pia mater of the brain), which develops further into the choroidea and an outer layer (similar to the Dura mater), which develops into the sclera and has continuity with the Dura mater of the N.opticus.” (1986: 102/103)
Thus one could say you can gain a direct glimpse of the cerebral structures when you look someone in the eyes.
Rohen (2002) provides an explanation of this statement. He explains that large areas of the occipital lobe differentiate further in relation with the visual system to serve the processing of visual inputs. He thus comes to the conclusion that through the structure of the visual pathway in the human being – especially after adopting an upright position – an in many respects unique spatial awareness is developed. Rohen also says that this enables the human being “to dissociate as individual from the environment and mentally process it due to the enormous development of the cerebral cortex.” (2002: 103)

Carreiro describes the functional consequences in an osteopathic context: “Since the eye bulb is a prolongation of the brain it displays movement patterns which are similar to those that Sutherland described for the central nervous system.” (2004: 168)
When looking at and treating eye problems, especially myopic conditions, it is certainly useful to keep this idea in mind.

The developments are always developments of the embryo/foetus as a whole. This holds on a larger scale for the development of the brain in relation to the growth of the cranial bones as well as on a smaller scale for the development of the eye in relation to the growth of the orbital cavity.
Rohen points out: “The growth of the brain induces the first development of the dura and the vascular supply. Only through these forces of growth the cranial bones develop. They form around the brain and especially also around the eye. In the whole region of the skull the organ themselves (brain, sense organs, masticatory apparatus, etc.) determine the form of the skull and the cranial cavities.” (2001: 80/81)

If you look at a statement by Sutherland in this context: “[...] the force lies in the fulcrum of a rhythmic balance. The fluctuation of the cerebrospinal fluid is active and changes the tension in the reciprocal tension membrane [...]” (2004, I: 54), you can come to the following conclusions:
If the membranes change their tension rhythmically, they will pull the cranial bones in their position. This does not only hold for the bones of the neurocranium, which are directly connected with the Falx cerebelli and the Tentorium cerebelli, it also holds for the bones of the visceroranium: they are moved by the cranial mechanism because they are influenced by the cerebrospinal fluid via the reciprocal tension membrane.

### 4.2 The eye is a fluid organ

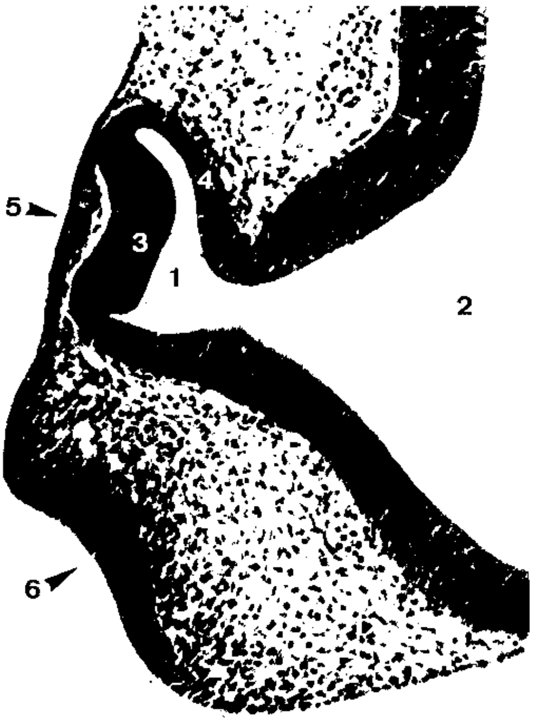
This chapter wants to summarize the eye’s fluid character. Some considerations that have already been mentioned in other chapters will be reiterated again in order to underline the special role of the fluid elements of the eye. The special relationships of the structures of the eye with the fluids will be emphasized to make the treatment approach which is applied in this study easier to comprehend.
The classic osteopathic literature offers a number of descriptions.
Magoun (1998) mentions the eye as a fluid medium, whose optic nerve, N. opticus, is surrounded by a perineural passage.
His statement is based on the fact that the optic nerve is not only enveloped by dural layers but also by a subarachnoid space that is filled with cerebrospinal fluid (cf. chapter 5.4 “Neurological causes”).
As described in chapter 5.2.2.1 “Changes of the intraocular pressure”, another main fluid component can be found in the eye chambers, which are completely filled with

aqueous fluid. The aqueous fluid is produced by the ciliary body and flows from the posterior chamber via the pupil to the anterior chamber (Lanz und Wachsmuth, 2004).
According to Gray (1989) the vitreous body, which comprises one fifth of the eye bulb, consists of 99 percent water.
Also the sclera is a fluid structure since, according to Gray "the sclera is visco – elastic, a factor important in the regulation of the intraocular pressure." (1989: 1181)
The cornea, too, can absorb fluids since it has to continuously secrete a protective film according to Gray (1989).

The elasticity of the eye bulb is of particular relevance. If you take a closer look you realize that external influences like traction, compression and other forces can change the shape of the eye bulb. To stay in line with Sutherland's considerations with regard to the interdependence of structure and function you have to deduct that this change of shape of the eye bulb also entails a change in function.

In relation to the ventricular system the eye has a particular significance.
I was able to find passages in the literature which claim that there is a ventricular system in the eye:
Rohen compares the ciliary process of the ciliary body with the choroid plexus in the ventricles of the brain. "While the posterior part of the ciliary body, which connects to the ora serrata, is smooth (Orbiculus ciliares), the anterior part forms 70 –80 leave-like projections (Processus ciliaris), which can be compared with the choroid plexuses of the ventricles in the brain and secrete a clear liquid, the aqueous fluid (Humor aquosus)." (2001: 174)
Langmann mentions that between the layers of the optic cup there is a small gap, which is called optic ventricle. "...the optic vesicles [start to] invaginate and form the double-walled optic cup [...]. The inner and outer layers of the optic cup are separated by a lumen, the optic ventricle, in the beginning. When the eye develops further this lumen disappears and both layers have direct contact." (1985: 346)

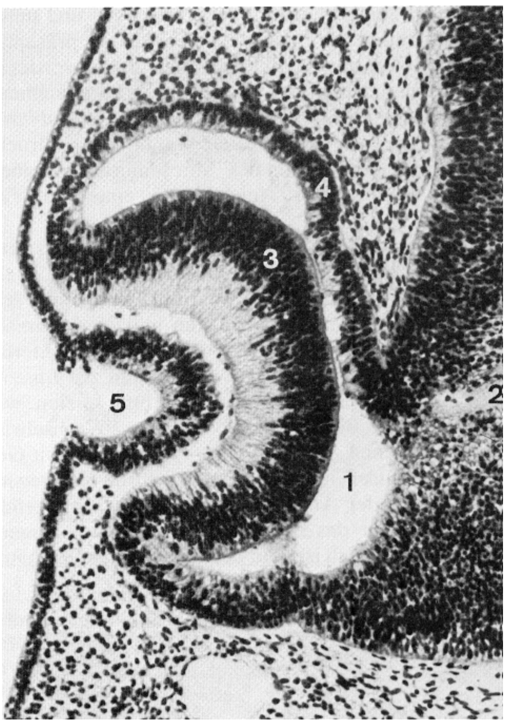
The figures 6a and 6b illustrate that embryologically there is a connection between the third ventricle and the optic cup.




1 Ventriculus opticus
2 Ventriculus prosencephali or III. ventricle
3 retinal disc or inner layer of the optic cup
4 external layer of the optic cup
5 lens placode or lens pits
6 nasal placode

**Fig. 6a** The preliminary eye in an embryo of 3.5 mm cranio-caudal length

This figure shows how the optic cup evaginates from the third ventricle.




1 Ventriculus opticus
2 Ventriculus prosencephali or III. ventricle
3 retinal disc or inner layer of the optic cup
7 external layer of the optic cup
8 lens placode or lens pits

**Fig. 6b** The preliminary eye in an embryo of 5 mm cranio-caudal length

The assumption that there is a ventricular system in the ciliary body can be corroborated when we compare the cerebrospinal fluid with the aqueous fluid. If a miniature ventricular system was present in the eye the two fluids must resemble each other.
Evidence for that I found in the medical dictionary Pschyrembel: “Aqueous fluid which is almost identical to cerebrospinal fluid in its composition and isotonic to serum, contains electrolytes, proteins, sugar, enzymes, hyaluronic acid, ascorbic acid; ... .” (1998: 792)
Also the definition of papilloedema in chapter 5.2.2.1 “Changes of intraocular pressure” points towards this connection. Waldeyer (2003) mentions an increase of pressure through the effect of cerebrospinal fluid on the intraocular space.
Magoun (1998) mentions the relation between fluid circulation at the infundibulum of the third ventricle and the N. abducens which supplies the eye.
Due to this comprehensive effect of the fluid on the structures of the eye I have come to the decision to treat this fluid organ with a fluid technique within the framework of this study.

## 5. Anatomical particularities with regard to myopia

If we look at the condition myopia from the perspectives of the cranial concept, the structures which have a functional relationship with the orbit and its content have to be examined and treated.

This includes the aspects of arterial and venous blood supply and the nerves on a sensory and neurovegetative level along the visual pathway right to the visual cortex.

It comprises also the bony framework, i.e. the interaction of the cranial bones, the relationships of the meningeal structures with each other but also their continuity with the sclera of the eye. All these issues play a key role in this context.

**Basically a change in the process of seeing can have its cause in the following areas:**

Along the optic axis, especially in the area of the cornea, lens, vitreous body or in the area that processes the visual inputs, especially in the area of the retina, the optic nerve or the visual cortex.

### 5.1 The orbit

Embedded in soft tissue (adipose tissue) the eye lies in the **orbit** which is formed by seven cranial bones.

The bony framework of the orbit is extremely important for the eye as a whole. It provides insertions for muscles and ligaments and its form and harmonious movement are very important for its content.

The openings in the bony framework where nerves and vessels pass through are dependent on the ability of the bones to move freely in relation to the tension of the meninges. Magoun writes:

“The orbit is a flexible cone consisting of seven bones (twelve for the two). All must be freely movable if the eye is to be healthy and the extrinsic muscles function normally.” (1951/1997: 159)

In “Entrapment Neuropathy” he describes that fixations of the orbital bones play a significant role in problems with the eyes because they can provoke a venous stasis or increased dural tension. “The four walls are made up of seven bones for each orbit: the frontal, sphenoid, maxilla, zygoma, palatine, ethmoid, and lacrimal. Fixation of any of these constituents can be significant in eye malfunction because of the resulting venous stasis or dural tension” (1998: 192)

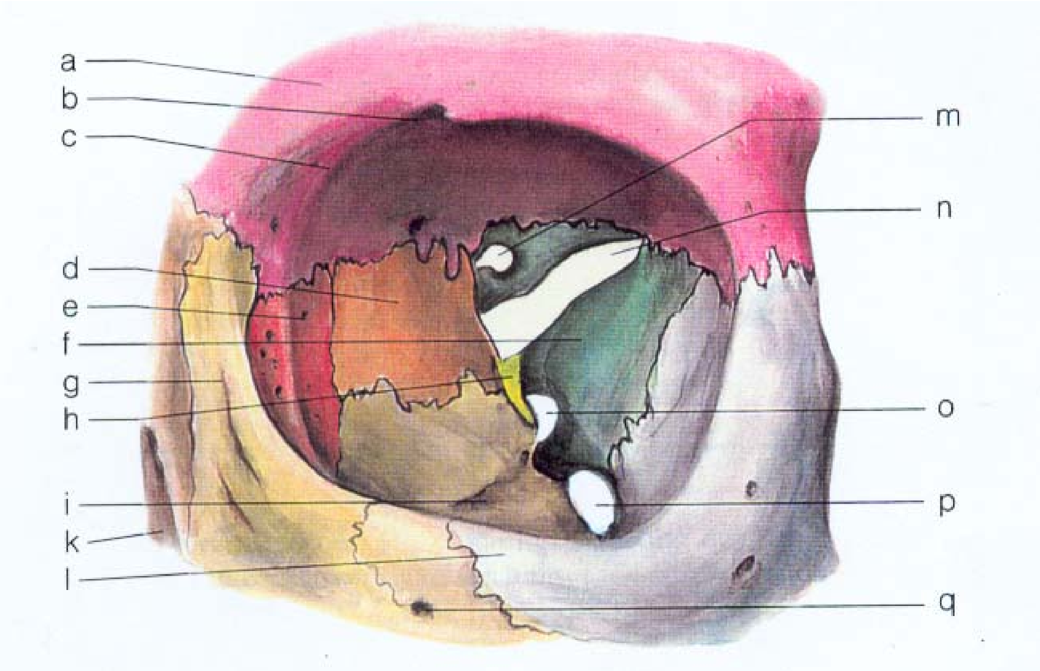



**Fig.7**

Bones and orifices of the orbit

A Os frontale

B Incisura supraorbitalis

C Trochlea

D Os ethmoidale

E Os lacrimale

F Os sphenoidale

G Os maxillare

H Os palatinum

I Sulcus infraorbitalis

K Os nasale

L Os zygomaticum

M Canalis opticus

N Fissura orbitalis superior

O Foramen rotumdum

P Fissura orbitalis inferior

Q Canalis infraorbitalis

The form of the orbit changes with the flexion and extension movements of the SBS with the aim to supply the eye with fluid. (Magoun, 1997)

According to Magoun (1997) many eye problems (e.g. pain, glaucoma, tiredness of the eyes) are caused by an impaired drainage through the superior orbital fissure towards the cavernous sinus.

When the sphenoid moves into flexion according to Magoun (1976) its Alae majores move anteriorly, which causes the eye bulbs to become relatively more prominent.
Literally he writes: “As the sphenoid goes into flexion the greater wings move anteriorly, the eyeballs become relatively more prominent, the zygomae are everted inferolaterally to increase the superomedial–inferolateral diameter...“”(1976)
The eye bulb is pushed anteriorly (Magoun, 1998). This changes the tension in the walls of the cavernous sinus and also has an effect on the circulation of venous blood of the eye as described in chapter 5.2.2 “Venous causes of eye lesions”.
“...the points of origin of the extrinsic muscles move forward in integrated relationship.” (Magoun: 1976: 206)

In the extension movement of the SBS the orbit moves exactly opposite to its movement in the flexion phase. The eye bulb becomes longer and the point of sharpest vision is displaced more anterior, which can be a predisposition of myopia.
Magoun (1976) postulates that an extension pattern with a longer orbit has an effect on the form of the eye bulb, which means that the light’s rays are focused before the retina: “In myopia the greater wings may be shifted backwards, increasing the anteroposterior diameter, so that the focal point is in front of the retina” (1998: 192)
Also Becker writes: “In myopia or nearsightedness, the rays of light are focused in front of the retina.” (1997:365)

A torsion pattern or a sidebending-rotation pattern (SBR) of the SBS has other effects on the orbit. Magoun writes: “In torsion or sidebending rotation, on the side of the inferior greater wing, the sphenoid border is carried antero–inferiorly while the maxillary border shifts posteroinferiorly to narrow the [inferior orbital] fissure.”
In this context Becker argues that in a torsion pattern one eye becomes far-sighted while the other one becomes short-sighted. He also says that this can be the case in a SBR-pattern but to a lesser extent.
Naturally this has consequences for the neural pathways and vessel that pass through.
Magoun (1976) says:

“Should one eyeball be protruded and the other retracted with torsion or sidebending rotation, the prominent eyeball tends to become dominant and the other to atrophy from disuse.” (1976: 207)

### 5.1.1 The axes of the eye

Two different descriptions of the axes of the eye can be found in the literature. I will take this into account in my paper.

Fryman (1998) describes the axis as running through the posterior border of the Sella turcica, which extends in the posterior cranial fossa above the Tentorium cerebelli.

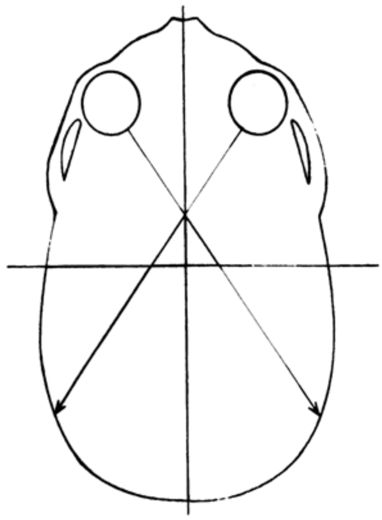


**Fig.8**

According to Carreiro (2004) the axis of the bulb (optic axis) is marked by the optic nerve. She argues that the axis runs though the inferior and medial part of the superior orbital fissure.

This optic axis differs from the axis of the orbit by 23°. Therefore the point of sharpest vision lies laterally to the blind spot (Prometheus, 2006).

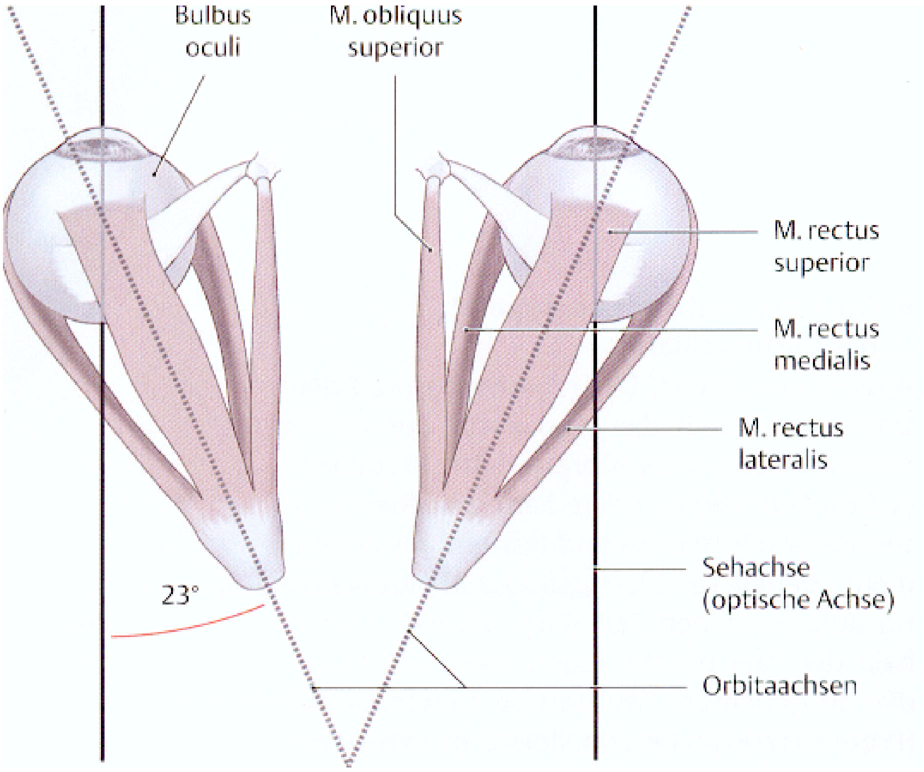



**Fig. 9**

Sehachse (optische Achse) = visual axis (optic axis)

Orbitaachsen = axes of the orbit

Carriero (2004) points out the deviation of the axes.

This will be taken into account in the description of the treatment technique applied in this study.

## 5.2 Causes of myopia in the area of the arterial and venous passages

### 5.2.1 Arterial causes of myopia

Figure 10 illustrates the arterial supply of the eye:

The A. ophtalmica branches off the A. carotis interna immediately after it has passed through the dura. In the subdural space it runs arteriorly and laterally towards the intracranial opening of the optic canal where the optic nerve also passes through. (Lanz und Wachsmuth 2004:470, 478)

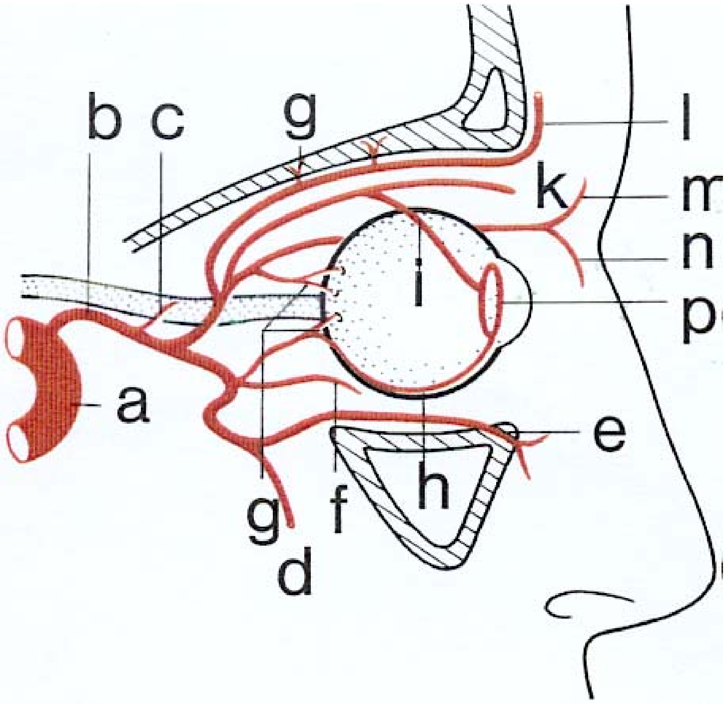



**Fig. 10**

Arterial supply: **a** Arteria carotis interna; **b** A. ophtalmica; **c** A. centralis retinae; **d** ramus maxillares; **e** ramus infraorbitales; **f** rami musculares; **g** Aa. ciliares posteriores breves; **h** Aa. ciliares posteriores longi; **i** A. ciliares anterior; **k** A. lacrimalis; **l** A. supraorbitales; **m** ramus palpebralis; **n** ramus angularis; **o** rami ethmoidales; **p** circulus arteriosus iridis

Then the A.ophtalmica crosses the optic nerve in a curve where it forms numerous small branches to the eye.

Another branch is the A. centralis retinae. It begins underneath the N. opticus. For a short distance it lies in the dural nerve sheath and runs to the retina (Gray´s Anatomie, 1989).

After passing through the sclera long arterial branches run to the ciliary body and to the Circulus iridis major (Lanz/Wachsmuth, 2004).

Due to dural tensions an irritation of the A.ophtalmica in the region of the optic canal is imaginable just like an impairment of the arterial branches via the sclera. According to Magoun (1997) especially the A. carotis interna, the A. ophtalmica and the orbital branches at the apex of the orbit are prone to impairments.

### 5.2.2 Venous causes of myopia

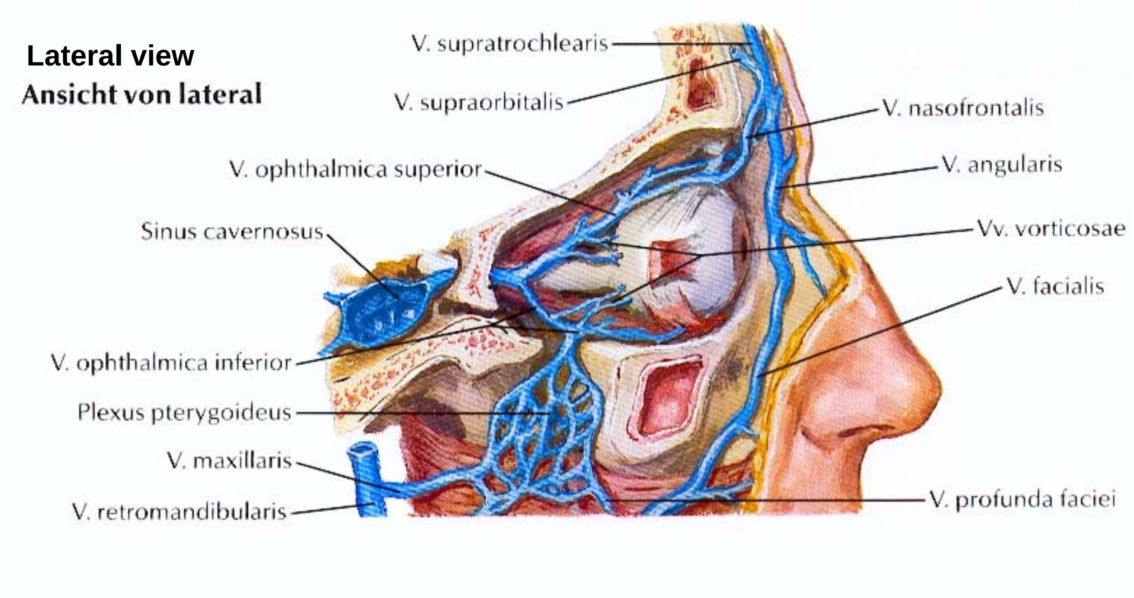



**Fig. 11**

The venous passages are related to many structures in the head. The venous drainage of the eye is effected by the V. ophtalmica superior, which merges with the V.ophthalmica inferior in the vicinity if the Fissura orbitales superior and from then on is called V. ophtalmica (Lanz/Wachsmuth). Figure 11 illustrates that the V. ophtalmica superior is formed by the V. nasofrontalis and V. angularis in the medial corner of the eye. It leaves the orbit (according to Tondüry, 1981) through the superior orbital fissure and receives among others the Vv. vorticosae.

The V. ophtalmica inferior receives the Vv. vorticosae of the lower half of the eye bulb. According to Lanz/Wachsmuth (2004) it meets the V. ophtalmica superior.

At the eye bulb the venous system begins with the canal of Schlemm (Sinus venosus sclerae).

According to Lanz/Wachsmuth the aqueous fluid runs via the pupil from the posterior chamber into the anterior chamber of the eye from where it reaches the canal of Schlemm which is connected with the intra- and episcleral venous plexus via 20 to 30 canals. According to Waldeyer (2003) these canals either reach into the deep venous plexus or they pass through the sclera and open up as aqueous veins into the episcleral veins. In this context it is imaginable that dysfunctions may occur due to abnormal tension of the sclera. Lanz/Wachsmuth (2004) talk about impairments of this system: some of the orbital veins pass through the M. orbitales. The contraction of the muscle can cause a constriction of the veins which leads to an intraorbital stasis of blood and protrusion of the eye bulb. The authors argue that the Vv. ophtalmicae superior and inferior can be narrowed through muscular contraction. According to them an exophtalmus might occur via the Anulus tendinosus communis.

In this context we must not forget that the optic nerve in its dural envelope passes in the vicinity. An increased dural tension might lead to a venous stasis because the V. ophtalmica passes through the superior orbital fissure to drain into the cavernous sinus. Disturbances in the reciprocal tension membrane, e.g. through meningitis, encephalitis or toxic factors can cause serious impairments of the eyes according to Becker (1997).

“The tone quality of the membranes must be perfect to insure good venous drainage from the skull and the orbits.” (Becker, 1997:359)

In addition, Becker writes that the cavernous sinus has a central role in the venous drainage of the skull: firstly, due to its anatomical location – it lies close to the SBS – on both sides laterally to the body of the sphenoid, secondly, due to its vicinity to the optic nerve and thirdly, due to its plexus-like structure and extensive connections.

The cavernous sinus is part of the membranous system and the sinus through which the drainage of the eye is mainly guaranteed.

Venous stases of the eyes can be caused by fixations of the bones which form the orbit. According to Magoun a slowing down of the circulation is normally due to a narrowing of the fissures. Magoun (1997) points out that venous stases with a congestion of the Vv. ophtalmicae, the Sinus petrosae and Sinus cavernosus back to the orbit can be caused by a narrowing of the superior and inferior orbital fissures.

Magoun postulates that a restriction of the venous drainage of the eye bulb which is well supplied with blood can be the consequence of a number of dysfunctions which can provoke a narrowing of the mentioned fissures. In this context Magoun writes: “Congestion in the cavernous sinus can make trouble. The congestion may arise in a variety of ways, from back pressure in the area of the jugular foramen due to disturbance of the occipitotemporal or condylar parts, from a shifting of the sphenoid or frontal bones, thus retarding drainage through the petrosal sinuses, or from maxillary interference with pterygoid plexus drainage.” (1998: 193)

Also Becker (1997) writes regarding a compression of the Sutura occipito-mastoidea, that traumatic lesions of the Sutura occipito-mastoidea have a direct effect on visual impairments on the same side due to the constriction of the venous drainage and backlash effects on the other side.

The mobility of the SBS does play a role in venous drainage not only indirectly through its effect on the dural membrane but also through its flexion and extension movements which according to Magoun (1997) promote venous drainage.

“Veins: The ophthalmic drains through the cavernous sinus into the petrosals. Its flow is accelerated by the pumping action of the respiratory motion of the petrosphenoid articulation. Its flow is retarded by undue tension on the walls of the cavernous sinus, by lesions of the bony components, by narrowing of the sphenoidal fissure and other similar causes.” (1997: 160)

According to Magoun the delicate walls of the veins are very vulnerable. This is how he describes (1976) the main way of the slowing down of the blood stream: “The principle avenue of retardation is by way of the ophthalmic vein, the cavernous sinus, the petrosal sinuses and especially the jugular foramen.” (1976: 207)

According to Becker (1997) also the related tension of the Sutherland fulcrum, which comprises the straight sinus, is relevant. Becker claims that the straight sinus is responsible for the venous drainage of the great vein of Galen.

### 5.2.2.1 Changes of the intraocular pressure

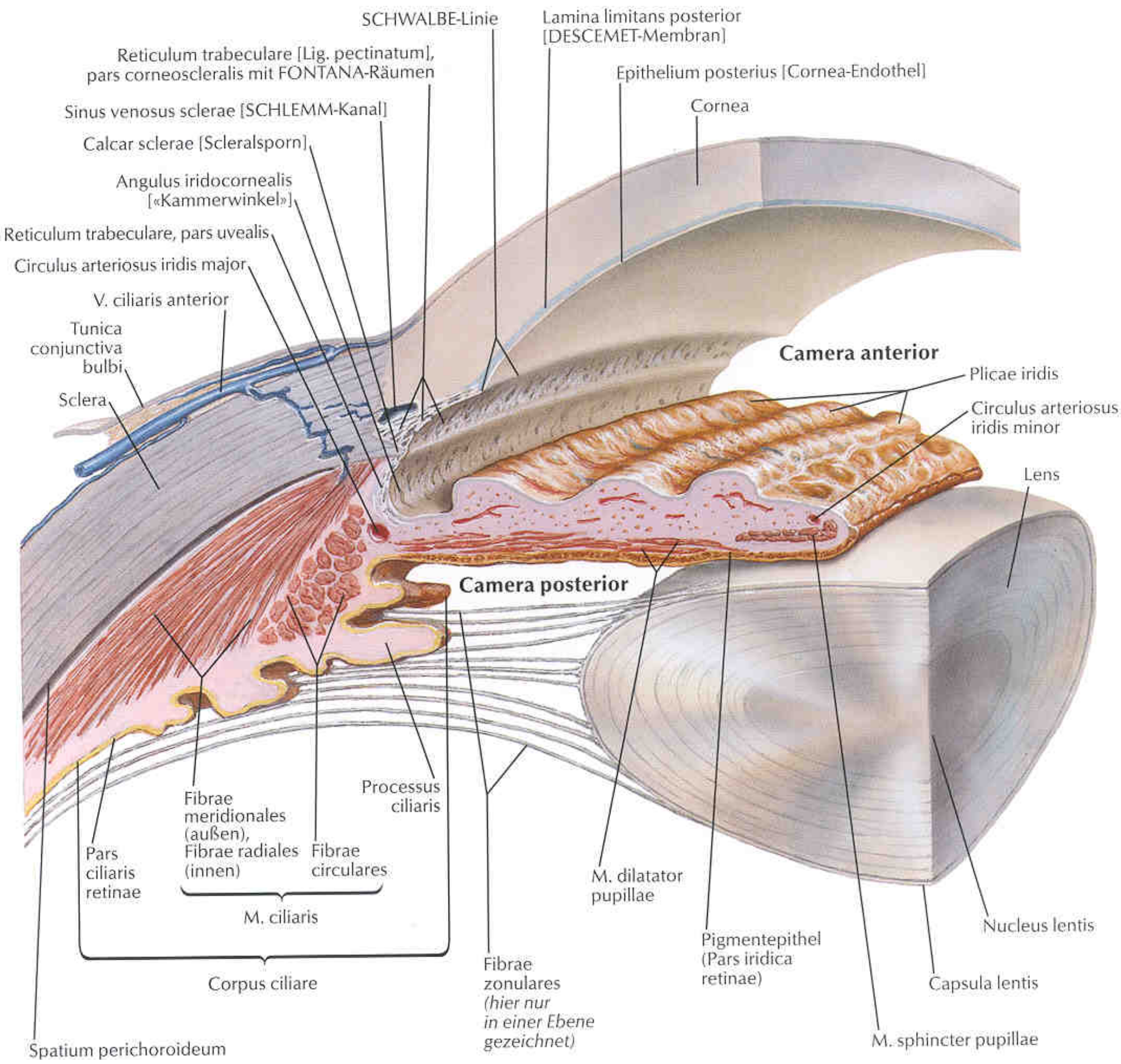



**Fig. 12**

Figure 12 illustrates that the Camera bulbi anterior is confined by the cornea, iris and lens. It is completely filled with aqueous fluid and communicates with the Camera bulbi posterior via the pupil. The Camera bulbi posterior is confined by the posterior surface of the iris, the ciliary processes (Processus ciliaris), which produce the aqueous fluid that reaches the anterior chamber via the pupil.

The perineural passage of the cerebrospinal fluid can be impaired in the region of the optic canal because according to Waldeyer the meninges accompany the optic nerve through the optic canal right to the eye. In this context I would like to refer to Lanz/Wachsmuth who found out that: “The presence of the arachnoid envelope can be verified throughout the whole canal as well as in the passage of the nerve through the orbit. In an adult person there are many connective tissue strands between the periosteum and the arachnoidea and Pia mater of the optic nerve, which provide a tight connection and a narrowing of the subarachnoidal fluid spaces". (2004:475) Waldeyer (2003) says that an increase of pressure in the cerebrospinal fluid can provoke a protrusion of the opticus papilla in the intraocular space which is called papilloedema.

According to Lanz/Wachsmuth (2004) the region around the Limbus corneae is of utmost importance for the intraocular pressure: this region represents the junction of the sclera to the cornea, where the iridocorneal angle is located and thus the drainage of the aqueous fluid takes place. This means that the iridocorneal angle is the peripheral niche of the anterior chamber of the eye which is confined by the Limbus corneae anteriorly, by the ciliary body and the trabercles of the iris posterolaterally. The authors also describe that at this junction between cornea and sclera the trabercular network and the canal of Schlemm are located in the sclera. Part of the venous system of the canal of Schlemm is embedded in the cornea.

The increase and decrease of the volume of the sphere of the eyeball is limited by the enveloping sclera. According to Lanz/Wachsmuth (2004) the sclera has to resist the well-regulated intraocular pressure. The authors also say that an intracranial increase of pressure is transmitted from the intracranial space via the subarachnoid space to the sheaths of the optic nerve.

In this context Becker points out:

"The eyeball with its intrinsic refractive surfaces is a liquid mass in a sclerous envelope and subject to the forces that surround it in its orbital home. It responds readily to any environment change, and the ocular change, and the intraoccular change is refracted as a refractive pattern." (1997:365)

Schulz-Zehden says: "Every change in intraocular pressure is balanced by a healthy eye through counterregulating measures because the clarity of the refractive apparatus depends on the constant distance of cornea-lens-retina." (1987:163)

In this context the junction of the ciliary body plays an important role: Lanz/Wachsmuth say that the external surface of the ciliary body corresponds to the M.ciliaris and has a connection with the sclera, the Lamina subarachnoidales and the Bruch's membrane. Rohen (1991) compares the Processi ciliare with the choroid plexus of the ventricles in the brain. In this context it is interesting that according to Lanz/Wachsmuth (2004) the iridocorneal angle becomes smaller in near accommodation. When the M. ciliare is contracted the diameter of the transverse section of the trabercle network becomes wider.

In addition, the longitudinal axis of the canal of Schlemm is supposed to also become bigger as well, because the scleral spur is projected.

In these structural relationships Selby sees a connection with myopia. “If the pressure of the aqueous fluid clearly increases, [...] the distances inside the eye change which entails unclear vision” (1992:79). According to Selby (1992) this can be a cause of short-sightedness.

Thus we can conclude a direct connection between accommodation and the regulation of the intraocular pressure.

This is also made evident through the importance of the fluids of the eye for the process of seeing. Thus the eye is a fluid organ also from a functional point of view.

### 5.3. The relevance of the muscles of the eye bulb

Figure 13 illustrates the muscles of the eye bulb (extrinsic muscles). According to Rauber/Kopsch (1987) the movements of the eye bulb are controlled by four straight (Mm. recti superior, inferior, medialis and lateralis) and two oblique muscles (Mm.obliquii superior and inferior).

Except the M. obliquus inferior (origin at the medial border of the orbit) all extrinsic muscles of the eye have their origin at the Anulus tenidineus communis, a tendinous ring which according to Rauber/Kopsch (1987) is on all sides connected with the bony walls of the orbit.

According to Lanz/Wachsmuth (2004) it encloses the N. oculomotorius, N. nasociliares, N. abducens and the A. ophtalmica and also the Fasciculus opticus. Also the Aa. and Nn. ciliares are fixed on this ring according to Lanz/Wachsmuth (2004).

On the one hand the ring is a junction between the dural sheath around the optic nerve and the periost of the orbit; on the other hand it represents the continuity of the fascial sheaths of the inserting muscles.

All extrinsic muscles of the eye insert on the sclera.

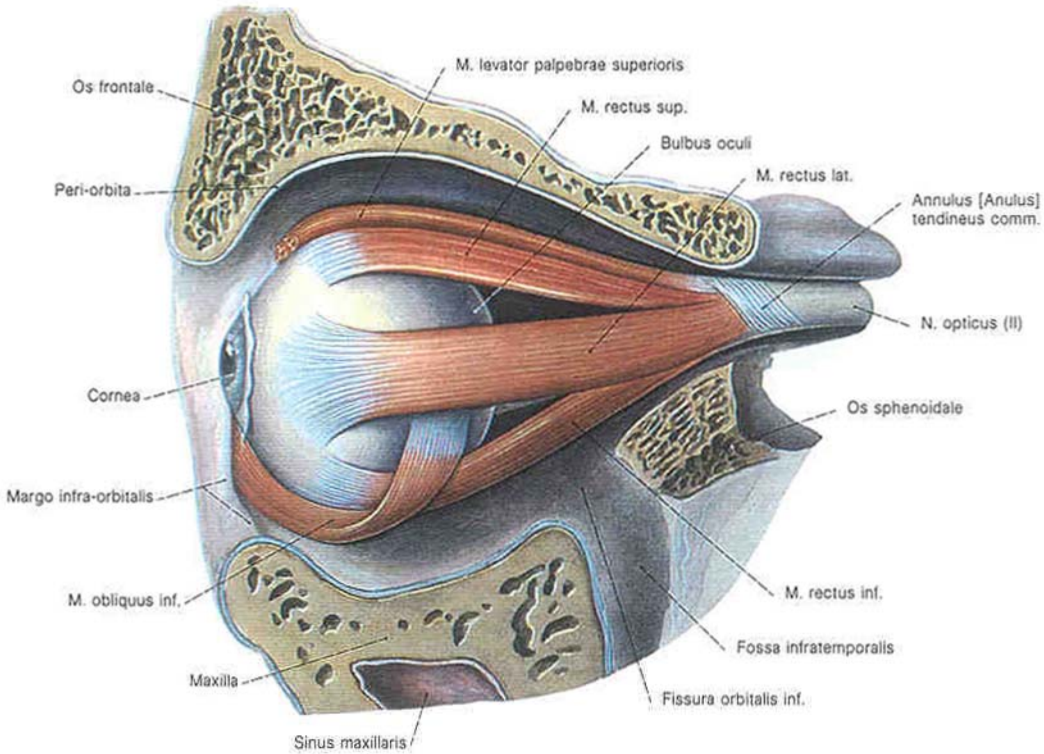
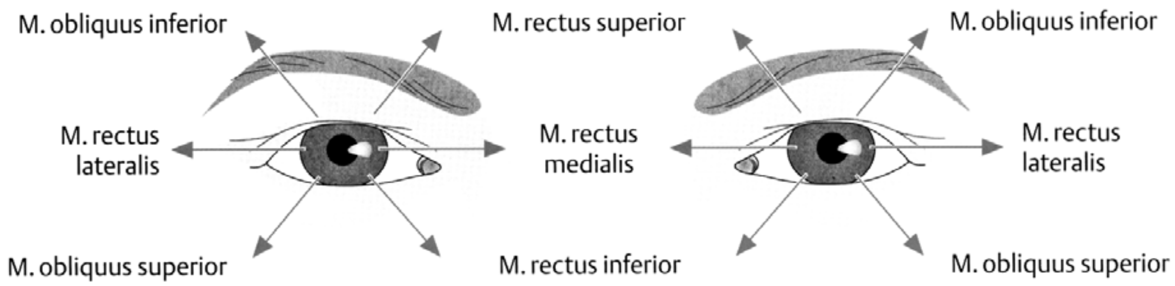


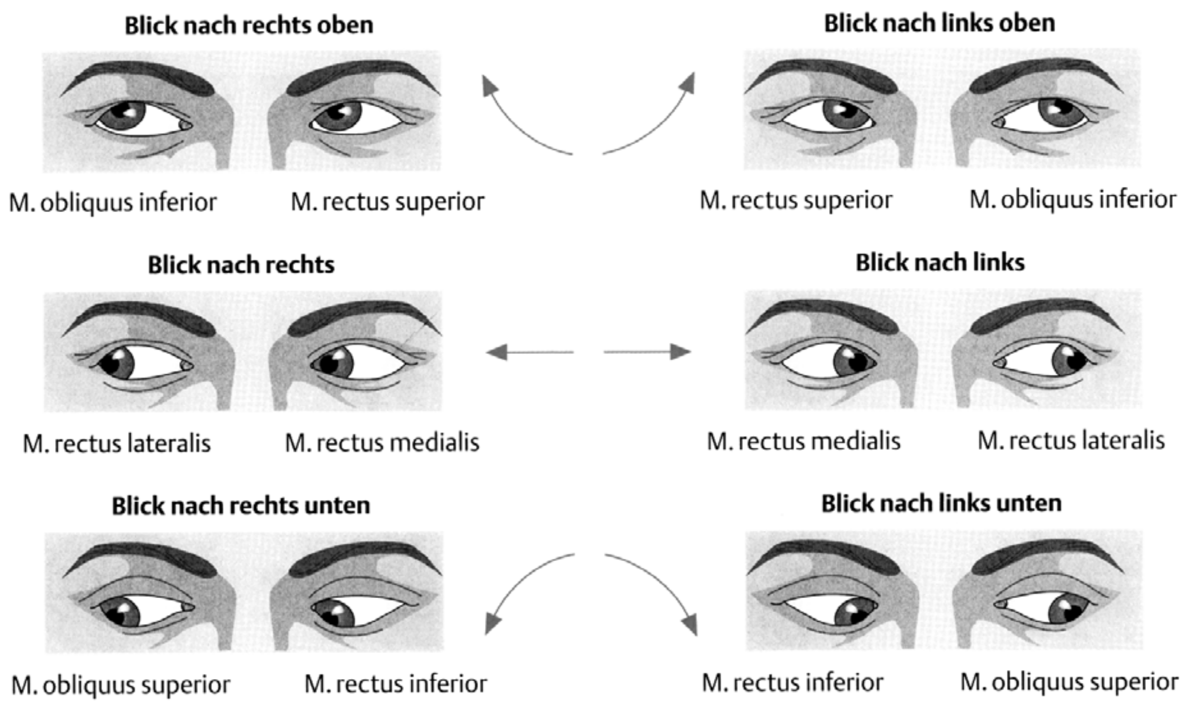

**Fig. 13**

The main direction of pull is determined by the respective orientation of the muscle and its point of insertion on the bulb.

The function and innervation of the individual muscles are listed in figure 14 below.

| | Muskel | Hauptfunktion | Nebenfunktion | Innervation |
|---|---|---|---|---|
| **a** | M. rectus lateralis | Abduktion | keine | N. abducens (VI) |
| **b** | M. rectus medialis | Adduktion | keine | N. oculomotorius (III), R. inferior |
| **c** | M. rectus superior | Elevation | Innenrotation und Adduktion | N. oculomotorius (III), R. superior |
| **d** | M. rectus inferior | Depression | Außenrotation und Adduktion | N. oculomotorius (III), R. inferior |
| **e** | M. obliquus superior | Innenrotation | Depression und Abduktion | N. trochlearis (IV) |
| **f** | M. obliquus inferior | Außenrotation | Elevation und Abduktion | N. oculomotorius (III), R. inferior |



| | |
|---|---|
| Muskel = muscle | Hauptfunktion = main function |
| Nebenfunktion = secondary function | Abduktion = abduction |
| Adduktion = adduction | keine = none |
| Innenrotation = internal rotation | Außenrotation = external rotation |
| Außenrotation und Adduktion = external rotation and adduction | Innenrotation und Adduktion = internal rotation and adduction |
| Depression und Adduktion = depression and abduction | Elevation und Abduktion = elevation and abduction |
| Blick nach rechts oben = looking up to the right | Blick nach links oben = looking up to the left |
| Blick nach rechts = looking right | Blick nach links = looking left |
| Blick nach rechts unten = looking down to the right | Blick nach links unten = looking down to the left |

**Fig. 14**

The Anulus tendineus communis is a good example of the various interrelations. Here we can see how a change in one structure has an effect on all the other related structures:

In this context Magoun (1998) says that every change in the distance between the origins and insertions of the muscles can entail an impaired function. The distance between origin and insertion can be altered through bony dysfunctions, where the muscles either loose their tone or become spastic. According to Magoun a membranous dysbalance is one of the most important factors causing nerve compressions. This can have consequences for refraction. Lanz/Wachsmuth point out that: "Impaired nerve supply [of the muscles of the eye] might lead to simultaneous nerve impulses in the antagonists with the consequence of a retraction of the bulb." (2004: 500)

Regarding muscular dysbalances the authors emphasize the role of the M. rectus laterales: If this muscle has its insertion too far posterior, the abduction is limited and the bulb will be retracted with each contraction.

The retraction of the bulb will dysregulate the path of light rays onto the retina.

From that we could conclude that an altered tone of the muscles inserting on the sclera leads to a change in the tension of the dura. Lanz/Wachsmuth (2004) describe that via a change in the tension of the Tenon's capsule also the tension in the sclera is altered: "Through the connection with the sheaths of the ocular muscles and their formation of the Cingulum bulbi and the Vagina bulbi every contraction of the muscles also influences these formations." (Lanz/Wachsmuth, 2004: 506)

Note: The Cingulum bulbi is a sort of belt of connective tissue at the internal surface of the Tenon's capsule. (Lanz/Wachsmuth, 2004). The Tenon's capsule is also called Vagina bulbi or fascial sheath of the eyeball; it is a different term for the connective tissue capsule around the eye bulb.

Conversely, also an altered dural tension can influence the muscle tone.

There are a number of anatomical considerations in this context:

Waldeyer (2003) says that the external surface of the Corpus ciliare corresponds to the M. ciliare, which according to Lanz/Wachsmuth (2004) is connected with the Lamina suparachnoidale, the sclera and the Bruch's membrane.

Marx (2006) describes the Bruch's membrane through its relation with the sclera as elastic aponeurosis of the M. ciliares and its antagonist.

Thus there is a connection of the fascial system with the sclera via the M. ciliares.

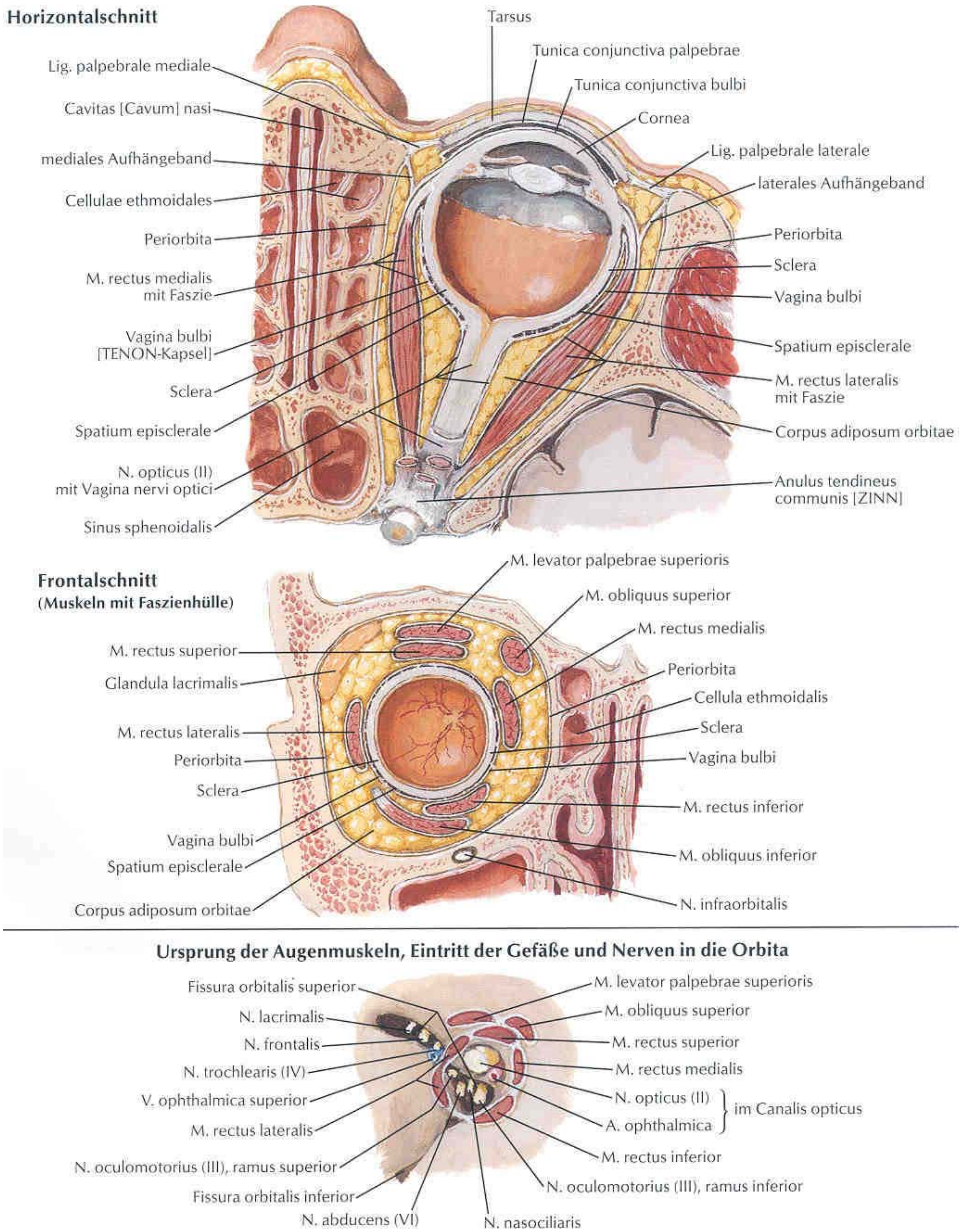
The Lig. suspensorium runs between the tendons and underneath the eye and can according to Elmström (1983) influence the form of the lens and thus its refractive properties.

Note: According to Gray (1989) the fascial sheath of the eye bulb fuses posteriorly with the neural sheath of the optic nerve. Underneath the bulb the fascia thickens and forms the Ligamentum suspensorium. The authors also point out that the fascial envelope of the M. rectus superior fuses with that of the M. palpebrae superiores, while the fascial envelope of the M. rectus inferior is continuous with the lower eyelid and the fascial sheath of the M. obliquus inferior. The expansion of the fascial sheaths of the M. rectus mediales and lateralis, which are connected with the Os lacrimale and Os zygomaticum limit as medial and lateral check-ligaments the movements of the Mm. rectus mediales and laterales (Gray, 1989). This is illustrated in figure 15.

The continuity of the lateral and medial suspensory ligaments, which Carriero (2004) calls "check–ligaments", with the fascial sheaths of the Mm. rectus laterales et mediales can be seen in the upper section of figure 15. Due to this arrangement the muscles of the eye bulb (extrinsic muscles) can mutually influence their tension. In addition, the picture also shows the joint insertion point of the respective muscular fascia with the Ligg. palpebrae laterales and mediales.

The lower section of figure 15 illustrates the close relationship of the fascias of the Mm. rectus laterales et mediales with the Vagina Bulbi. Directly underneath the latter the sclera is located, which is continuous with the dural septums in the eye.

The bony relations with the fascias of the muscles can also be seen in the lower section of figure 15. It clearly shows the insertions of the muscles on the bones which illustrate the connection of the fascias with the orbit.




From top to bottom: horizontal section, frontal section (muscles with fascial sheaths) and origins of the ocular muscles, passage of vessels and nerves into the orbit.

**Fig. 15**

The support system formed by the fascias guides and limits the movements of the eye to a certain extent. Carriero (2004) attributes a lot of importance to these relationships. She concludes: "The influence of these fascial structures on the eye is very important for the understanding of conditions like astigmatism, impaired refraction due to the form of the lens and presbyopia."

(Note: Presbyopia designates the accommodability of the lens.)

In this context the connection with the fascial system, which plays a key role in refraction, in relation with the scleral and dural structures is decisive and has therapeutic consequences.

Also the visual faculty of the eye has an influence on the tension in the muscles of the eye. According to Lanz/Wachsmuth (2004) only the healthy eye is used to focus if the visual faculty of one eye is severely impaired. In this case a fusion of the images of both eyes and seeing only one image with both eyes cannot take place anymore according to theses authors. The impaired eye takes on a divergence position.

Magoun (1976) emphasizes in this context that the muscles of the eye are very important with regard to bony lesions.

Due to the insertions of the muscles the Os frontale (for the M. obliquus superior), the Os maxillare (for the M. obliquus inferior) and especially the Os sphenoidale, which represents the point of insertion of the Anulus tendineus communis, play an important role for the muscle tone.

## 5.4 Neurological causes

The eye as an organ of perception which transmits impulses, is sensitive and can move is an organ that operates on a very high and coordinated level.

This coordination concerns not only the movements of the muscles of the eye, which should be the same for both sides, also the accommodation is one of the most highly coordinated processes of movement in the body. All these processes need a good and sophisticated nerve supply: through motor nerves which partly innervate only one muscle, but also through so-called mixed nerves with motor, sensory and neuro-vegetative fibres.

Gray (1989:1180) postulates: “The eye, therefore, is not to be viewed in isolation. Its array of modalities[...]. The eyes continuously guide almost all we do [...].”
This thought led me to look at the necessary nervous control that comes into play when it comes to the tasks of the eyes:

- the decision which object is interesting
- the change of focus from one object to another
- the synchronization of the images on the two retinas, so that we only see one picture
- the correlation of the eyes with the body, especially with head and neck
- the transmission of impulses from the retinas to the occipital lobe
- the venous drainage of the eye in relation with the reciprocal tension membrane.

The cranial nerves which innervate the eye can be subject to a number of disturbances:

Becker (1997) lists disturbances of the cerebral nuclei of the III, IV or VI cranial nerves due to potential causes in the brainstem (e.g. through polyneuropathia), or craniocerebral injuries, occipito-mastoidal dysfunctions, or occipito-atlantal dysfunctions with effects on the cerebrospinal fluid circulation and restrictions of the Sutherland fulcrum.
The optic nerve passes through the optic canal which is also a passage for the A. ophtalmica. In the orbit and also in the cranium the optic nerve is enveloped by meninges: according to Waldeyer (2003) by Pia mater and Arachnoidea as Vagina interna n.optici, as well as by the Dura mater as Vagina externa N. optici, which is continuous with the sclera in the region of the eye bulb.
“However, since there is a direct perineural pathway for the cerebrospinal fluid around the nerves, at least as far as the sclera, any chemical or trophic disturbance in that fluid medium may make itself felt in the function of the optic nerves.”(Magoun 1998:192)
Neural connections with the brain exist through sclera, Dura mater and leptomeninges which envelope the optic nerve. Prometheus offers the following description: “Since the optic nerve represents a prolongation of the diencephalon it is enveloped by all meningeal layers (Dura mater, Arachnoidea and Pia mater) and it is also surrounded by a subarachnoid space which is filled with cerebrospinal fluid and communicates with the brain and spinal cord.” (2006: 131)

According to Magoun (1976) this nerve can be irritated in the region of the Foramen opticum by the “tight sleeve” of the dural sheath, which is depicted in figure 16: “Even the optic nerve may be embarrassed by the "tight sleeve" of the dural sheath” (1976: 206)

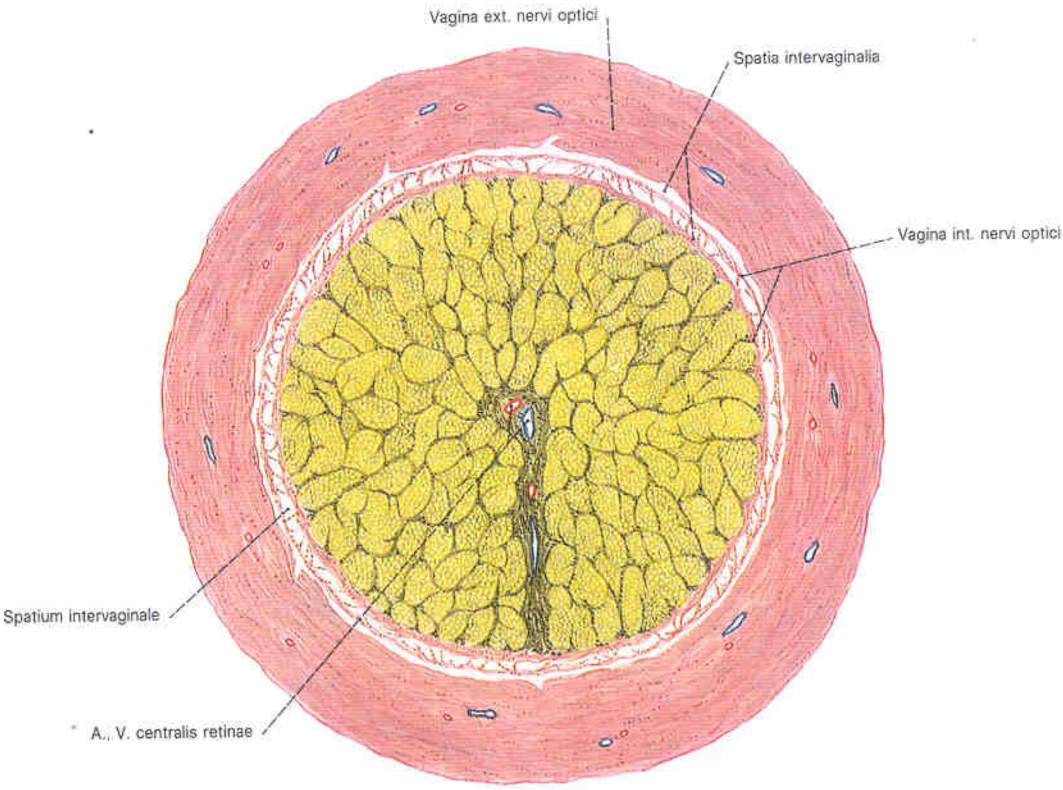



**Fig. 16**

Magoun (1998) mentions myopia in connection with the movements of the greater wings of the sphenoid. According to him a posterior shift increases the antero-posterior diameter which irritates the optic nerve.

He also says that if one greater wing is shifter anteriorly and the other one posteriorly. One eye bulb becomes more prominent and the other one becomes weaker, which also impairs neural function.

According to Magoun (1998) a narrowing of the superior orbital fissure can be provoked through increased dural tension but also through the insertions of the extrinsic muscles.

At the optic chiasm the site where the Fasciculi optici meet, which according to Rauber/Kopsch (1987) are composed of neurites of the third neuron of the visual pathway, also the cross-over of the fibres of the nasal halves of the retina can be found. The assumption that dysfunctions of the SBS through its relation with the sella turcica can irritate the optic chiasm stands to reason.

After they are relayed in the Corpus geniculatum the fibres of the optic nerve are relayed further on another neuron and end in the Area calcarina in the area 17 of the occipital lobe. The areas 18 and 19 belong to the optic aura (Waldeyer, 2004).

The occipital lobe can be impaired due to dysfunctions of the occipital bone.
According to Magoun Japanese people are “infamous myopes” because for generations the have been sleeping with their head on a bony pillow, which can deform the occipital lobe above the visual cortex. (1948, V)
If, however, the visual field is partly lost, this defect can be compensated through functional adaptations of the retina and also through the movement of the eyes according to Lurija (1991): by changing the focus the patients can easily compensate for this visual defect says the author.
According to Magoun (1976) intraosseous compressions between the body of the sphenoid and its lesser wing can be problematic for the optic nerve. This can have consequences for the visual pathway.

The N. oculomotoris which supplies all muscles of the eye with the exception of the M. obliquus superior and the M. rectus lateralis with its motor and parasympathetic fibres exits the Fossa interpendicularis right in front of the Pons and runs laterally along the Sella turcica through the wall of the cavernous sinus. It runs so closely along the edge of the Dorsum sellae that it can be easily irritated if there is a compression. According to Haase (2005) a release of the Tentorium cerebelli is very important in the treatment. Through its immediate proximity to the orbit it also has close contact with the structures that supply the organ of vision. The author mentions the cranial nerves III, $V_1$ and VI in particular, which pass through the Tentorium cerebelli. In addition she mentions that also the optic chiasm which lies on the Tentorium cerebelli plays an important role: The dural structures of the tentorium and the dural structures surrounding the optic nerve are situated in immediate vicinity and possibly have a mutual influence on each other.

Also when the N. oculomotorius passes through the part of the superior orbital fossa which is surrounded by the Anulus tendineus it can be irritated (Lanz/Wachsmuth 2004). This can have an effect on the muscles that are innervated by it: Through the preponderance of the M. obliquus superior (N. trochlearis) the eye bulb stands caudolaterally (Waldeyer 2003).
Effects on the parasympathetic fibres of the M. oculomotorius which continue to the M. sphincter pupillae entail a dilatation position of the pupil. According to Prometheus (2006) the near accommodation of the lens is effectuated through the contraction of the M. ciliares which is innervated by the N. oculomotorius: The lens takes on a more sphere-like shape.  According to Waldeyer (2003) a paralysis of the oculomotor nerve

can thus have consequences for the accommodability of the lens. This can possibly influence the curvature radius of the lens and thus the visual acuity.

According to Magoun (1976) nerve irritations can be caused by an overstimulation of the Erdinger-Westphal nucleus through vagotony, e.g. from the region of the sacrum. If the parasympathetic Erdinger-Westphal nucleus is stimulated continuously, it sends more neural impulses to the M. ciliares. The muscle becomes hypertone and this causes a hypercontraction of the lens.
This favours the occurrence of myopia.
For the N. trochlearis the wall of the cavernous sinus (Magoun) and the superior orbital fissure are critical passages on its way into the orbit to the M. obliquus superior (Waldeyer, 2003).
If this nerve is irritated, it can cause a medial malposition of the eye with the eye bulb rolled exteriorly. Tensions can also occur at the site where the nerve passes through the Tentorium cerebelli, at the point of cross-over of the medial and lateral borders of the tentorium (Magoun, 1976).

Also the sphenopalatine ganglion can be irritated by bony dysfunctions. According to Sutherland (2004) this has consequences for the N. infraorbitales, a sensitive branch of the N. maxillares, which innervates the skin of the lower eyelid. This branch can be irritated at the site where it passes through the Fissura infraorbitales.

According to Magoun (1998) dysfunctions in the venous drainage of the pituitary gland and also the fluid circulation in the region of the infundibulum of the third ventricle can cause irritations of the N. abducens. But the nerve can also be irritated along its further passage in the region of the cavernous sinus, at the point of cross-over of the medial and lateral borders of the tentorium in the region of the petrosphenoidal ligament at the Apex petrosum. This site is the most vulnerable part of the nerve according to Magoun (1998). Another possible site of nerve irritation can be found at the Sella turcica, in the region of the pituitary gland with its close connections to the sphenoid. In addition, irritations of this purely motor nerve, which innervates M. rectus lateralis, can occur when it passes through the superior orbital fissure. According to Waldeyer the affected eye then pulls medially.

The movements caused by the primary respiration mechanism entail rhythmic changes in the tension of the reciprocal tension membrane and its connections to the eyes.
Also the drainage of the venous passages in the cranium which are embedded in the dural layers is gently stimulated by these movements.
This is important for the nutritional function of the supplying structures and the totality of the eye.

### 5.5 Causes in the region of the bulb in relation to the reciprocal tension membrane

Through a number of ligaments which originate at the periorbit and insert on the Tenon's capsule that envelopes the eye bulb, the mobility of the eye is ensured.
The capsule is fused with the sclera at the site where the Fasciculus opticus exits immediately behind the posterior margin of the cornea. Anteriorly it has fascicles, which grow into the Septum orbitale and into the Orbita (Rauber/Kopsch, 1981).
Through these interrelations mutual influences are possible.

The muscles of the eye "pierce" the capsule to reach the sclera. Since the muscles and tendons are linked with the Tenon's capsule through their sheaths, as described in chapter 5.3 "Relevance of the muscles of the eye", every muscle contraction indirectly leads to an increase of tension in the capsule.
According to Schultz-Zehden (1987) also the cornea has to endure and counterbalance considerable pulls through the four straight eye muscles. Through this balancing function changes in the shape of the curvature of the cornea which would impair the perception of pictures can be avoided.

It is also important to mention strands of connective tissue which branch off the fascia at the site where the Mm. recti mediale and laterale pass through and which enter the orbit as actual suspensory ligaments of the eye bulb (Rauber/Kopsch, 1981). This description corresponds to that of the "check ligaments" by J.Carreiro.

The eye bulb which nowhere touches the walls of the orbit also depends on the size of the orbital fat body (Corpus adiposum) (Rauber/Kopsch, 1981).

According to Lanz/Wachsmuth (2004) the eye bulb moves one to two millimetres further back into the orbit when the eyelids are closed.

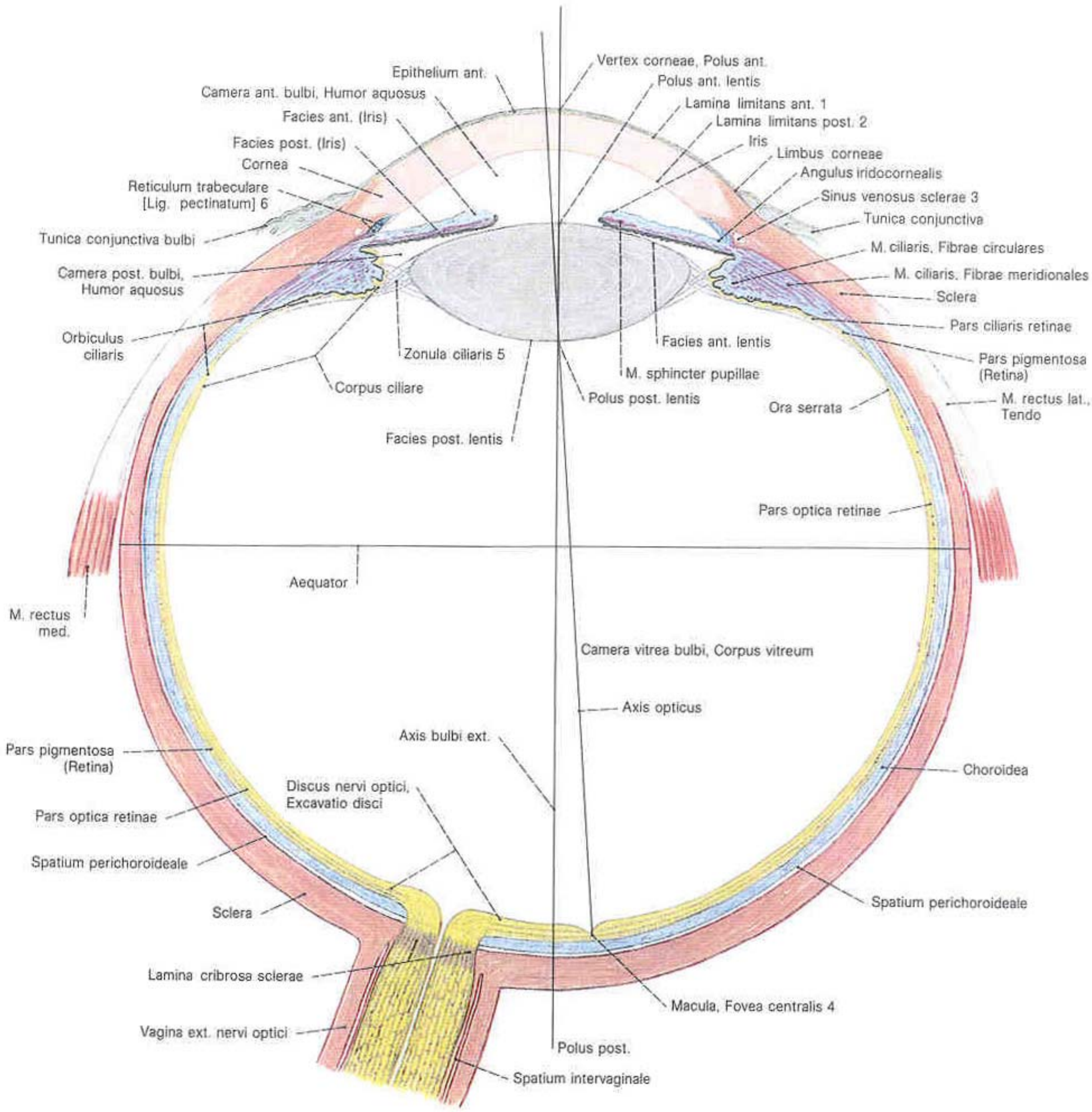



**Fig. 17**

Figure 17 illustrates the continuity of the inner layer of the dura with the nerve sheath of the optic nerve. These tissue structures are also continuous with the sclera.

The interrelations are very important for osteopathic treatment because you can possibly have an influence on the tension of the sclera and cornea, which is to a large extent responsible for refraction.

Vaughan, Asbury and Thabbara (1989) point out the remarkable similarity of sclera and cornea. According to the authors the cornea has the ability to absorb a lot of water, while the sclera in its normal condition is almost completely hydrated. Therefore we can say that if a change in the dural tension has an effect on the sclera, it will also influence the refractive cornea. This could be another cause of myopia. An irritation of the optic nerve can directly be caused by abnormal dural tension.
But these tissue structures also offer a good possibility for osteopathic intervention.
Haase (2005) emphasizes the importance of the cornea and its fascial interrelations. She considers the structures cornea, sclera and Dura mater as fascias in a particular sense.

According to Lanz/Wachsmuth (2004) the Anulus tendineus communis, the common annular tendon of the four straight muscles of the eye is closely connected with the dural envelope of the optic nerve and the periosteum in the region. This is important for the tension of the sclera and its effect on the ciliary body and the form of the bulb.

Through functional interrelations a mutual influence is possible.

Not only the sclera in the region of the optic nerve is a continuation of the **dura**, figure 18 shows that also a prolongation of the **arachnoidea** envelops the optic nerve.

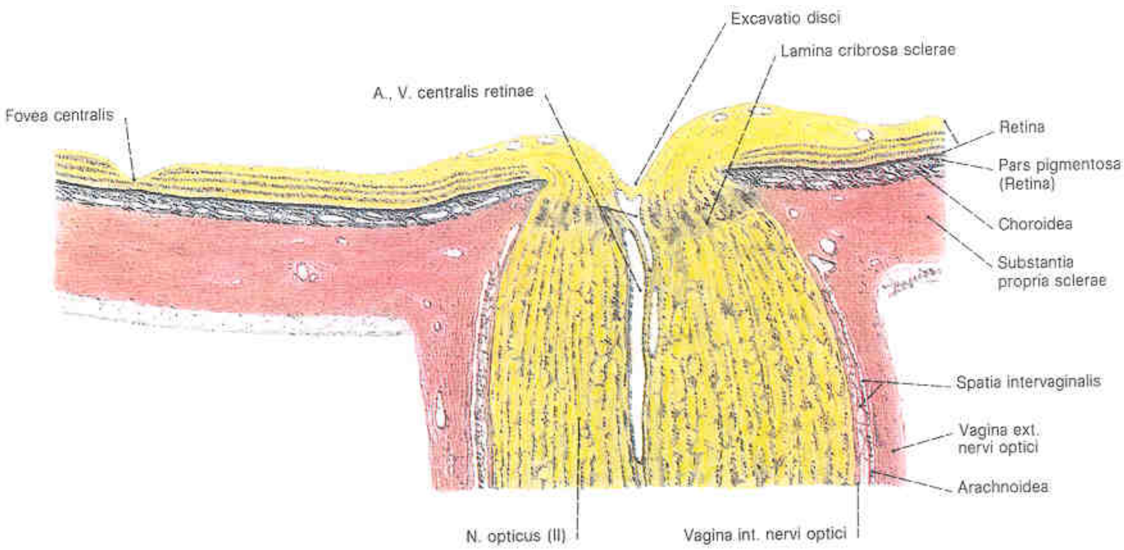



**Fig.18**

If the intracranial pressure increases this increase is transmitted via the totality of the **subarachnoid space** (Waldeyer, 2003).

According to Magoun (1998) dysfunctions follow the path of the cerebrospinal fluid. In the case of a mechanic or trophic disturbance this will have an influence on the function of the optic nerve. Forces of pressure are transmitted by the dura on the sclera and influence the optic nerve.

Sutherland (2004) describes this interrelation with his physiological patterns of movement:

The Crista galli is the anterior superior pole of attachment of the reciprocal tension membrane, because this is where the Falx cerebri attaches. In the flexion phase of the SBS the Lamina perpendiculares, which is a prolongation of the Crista galli, goes down. In the extension phase the Lamina moves upwards.

This mechanism continues over the totality of the reciprocal tension membrane; in this rhythmic movement the cross-over points of the medial and lateral borders of the tentorium in the region of the clinoid processes have to be considered in particular especially with regard to the cranial nerves.

Without this movement also the mechanism of the eye bulbs in their fascial context cannot function normally.

If the movements of the cranial bones are restricted in the region of their sutures, the dynamic reciprocal tension will also be disturbed. Changes in the balanced tension of the membranes have an influence on the venous system in the cranium.
Therefore abnormal tensions in the reciprocal tension membrane do not only entail altered tensions in the eye bulb but also a reduction of the drainage through the veins of the eye.

Magoun (1976) points out that all cranial nerves pass through folds of the Dura mater in the vicinity of the clinoid processes and through the cavernous sinus. Along this passage irritations might occur.
A balanced reciprocal tension membrane is thus not only important for the mobility of the bones but also for the nerve supply, the circulation of cerebrospinal fluid and the venous drainage of the eye.
The activating force in this context is the PRM, the primary respiration mechanism.

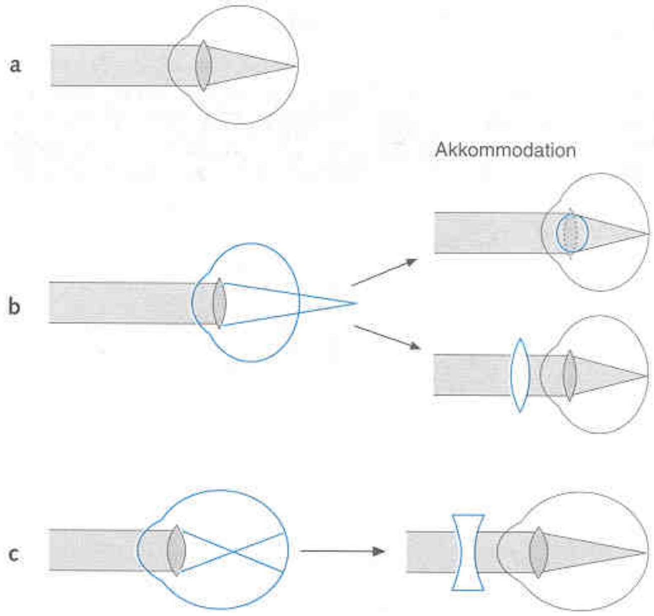
# 6. Glasses

## 6.1 Glasses: a proposal of correction by conventional medicine

The previous chapters have pointed out interrelations and connections which can explain the problem of myopia in the cranial concept.
The topic has been considered from the perspectives of possible bony dysfunctions, altered tensions in the reciprocal tension membrane, irritations of the relevant cranial nerves, altered tone of the muscles of the eye and changes concerning the fluid circulation.
Through functional interrelations in a physiological sense but also in the sense of dysfunctions, the cranial concept offers many possibilities.
These possibilities can be used in osteopathic treatment to improve vision in a myopic eye.

Conventional medicine solves the problem myopia on a completely different level. It offers optical visual aids to the patients taking into account the following considerations:
“Minus glasses” make things look smaller. They are thinner in the centre and thicker at the edges; they bend rays of light outwards and spread them away from the focus. Short-sighted eyes need minus glasses. Farsighted eyes need “plus glasses” which bend rays of light inwards and bring them to focus.
The extent to which the rays of light are focused or spreaded through the lens, the refractive power is expressed in dioptres (dpt.). The refractive power is the reciprocal value of the focal distance in metres. This means that a lens of plus 2 dpt has a focal point in a distance of 50 cm; plus 3 dpt in 33 cm, plus 4 dpt in 25 cm. Minus lenses are shaped so that they have a “negative focus”, i.e. a focus in the direction opposite to the direction where the rays of light come from.
Glasses with - 5 dpt spread the light as if it would come from a source of light 20 cm in front of the lens; glasses with - 2 dpt spread the light as if it came from a source of light 50 cm in front of the lens.
Cylinder lenses compensate astigmatism (indicated as: cyl.), while normal glasses are spherical (Diepes, Liebsch).

This is illustrated by figure 19:




**Accommodation**

**Fig 19**

### 6.2 The disadvantages of glasses

Of course, once the glasses are put on, vision is immediately improved.

Nevertheless if the glasses are worn continuously, vision is constantly corrected through the glasses, which makes the eye rigid:

The eye has to be less active as regards accommodation and the perception of objects. This holds especially for the M. ciliaris which normally constantly corrects the curvature of the lens.

According to Elmström (1983) the problem becomes increasingly chronic and organic. The dysfunctional state is maintained by the glasses, even though wearing them improves the symptoms. Elmström also writes: “To maintain the state of dysfunction, the nervous system is required to constantly keep the innervated structures in the abnormal tone that set up the problem in the first place.” (1983:60)

Wearing glasses on a continuous basis has also other consequences for the patient: The patients tend to become dependent from the glasses. In a situation where the patients cannot wear the glasses they feel insecure. They can only relax if they are wearing the glasses.

Another aspect is the frame of the glasses: depending on its form and thickness the frame also limits the field of vision. Outside the frame vision is as blurred as it would be without the glasses.
For wearers of glasses the field of clear vision lies only in the centre of the retina. The large peripheral fields of the retina are no longer used. Normally the use of the peripheral fields of the retina is facilitated through the activity of the extrinsic muscles. Since they are no longer used, they loose their function and atrophy.
For most of the myopic patients the prescription of glasses is the final correction.
Often they are advised by the ophthalmologist to wear the glasses permanently, without raising the awareness that they are only visual aids.
In contrast to patients who need walking aids and who are advised to be active whenever possible to get rid of the walking aids as soon as possible.
But as regards the visual aid “glasses” it is considered normal to wear them for the rest of life. Most people wear their glasses for the rest of their lives and accept a chronic and progressive deterioration of their eyesight.

With this I just want to point out that the wearing of glasses not only leaves the problem unsolved, it also actively prevents an improvement of eyesight.

# 7. The orbit fluid drive

In this chapter I will explain the treatment technique that was applied in the study.
In the interaction of the totality of its structures the eye is regarded as fluid organ. In this approach the fluid is the medium through which full function can be re-established on other levels.
Especially the fluid which influences the tension of the dura and sclera plays a major role.

### 7.1 The orbit fluid drive: the idea

**An osteopathic treatment shall increase the activity of the eye, ameliorate its capacity of movement and improve its refraction.**

The eye, which is a fluid organ, sends and receives impulses from the environment. It is embedded in a cavity, whose form is decisive for the form and function of the eye.
All structures which make up the soft bed of the eye, which is well-supplied with blood, all suspensory and supportive structures of meninges and fascias, all these structures depend on the activating force of the primary respiration mechanism.
In the following section I would like to describe the most important physiological processes with the focus on the treatment technique, which I will describe in detail afterwards:

The mechanism of primary respiration facilitates gentle movements of the bones, which entail a widening and narrowing of the orbit. These movements effectuate a gentle massage of the structures of the eye, which again has effects on the physiology of circulation of the eye.
Also the muscles of the eye, which insert on the roof and floor of the orbit and on the common annular tendon, are massaged through these rhythmical movements.
Sutherland writes: “As the sphenoid moves forward, the eyeballs move forward also. As the sphenoid moves backward, the eyeballs move backward also.” (1990, 78)

The movements which are caused by the mechanism of primary respiration provoke a change in the tension of the reciprocal tension membrane with its connections to the

eyes. The venous passages in the cranium, which are embedded in the dural layers, are also gently drained through these movements.
This is important for the overall function of the structures which supply the eye and also for the eye as a whole.
The objective in a craniosacral treatment is to release restricted movements, to reach a balanced tension of the membranes and to improve circulation and especially venous drainage, so that the vascular supply of the eye is stimulated. Other objectives in the treatment of myopia are to correct possible impairments of the cranial nerves at the sites where they exit their intracranial passages and to improve the vitality of the cranial rhythm.
The improvement of the motility of the bones aims at eliminating unfavourable strains. This can alter the tension in the muscles of the eyes to an extent that they can adequately adapt to the ever changing demands on vision.
The eye bulb itself maintains its form to a large extent through the fluid elements it contains. If the jelly-like mass has the best-possible trophic state the form of the eye bulb, which is decisive for visual acuity, is stable.
In this context it is very relevant that the eye bulbs are surrounded by cerebrospinal fluid within the leptomeninges.
Since the eye is a liquid organ a treatment on a fluid level is especially advantageous. Therefore a fluid drive technique suggested itself as treatment method. In this method you work with the cerebrospinal fluid which for Still was the highest know element in the body: “Dr. Still referred to the cerebrospinal fluid as the “highest known element in the human body.” (Quoted according to Magoun, 1951/1997: 15)

## 7.2 The orbit fluid drive: the treatment technique applied in the study to examine and treat myopia

You palpate the movement of the orbit by placing your fingerpads around it on the bones: all five fingers palpate around the orbit. The thumb is placed on the nasion, the little finger on the orbital process of the frontal bone, the ring finger palpates the zygoma, the middle finger the descending branch of the maxilla and the index finger the ascending branch of the maxilla. The other hand is placed diametrally opposite on the

occipital bone. With this hand contact you work along the axis as described by Frymann (1998).
Chapter 5.1.1. "Axes of the eye" contains a picture which illustrates the axes.
Towards the end of that chapter it is also described, that not only the axis of the orbit but also the relation to the optic axis has to be taken into account.
When I have placed my hands I first start to gain an impression of the rhythm and expression of the tissues.
There is a state in which you can feel the activity that comes from the body; this activity that you can feel with your palpation.

With the fingers of the hand that is placed on the occiput you direct the fluid from the palmar side of this hand towards the orbit and eye bulb. Once the movement impulse reaches the diametrally opposite point you can feel the fluid changing direction and flowing back to your occipital contact.
You follow the movement of the slow fluctuation of fluid that takes place between your two hands.
Often a movement is restricted. With the waves of the cerebrospinal fluid you can detect such restrictions and treat them.
According to Magoun (1997) a dysfunction can express in different ways. But all dysfunctions are characterized by a certain resistance. Since dysfunctions change the molecular structure of tissue according to Magoun (1997), the tissue's resistance to fluctuation increases. Depending on the severity of the dysfunction this resistance changes. Magoun calls this the "fluid shock". This facilitates the localization of lesions.
With every fluid wave that fluctuates back and forth you can feel changes in the tension. You can feel how the fluid moves anteriorly towards the orbit and causes a change in tension there. The same holds for the wave of fluid that is directed from the orbit towards the occiput.
The practitioner follows the fluctuating movement until he/she notices a certain balanced tension: the point of balance.
After such a point of balance the fluctuation can start again until it finds a new point of balance.
The practitioner stays with the wave-like fluctuation that changes the tension in the tissues until a very quiet state in the tissues is achieved. This very quiet and still state is called stillpoint. In this stillpoint the practitioner is a calm but attentive listener.

When the fluid expands again the movement can be felt anew and maybe a release in the region of the dysfunction could be achieved.
The practitioner then lets the powerful and dynamic mechanism work. It is possible that a second stillpoint occurs. If the procedure is carried out correctly the restricted structures can soon move more freely.

Magoun gives the following instructions: “[The cerebrospinal fluid] ... fluctuates within its closed container and may be directed to assist in the release of ligamentous and membranous articular strains by virtue of its intelligence and potency. When so directed or started on a mission, the cerebrospinal fluid wave or “tide” continues to a functional conclusion unless interrupted. Directional control is effected by skilful use of the operator’s hands on the cranium.” (1997: 16)

The practitioner should be aware that the physiological movement of the eye bulb differs from that of the orbit. According to Carreiro (2004) the eye bulb, which is a projection of the brain, has similar movement patterns to those that Sutherland described for the central nervous system.
“During the flexion phase the eyeballs converge in the direction of the Lamina terminalis with their a-p diameter decreasing and their transverse diameter increasing. The optic nerve marks the pivot point of the movement of the eyeballs. During the extension phase of the SBS the eye bulb moves away from the Lamina terminalis, with its a-p diameter increasing and its transverse diameter decreasing.” (Carreiro, 2004; 168)
In order to differentiate whether the problem lies in the relationship of the eyeball to its origin or whether the cause can be found in the tension of the bones we have to differentiate between the different movements. Carreiro: “By placing your fingerpads along the margin of the orbit you can observe that the movements of the bones are oriented in the direction almost immediately posterior to the centre of the external surface of the orbit, while the inherent movement of the eyeball is directed superiorly and medially of this point.” (2004: 168)
This is due to the fact that the axis of the eye bulb differs from that of the orbit by 23° as described in the chapter 5.1.1 “Axes of the eye”.

This powerful and dynamic mechanism works with the health of the body.

If the described technique is applied carefully and thoroughly not only the affected structures identified in the analysis can be released. Since the human body is an entity it will also react as an entity to the treatment. If restrictions are released the self-healing powers of the body are activates and the whole body will become active in a new and altered form: because the body has the capacity to express and maintain health – and to heal itself.

After I have examined and treated the structures that I have mentioned I check the expression of movement of the orbit again because I want to feel whether something has changed in the region of the eyes.

## 8. Statistical analysis

The study was carried out as controlled randomized comparative study.

### 8.1. Results of the study

A total of 54 test persons agreed to participate in this comparative study. They were randomized in two groups.

The patients were attributed to the groups randomly: they had to draw lots.

For a period of 20 minutes the test persons either received an osteopathic treatment in the form of an orbit fluid drive (osteopathy group), or they received no therapy but observed a 20 minute period of rest (control group). The participants' refraction was measured by an independent optician before (pre-test) and after (post-test) the intervention or the period of rest. Since not all of the questionnaires were returned or some patients were excluded (cf. annex) a total of 42 test persons (77.8% of the original number) were included in the analysis, with 20 patients in the osteopathy group and 22 in the control group. After 4 weeks the test persons belonging to the osteopathy group had to undergo a follow-up measurement where the quality of their eyesight was measured again to identify long-term effects of the treatment.

## Analysis of the study results

The study results were statistically analyzed by David Rummel, a statistician from Munich.

This section tries to answer the following questions:

1. Was the randomization concerning age, gender, and eyesight successful in both groups?
2. Are there significant changes in the test persons' quality of eyesight within the groups?
3. Is there a significant difference in the development of the quality of eyesight between the two groups?

### 8.1.1 Characteristics of the test persons

First of all the randomization with regard to the age of the test persons was examined. The average age of the totality of test persons was 28.67 years with a standard deviation of 11.46 years. Despite this high variability of the age within the total number of test persons, the two groups (osteopathy and control group) did not differ significantly with regard to average age[1] (t=0.769; p=0.446) or age distribution[2] (F=0.642; p=0.428) (cf. figure I). Thus the randomization concerning age can be qualified as successful.

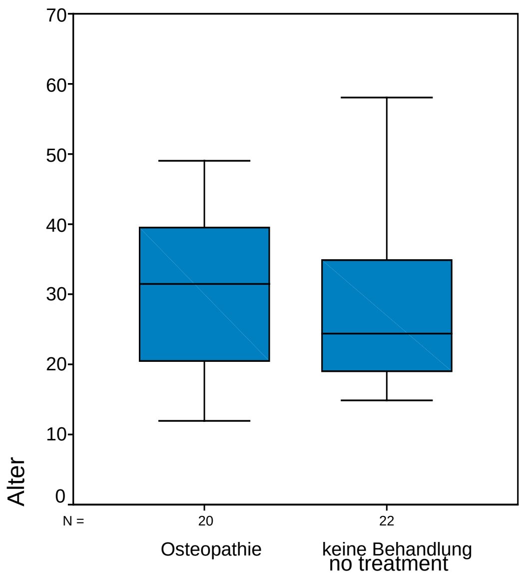



**Figure I:** Range of variation, interquartiles and median values of the variable "age" of the two groups (n=42)

Further, the randomization with regard to the gender distribution in the two groups was analyzed.

The share of female test persons of the overall sample group was 61.9% (26); that of male test persons amounted to 38.1% (16). This gender distribution is also reflected in the two groups (cf. figure II), which means the assumption that there could be a sys-

[1] based on the T-test for homogenous variances
[2] based on the Levene test

tematic difference has to be eliminated ($\chi^2$ = 0.059; p= 0.808): women and men are equally distributed in both study groups.

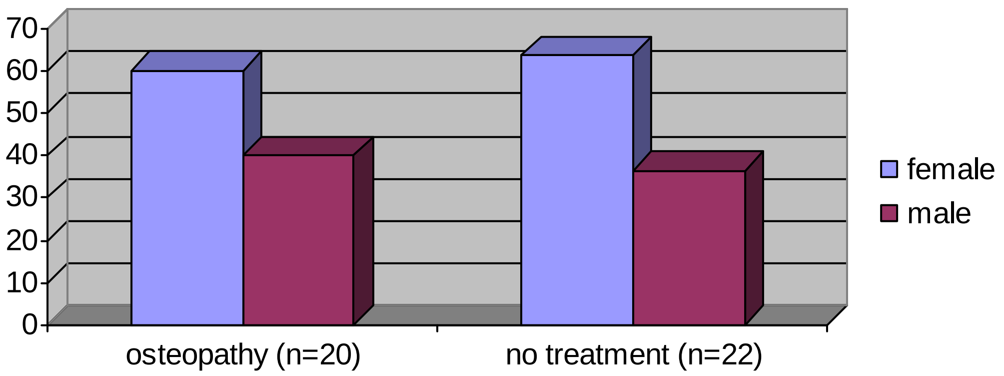



**Figure II:** Gender distribution (%) in the two groups

Finally, the refractive power (in dioptres) of the test persons in the two groups was compared.

Equally, no differences with regard to refractive power (myopia) between the osteopathy group and the control group could be identified before the intervention. The average dioptre value (median value) of the test persons in the control group was -1.5 for the right eye and -1.75 for the left. The patients of the osteopathy group had slightly higher values with an average of -2.625 for the right and -3.0 for the left eye (cf. figure III). These differences, however, are marginally not significant as proven with the U-test (right eye: p=0.052; left eye: p=0.106).

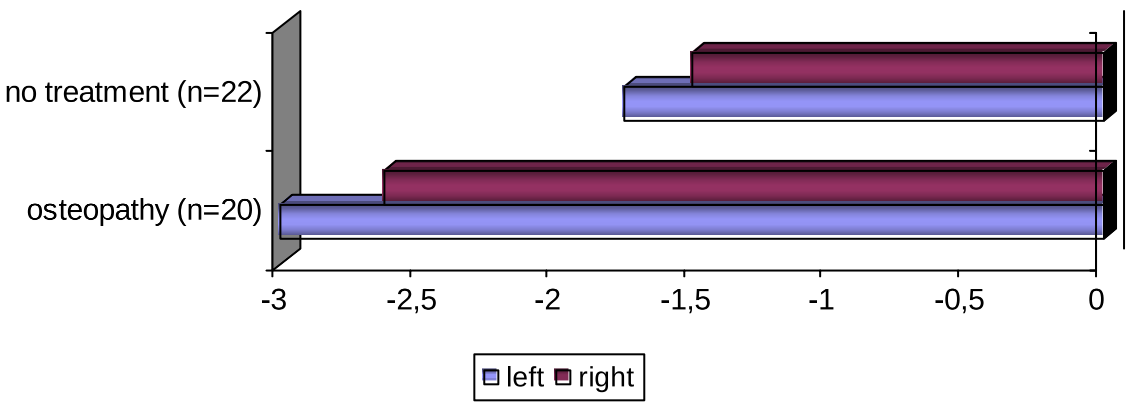



**Figure III:** Average dioptre value before the intervention

Recapitulating we can say that the randomization was successful in both groups with regard to age, gender and quality of eyesight.

Looking at the refractive power of both eyes together it is striking that only one person (in the osteopathy group) had a pronounced difference in the quality of eyesight between his two eyes (more than -3 dioptres). All other participants in the study had an average difference of -0.726 dioptres with a standard deviation of 0.659 dioptres. If we eliminate the patient with the pronounced difference from the analysis, average myopia for both eyes together can be describes as follows (cf. figure IV): 48.8% of the test persons had slight myopia (up to -2 dioptres), 39% suffered from moderate short-sightedness (up to -6 dioptres) and in 12.2% of the cases the condition was severe (more than -6 dioptres).

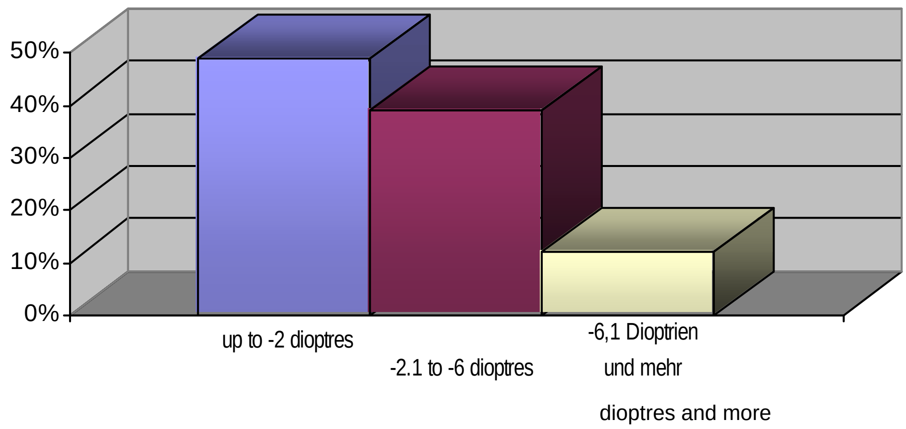



**Figure IV:** Distribution of severity of myopia in the overall sample group (n=41)

Analysis of the habitual use of glasses

Approximately two thirds of the test persons in both the osteopathy (65%) and in the control group (63.6%) wear glasses or contact lenses regularly, the remaining third does not need those visual aids for all activities, e.g. only for driving the car. On average the glasses or contact lenses have been worn for about 13 years, with a standard deviation of 10 years. Most of the test persons (70.7%) received their glasses between the age of 11 and 18, 12.2% before their $11^{th}$ birthday and 17.1% after they had turned 18. This distribution underlines the growth-related and hormone-related changes of eyesight during puberty.

Analysis of accompanying complaints

38.1% of the test persons complained about additional problems, most of them mentioning headaches (21.4%), followed by burning, tired eyes (14.3%). These complaints seem to be somehow related to the patients' quality of eyesight (CC[3] = 0.307): one third (33.3%) of the test persons with mild to moderate disturbance of eyesight complained about other problems, while this percentage doubled (66.6%) among the patients whose eyesight was highly compromised.
This correlation illustrates to what extent the eye reacts adaptatively to dysfunctions of other structures in the body. And maybe this adaptation takes place at the expense of the eye's function, especially its accommodability. This can be recognized also in the following section of the analysis of the study results.

Analysis of birth complications

26.2% of the participants mentioned birth complications, with Caesarean section being the most common complication (9.5%). However, no direct relation to myopia could be detected (CC = 0.173).

Analysis of indicated regulating dental devices

16.7% of the test persons had to wear braces or other forms of regulating devices for their teeth. Data indicate that with an increasing severity of myopia also the probability that the test person had to wear braces increases: 75% of the mild cases, 87.5% of the moderate cases and 100% of the severe cases had to wear some sort of regulating device. Nevertheless the correlation is not very pronounced (CC = 0.246) and because of the small number of test persons of only limited significance. Table 1 below gives a concise overview of the results of the demographic description of the test sample.

[3] CC = contingency coefficient

| Characteristics | overall (n=42) | osteopathy group (n=20) | control group (n=22) |
|---|---|---|---|
| average age in years (SD) | 28.67 (11.46) | 30.1 (12.06) | 27.36 (10.99) |
| gender distribution % (women : men) | 61.9 : 38.1 | 60 : 40 | 63.6 : 36.4 |
| average dioptre value (left : right) | -2.0 : -2.25 | -3.0 : -2.625 | -1.75 : -1.5 |
| average time of wearing visual aid in years (SD) | 12.98 (10.07) | 14.53 (10.29) | 11.64 (9.91) |
| habitual use of glasses % (always : not always) | 64.3 : 35.7 | 65 : 35 | 63.6 : 36.4 |
| additional complaints % (yes : no) | 38.1: 61.9 | 30: 70 | 45.5: 54.5 |
| complications at birth % (yes : no) | 26.2: 73.8 | 25 : 75 | 27.3 : 72.7 |
| dental regulation % (yes : no) | 16.7: 83.3 | 15 : 85 | 18.2 : 81.8 |

**Table 1:** Characteristics of the study sample

It has to be critically pointed out that the issue of astigmatism could not be addressed in the study. It would have definitely been interesting to also include malpositions of the axes. But due to the complexity of the question this would have gone beyond the scope of this study.

### 8.1.2 Development of eyesight within the groups

Since the randomization with regard to age, gender and myopia was successful, this chapter will look at how refractive power has changed within the two groups. We start from the assumption that a) the refractive power within the osteopathic group will improve significantly on both eyes, while b) there will be no significant changes in the refractive power in the control group before and after the intervention.

The first thing that attracts attention within the osteopathic treatment group is that in 35% of the patients the refractive power improved significantly on both eyes immediately after the 20-minute treatment. For another 15% of the test persons the quality of eyesight of one eye improved. 30% of the participants did not notice any change, while 20% reported a deterioration of their refractive power, especially of the right eye. Since these patients were of different age and gender, their eyesight was impaired to different degrees and they had different additional complaints, other influencing factors have to be the reason why the osteopathic treatment led to a negative outcome in one fifth of the participants. A possible explanation would be that the impaired eyesight is related to organic problems (e.g. a liver condition), which cannot be sufficiently diagnosed and treated by the orbit fluid drive technique.

This shows that one single technique alone is not enough. An osteopathic treatment which considers the totality of the body might provide different results. This could be one point of criticism concerning this study.

Within the framework of a scientific study it would be difficult, however, to subject a comprehensive osteopathic treatment to scientific parameters in order to be able to make a clear statistical analysis of it. Therefore I tried to establish results of one single technique to obtain clear data and analyse the data statistically.

Since the eye has interrelations with the rest of the body via numerous structures, dysfunctions can affect it via cranio-sacral, neural, fascial, fluid, vasomotor and osteoarticular pathways. This was already pointed out in the analysis of the accompanying complaints.

If we compare pre- and post treatment measurements of the osteopathic group more pronounced but at the same time more inhomogeneous changes in the refractive power can be observed for the right eye than for the left: while in 30% of the patients the eyesight of the right eye did not change, this was the case in 60% of the patients for the left eye.  Eyesight of the right eye improved in 50% of the participants by up to one dioptre, eyesight of the left eye only improved in 35% of the test persons by half a dioptre maximum (cf. figure V).

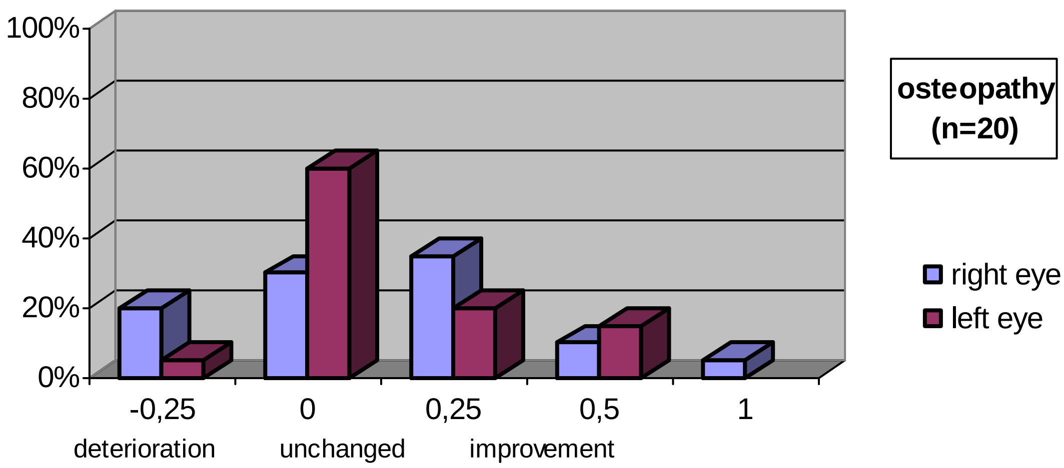



**Figure V:** Changes of refractive power between pre- and post-test in the osteopathy group (%)

In this context also the question whether one eye is dominant would be interesting. It would be interesting to find out what significance such a probable dominance of one eye has for the individual test person, in how far this is measurable and whether it would be comparable with the dominance of the right hand in most of the people.
A reason for the fact that the right eye can be influenced more could maybe be found in the region of the visual cortex. It would be worth examining in how far a different reaction of the right and left field of the visual cortex can be observed within physiological limits. In this context the difference in the processing of both visual cortex fields can be observed with regard to the crossed and uncrossed visual pathways within physiological conditions. A comparison between visual acuity in the osteopathy group measured in the pre- test and in the post-test by means of the Wilcoxon-test shows significant changes[4] for both the right eye (Z=-1.895; p=0.029*) and the left eye (Z=-2.165; p=0.015*). The hypothesis that within the osteopathy group the refractive power of both eyes will significantly improve immediately after the treatment could thus be confirmed.

Also four weeks after the intervention the effect of the osteopathic treatment continued to be perceivable: the vision of both eyes remained optimized or improved continuously in 20% of the cases (cf. figure VI). This was proven by comparing the original measurements with the follow-up measurements using the Wilcoxon-test (right: Z=-2.434; p=0.0075**; left: Z=-2.652; p=0.004**).

Even though the hypothesis that osteopathic treatment can achieve a persistent improvement of the visual acuity within the osteopathic treatment group could be confirmed with a statistically very significant result, which can be regarded as indicator for the efficiency of the osteopathic approach in the treatment of myopia, the stability of the changes in the refractive power could not be clearly established since no follow-up measurement was carried out for the patients of the control group.

[4] Since we had a directional hypothesis, we had to halve the probability error.

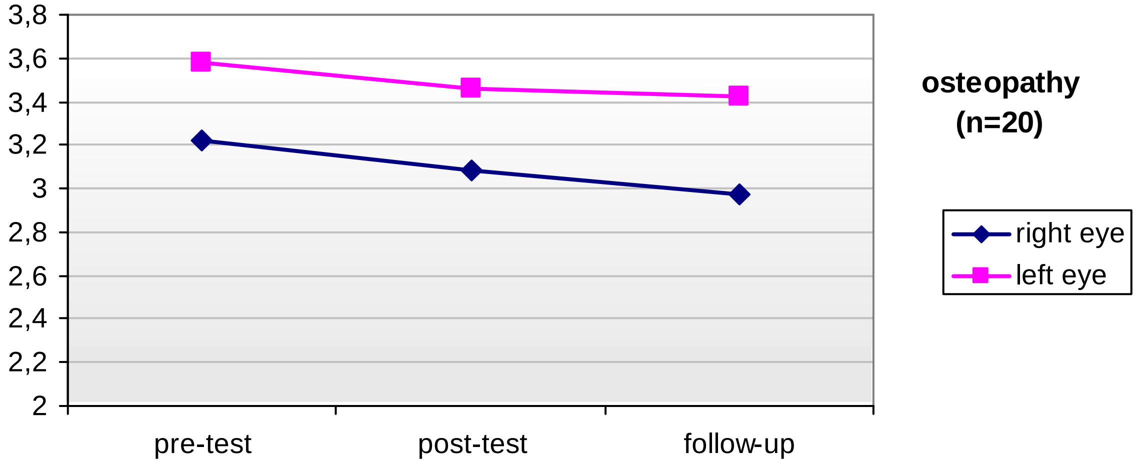



**Figure VI:** Average quality of vision in the osteopathy group according to time of testing

A differentiated analysis of the changes in the refractive power within the osteopathy group showed a statistically significant age effect since the refractive power of the right and left eye improved significantly only in older test persons (19 years of age and older). In younger patients (up to 18 years of age) no obvious improvements of eyesight could be detected. In this context it has to be pointed out that in younger years the body is subject to many influences, especially the influence of growth which goes hand in hand with hormonal changes.

The question thus is whether these circumstances limit the effect of a therapeutical intervention in comparison with patients whose development is already completed.

Nevertheless a tendency of improvement of the refractive power could be observed also in adolescents. In order to verify this improvement over some period of time it would be desirable to examine how the eyesight of these young patients would develop after repeated interventions.

In this respect the age at which the visual aid was prescribed for the first time is interesting. It can be observed that the values measured in the group of persons who received their first glasses before the age of 18, improved significantly more (at least with regard to their left eye) than those of patients who received their visual aids after the age of 18.

No gender effect related to the change of eyesight could be detected (cf. table 2).

| | n | pre-test | post-test | follow-up | $\chi^2$ | p |
|---|---|---|---|---|---|---|
| Age | | | | | | |
| up to 18 years (le:ri) | 4 | -1.81 :-1.75 | -1.81 : -1.81 | -1.75 : -1.62 | 2.000 : 3.200 | 0.368 : 0.202 |
| 19 years and older (le:ri) | 16 | -4.01 : -3.95 | -3.87 : -3.41 | -3.84 : -3.31 | 8.882 : 7.171 | **0.012*** : **0.028*** |
| Gender | | | | | | |
| male (le:ri) | 8 | -3.56 : -3.19 | -3.47 : -3.03 | -3.44 : -3.09 | 4.769 : 3.263 | 0.092 : 0.196 |
| female (le:ri) | 12 | -3.58 : -3.25 | -3.46 : -3.12 | -3.12 : -2.89 | 5.250 : 5.250 | 0.072 : 0.072 |
| First prescription of seeing aid | | | | | | |
| ≤ 18 years (le:ri) | 15 | -3.85: -3.30 | -3.73 : -3.22 | -3.70 : -3.07 | 8.960 : 4.171 | **0.011***: 0.124 |
| ≥ 19 years (le:ri) | 4 | -2.87 : -3.12 | -2.81 : -2.87 | -2.75 : -2.81 | 0.667 : 1.500 | 0.717 : 0.472 |

**Table 2:** Average quality of eyesight in the osteopathy group with regard to age, gender and moment of first prescription of seeing aid according to time of testing

Looking at the development of the visual acuity within the **control group** it is striking that almost no changes could be observed: in 90.9% of the participants the quality of eyesight remained unchanged immediately after the period of rest; only two persons showed either an improvement or a deterioration of the refractive power of the right eye by a quarter of a dioptre (cf. figure VII). Thus the hypothesis according to which no significant changes of refractive power were expected in the control group before and after the period of rest was confirmed (right and left eye: Z=0.000; p=1.000)[5].

[5] based on the Wilcoxon-test

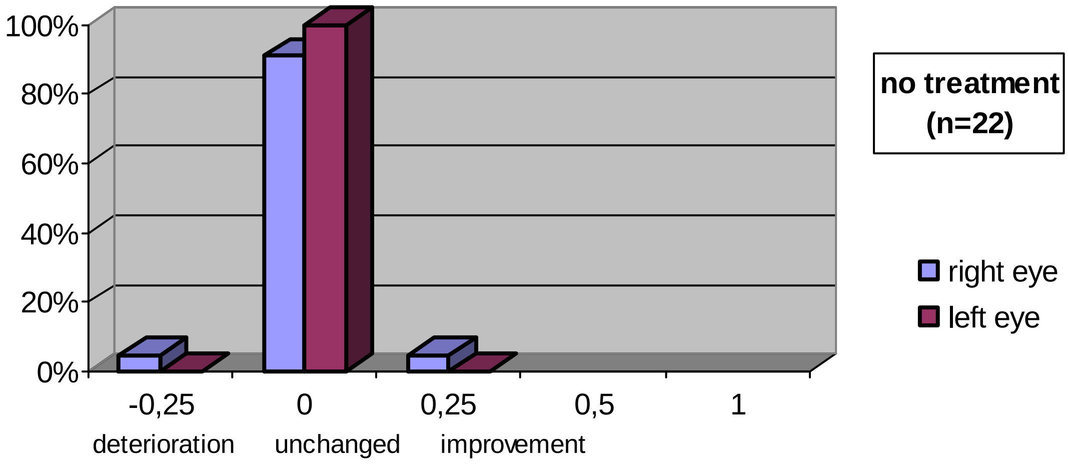



**Figure VII:** Changes in refractive power between pre- and post-test in the control group (%)

### 8.1.3 Comparison of the development of visual values between the two groups

The following section will present the results of the survey by putting emphasis on comparing the development of the visual values in the treatment group with the control group to underline the efficiency of the osteopathic treatment approach compared to a non-treatment. We start from the hypothesis that compared to the control group the refractive power of both eyes will improve significantly in the osteopathy group.

In order to verify this hypothesis we used the Mann-Whitney-U-test. One glimpse at figure VIII shows that the average visual values of the right eye have improved slightly in the osteopathy group – the average difference between pre- and post-test values being -0.1375 dioptres; while in the control group the average quality of eyesight did not change. Despite the fact that the change in the intervention group seems to be minor at first sight the difference between the two groups is significant with Z=-1.870 and p=0.03.

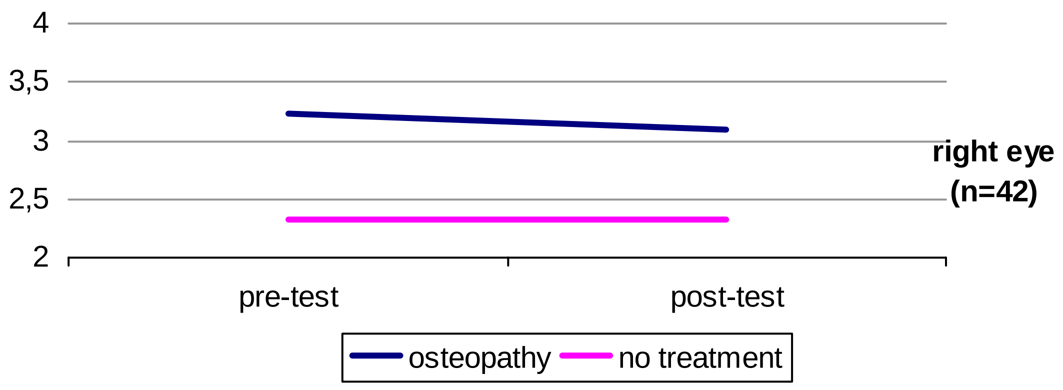
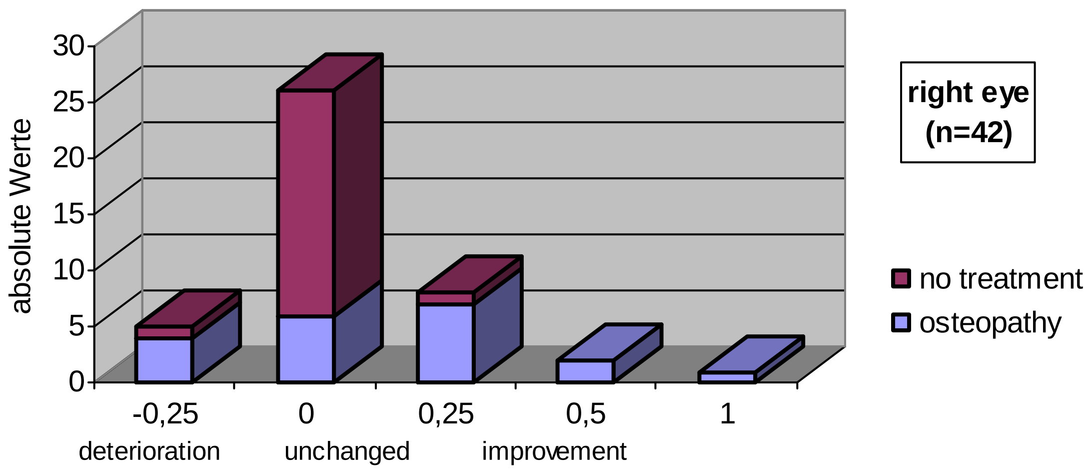



**Figure VIII:** Development of the quality of eyesight of the right eye – comparison of the two groups

If we take a more differentiated look at the changes in the quality of eyesight of the right eye, we can see that half of the participants of the osteopathy group benefited from the therapy, while the period of rest showed no effect on 20 out of 22 test persons (cf. figure IX). At the same time – taking into account random fluctuations – we have to emphasize that the chosen osteopathic technique (orbit fluid drive) as singular means of diagnosis and treatment for myopia seems to be not sufficient since a fifth of the patients experienced a deterioration of their eyesight.

I will talk about this more in detail in the chapter "Outlook and discussion".




absolute Werte = absolute values

**Figure IX:** Changes of the quality of eyesight of the right eye (in dioptres) of the two groups

Equally, the visual values of the left eye have improved between pre- and post-test in the osteopathy group compared to the control group: while the average difference in the refractive power in the control group was 0 (i.e. in none of the test persons of the control group a change in the quality of eyesight of the left eye could be observed), the dioptre value of the left eye in the osteopathy group improved by -0.1125 (cf. figure X). Thus a very significant difference between the two groups could be detected with regard to the left eye (Z=-2.428; p=0.003). This means that the hypothesis according to which the quality of eyesight of both eyes in the osteopathy group will improve significantly in comparison to the control group could be confirmed.

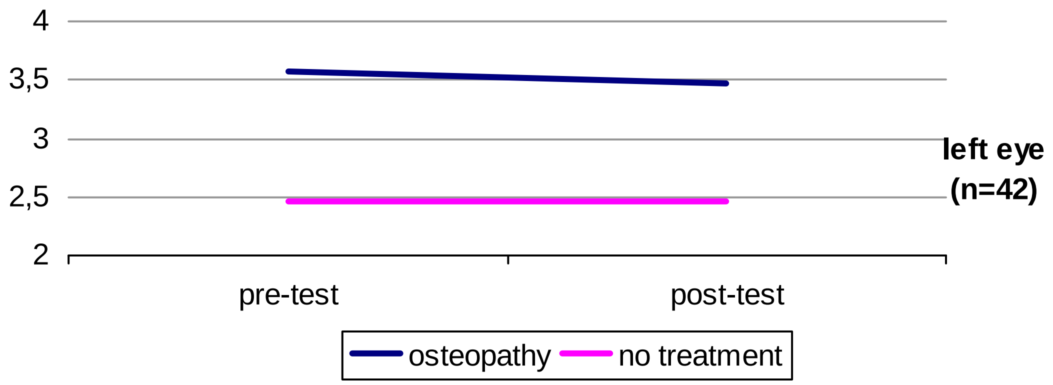
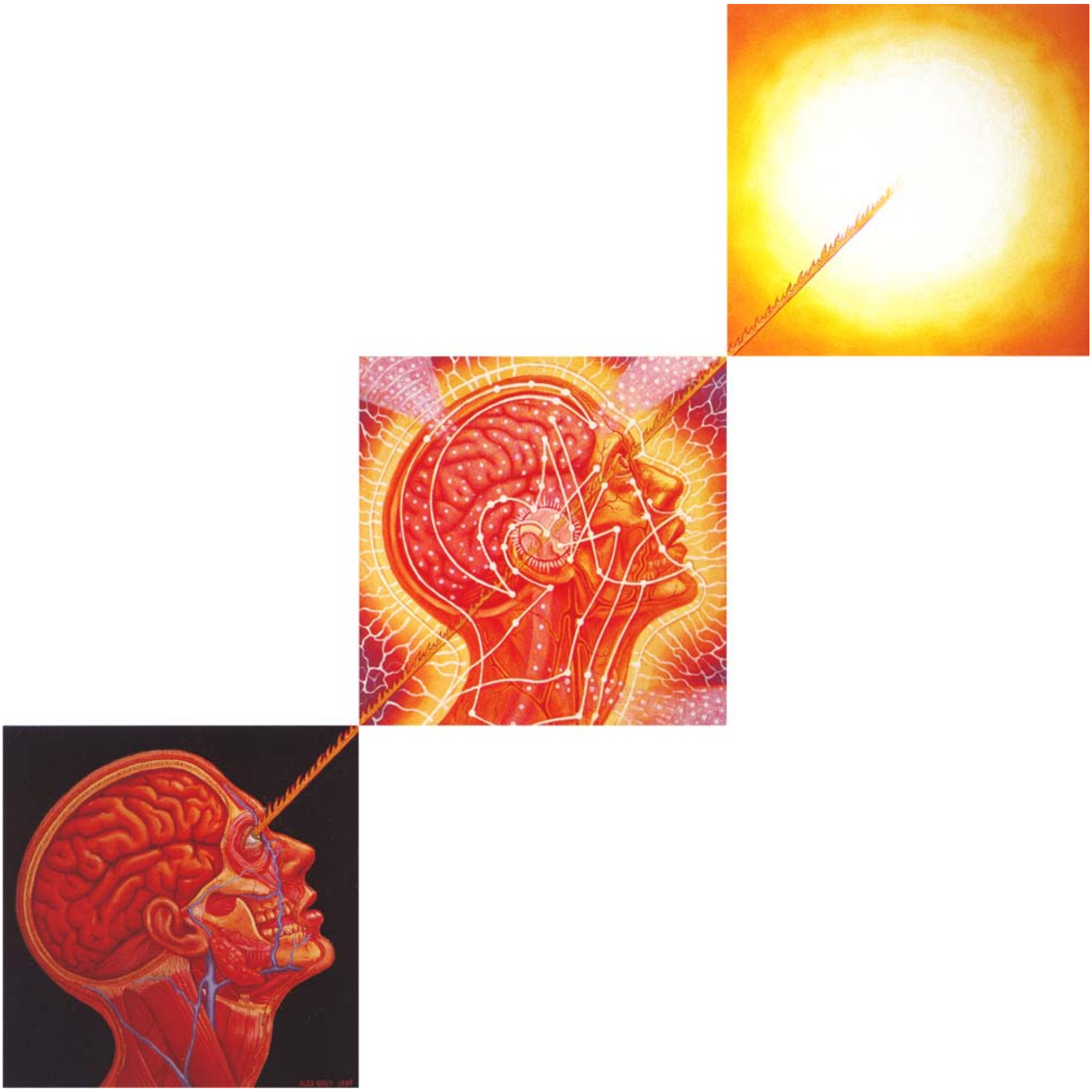



**Figure X:** Development of the quality of eyesight of the left eye - comparison of the two groups

**Conclusion**: The question whether the application of the orbit fluid drive would lead to an improvement of the visual acuity in myopic patients could be answered affirmatively: The randomization with regard to age, gender distribution and initial values of dioptres (visual acuity) was successful in both groups. A significant change could be observed in the visual values measured in the treatment group and a significant difference could be observed in the development of the values between the two groups.

## 10. Outlook and discussion



The work with my patients led me to the idea to carry out this study.
In my practice I could already achieve surprising results in the treatment of patients with myopia.
Initially, these results were mere accidental findings in patients who had come to me with different complaints: after my osteopathic treatment these patients, who already had glasses, developed symptoms like altered vision, insecurity and headaches.
When they consulted their ophthalmologist or an optician, the practitioners found out that the eyesight of theses patients had significantly improved. This meant that the patients' normal glasses now were disturbing because they corrected too much and thus the patients developed the above mentioned symptoms.
The reports of my patients prompted me to take a closer look at myopia.

First I thought about what kind of techniques would be best to chose for the treatment. There was the possibility to consider the application of specific treatment techniques for specific structures of the eye in this study. The second option was a treatment which involved the examination and therapy of the body as a whole – in line with the osteopathic philosophy which regards the body as an entity.
In a personal conversation with Nusselein we discussed how well my thesis could be defended if a treatment in the usual osteopathic manner was carried out. The concerns in this context were that the examination board could put forward the objection that the treatment was difficult to narrow down and too general. Therefore I decided to apply a focused treatment so that it would possible for me to work with a single treatment technique.
Thus Nusselein (personal communication) inspired me to use a fluid drive of the orbit through which it would be possible to treat the structures of the eye, i.e. not only the orbit as bony container but also the eye bulb and its structures. The objective of my treatment was to achieve an optimization of these structures in order to obtain improvements on all levels of the eye.
Once I had decided to apply a fluid drive of the orbit as treatment technique I searched the available literature and found a lot of osteopathic texts which helped me to develop the technique. Particularly helpful were the works of Becker, Magoun and Sutherlands.
Nevertheless, in the end it was the philosophy of Dr. A.T. Still that influenced me the most, above all his aspiration to water the "withering fields" to promote health in the

body. Magoun said in this context that: "...the cerebrospinal fluid has many other functions worthy of consideration. It is vital to central nervous system metabolism.
It is the vehicle for the secretions of the posterior lobe of the pituitary. It provides the body with protective and restorative powers which, when withdrawn from any certain area, result in the "withering fields" spoken by Dr. Still." (1997:17)
**"The agents of correction are the fluid and the membranes."** (personal communication: Nusselein) Sutherland's statement promoted my idea to choose a treatment technique that has an effect on the fluid level in the body. Also Sutherland's own osteopathic experience with this approach provided an additional motivation for me to work with the fluid.
"The first principle in the primary respiratory mechanism, the fluctuation of the cerebrospinal fluid, has a potency with an Intelligence, as I found out. This potency is an invisible "Fluid" within the cerebrospinal fluid. The potency of the Tide is what we have to consider – something with more power in the reduction of membranous articular strains of the cranium than any force you can safely apply from the outside." (1990: 30)

The eye, a fluid organ, is embedded in a bony container, which can also be influenced by a fluid technique. Thus it was self-evident to also apply the following statement for the eye:

"What are bones but a different form from fluid? What is the little hailstone that comes down from heaven but fluid? What is the earth out here, this world that we walk on, but fluid? It is all material manifestation and, back of that, fluid, when we learn to think with Andrew Taylor Still" (1990: 30)

Also Becker's statements concerning the fluid drive showed me how physiological movements are expressed through the liveliness of fluids:
"The science of osteopathy begins with a manifesting structure and function of the individual. It is expressed as a fluid-drive, motile, mobile mechanism within body physiology" (1997: 7)
In this context I would like to come back to my assumption that there is a sort of ventricular system in the ciliary body. My plan is to continue my research in this field and to examine more closely this "ventricle" in the eye and its relationship with the well-known ventricles in the brain.

Based on this research maybe new treatment approaches could be developed. In the consideration and treatment of eye problems, especially of myopia, it will be definitely reasonable to keep this aspect in mind.

After the study was over for the test persons, i.e. after I had carried out all study-related treatments, I offered the patients a free osteopathic treatment. This offer was based on the consideration that I did not want to disappoint the participants in the control group because they were “only” control patients and did not receive a treatment within the framework of the study.

In this free treatment my focus was no longer only on the problem of “compromised vision”, instead I carried out a normal osteopathic treatment which comprised a comprehensive case history and treatment in line with the philosophy of osteopathy.

In the course of these free treatments I obtained interesting findings:

More often than in my usual patients I found liver problems in the test persons. This could indicate a connection of the eye with metabolic processes, where the eye adapts to dysfunctions in the organs that are involved in the processes of metabolism.

Thus I think a study that looks at these connections would be very interesting and I would propose the implementation of such a study. Particularly, it would be interesting to take a closer look at fascial, neuro-vegetative, vasomotor, hormonal and other connections between the liver and the eyes.

Further I found that my “test patients” had extraordinary emotional burdens combined with the urge to talk about their problems much more often than in other patients. Since we already knew each other through the study, the patients were very open. The “test treatment” had triggered something in the patients and they had the desire to continue this process.

Some patients were very surprised by the change in their visual acuity, if not unsettled. It is particularly interesting that the patients whose vision had improved most considerably were those who were most insecure.

As I have already pointed out, it would be interesting to continue the research based on my results, because more questions have come up:

In how far are liver problems and mental/emotional burdens relevant for vision? Or is it that these people do not want to face things, do not want to “look something in the eye” and this is the reason for their short-sightedness?

Psychologists have known for some time that the emotional situation, the rhythm of life, everyday stress and the individual way of processing these things play a role in eye problems. Also the eye muscle exercises, which were mainly developed by Bates, are well known.
William Bates, an ophthalmologist, noticed that his short-sighted patients displayed visual habits which seemed to point towards increased tension in the external muscles of the eye. According to Selby (1992) Bates came to the conclusion that the altered form of the eye bulb which is responsible for the short-sightedness was due to this increased tension in the muscles of the eye. Thus he developed exercises to relax the muscles of the eye.

Also nutrition has a great influence on eyesight. It would be interesting to develop a comprehensive concept with the objective to improve a patient's vision, in which osteopathy also would play a major role.

In this context also the relationship of the eye with the brain plays an important role. In the literature I found evidence that there is already a close relationship in the embryologic development.

The proposition that the eye is a projection of the brain is based on the one hand on the embryological development and on the other hand, on the functional interrelation of the structures. In Chapter 4.1 "The eye: a projection of the brain" I have explained the interrelations in detail. From a physiological point of view Waldeyer describes:
"In electrophysiological experiments stimuli to the primary visual cortex can provoke the perception of images. [...] It is particularly interesting that some neurons react specifically to the spatial perception of streaks of light[...]. Movement- and direction-dependent cells react more sensitively to dynamic changes in the visual field than to static forms and patterns. This has led to the assumption that there is a modular organization of the visual cortex. [...]
If the secondary visual cortex, which can store visual memory, is destroyed through a pathological process, psychic blindness (visual agnosia) occurs. It consists in the inability of the patient to recognize familiar objects and to make sense of them, because he does not have any memory of former visual impressions." (2003: 460)
The influence of the eye on the neuro-vegetative system is described by Hollwich as an additional function of the eye: "The 2nd function of the eye uses the light not as a me-

dium of seeing but as stimulus for autonomous processes of metabolism, vegetativum and endocrinium." (Sturm, Birnmeyer, 1977: 1131, 1132)

The authors mention an experiment on the colour-change of plaice where the fish changes colour to blend with its surrounding: If you put the head of a plaice on a dark background its whole body becomes dark, even though the body lies on a light background – the same happens the other way round. With this experiment it could be proven that the colour-adaptation of the plaice is effectuated through its eyes. The authors conclude that: "The eye fulfils a visual and a biologic function: it is a receptor of light to perceive images and it is also a transmitter to stimulate and regulate the vegetative nervous system and numerous metabolic and organic functions."

(1977: 1134)

In this context they point out the innervation of the upper cervical ganglion by sympathetic fibres, which run from the retina to the cervical ganglion.

Another aspect that should be examined further is whether the ventricle in the ciliary body (Rohen, 2001), which exists during embryologic development, is still present in an adult. This could have therapeutic consequences.

Gradually it becomes more evident to what extent the eye functions as part of the brain. Like Schulz-Zehden underlines the functional unit eye-brain:

"In contrast to a camera seeing with the eyes is not a simple and immediate process. While an image enters the box of the camera and becomes visible on the film, the human eye and brain form a complex system, which perceives, analyses, transmits and stores stimuli that come from the outside. Seeing and perceiving are coupled with thinking and we often think how we see and vice versa. The filtering of unnecessary information is an essential part of the organization process. The eye which is controlled by the brain sees selectively, it sees subjectively and only perceives what the mind is interested in or what it wants or is forced to see...." (1992: 106)

According to Strempel (2004) we can conclude that the image on the retina allows for different possibilities of interpretation on the part of the brain. Thus she comes to the conclusion that what we see and especially how we see it influences our image of reality and the world.

To corroborate her conclusion that seeing and perceiving is always subjective and selective Strempel presents a study which was published in the magazine New Scientist (Vol. 168, 200):

This study was based on an experiment. In this experiment a young man asks a woman for the right way. She has already been explaining the way for a minute when suddenly two workers who carry a door pass between them. When they have passed a completely different man stands on the spot where the first man who had asked for the way had stood before; the two men swapped while the door was carried past. Half of the test persons did not even notice that their interlocutor had changed and simply continued to explain the right way.

Based on this experiment Strempel (2004) concludes that from an enormous plethora of sensitive input the brain picks the details that are important for the particular moment, the rest it simply makes up. (cf. Lurja).

To what extent the things we perceive are dependent on sensation but also on the attitude with which we see can be illustrated by another study carried out by Harvard researchers, which was also quoted by Strempel:

In this study the test persons were assigned the task to watch a basketball video. They were told to count the passes of one of the teams. After 45 seconds a man dressed up as gorilla walked across the court.

Amazingly 40 percent of the test persons claimed that no gorilla had walked across the court. But when they were shown the video again and they did not have to count passes, they clearly perceived the gorilla, but argued that this was another film.

Strempel (2004) sees the process of seeing as a highly differentiated interplay between the eyes and brain. According to her seeing depends very much on the anatomical conditions and the reciprocal action of the two organ systems.

The connection between dura and sclera with its continuity with the cornea at the Limbus cornea is decisive in this context. The incident light first goes through the cornea, which has the greatest refractive power with 23 dioptres, before it hits any other structure of the eye. As continuation of the dura it is the cornea which is the first instance to decide what is perceived. Here, a structure of the brain makes the first decision. This is very relevant and might provide answers for the questions that arose.

The wonderful thing in osteopathy is that this structure of the brain, the Dura mater, can be treated osteopathically, in this case with the fluid drive of the orbit.

Thus the question arises whether this treatment only has an influence on the ability of the eye's accommodation with regard to myopia, or whether the process of seeing can be influenced as a whole.

According to Still the human being is an entity, a self-regulating organism, created by the Grand Architect. Since the entity of the human being reacts as an entity also in the case of myopia, other aspects of the body might come into play. Based on my observations, it could thus also be possible that liver problems might have an influence on the eyes. I think it would be worth to carry out a follow-up study on this topic, which should work with a comprehensive examination and treatment concept.

With my comments and explanations I wanted to point out the difference between the treatment methods of osteopathy and a correction of the path of incident rays of light by means of corrective lenses.

The correction by means of visual aids is achieved through the corrective function of the lenses with regard to the aspect of accommodation.

The objective of osteopathic treatment is to influence all structures involved in the process (structures involved in the reception of light, refraction and perception) to have an influence on the process of refraction in general. In this context the influence of the dural structures and their continuity with the sclera and cornea is particularly relevant, especially since the cornea has the greatest refractive power.

By now I also treat many children preventively. I think this makes sense especially considering the "alternatives" that are on offer "after the horse has left the barn". Thus I would suggest including osteopathic treatments in the framework of preventive medical checkups on a routine basis; through these treatments the brain would get some support.

Already Becker claimed that: "Practically every child who is brought for diagnosis with a serious cranial distorsion will exhibit some type of eye muscle palsy or refractive problems." (1997: 364)

Schulz-Zehden illustrates to what extent seeing influences thinking and perception:

"The processes of image formation in all qualities (e.g. colour, form, contrast, depth of focus, three-dimensional picture) are complex and require a feedback between eye and brain. After a visual stimulus has been perceived and considered as worth seeing, the optic apparatus is focused on the image. This involves e.g. looking at the object so that (sic!) it is depicted as the point of sharpest vision, focusing, accommodation and adaptation of the pupil width or perception of details through coordinated movements of the eyes ". (Schulz-Zehden, 1986, 107)

According to this explanation not all impressions that reach the retina are also perceived. From the enormous amount of stimuli that reach the eye only a small fraction is selected. This selection is a valuation or degradation that follows subjective criteria according to stored experiences.

If we look at the process of seeing from this perspective several questions arise: How do we see? If the eye is more than an optic apparatus: What role does it play in the organism as a whole? Who or what is responsible for selection in the process of seeing? How are the structures organized in a human being who sees things in his/her personal way? Why does everybody see differently? Who is the observer?

In my thesis I have described the process of seeing from an osteopathic point of view and I have also tried to point out various interrelations within the body.

I would like to close with a sentence of Rolin Becker, which can be a great motivation for continuing to detect, develop and promote new knowledge through further research into the secrets of life and the human body:

“Dr. Still ... was guided by a Spirtual Fulcrum and so was Dr. Sutherland. If we, as students of the science of osteopathy, are to understand osteopathy, we will find it necessary to reawaken our knowledge of the Deity that centres us, make our Spirtual Fulcrum for our guidance, and learn to think, feel, and use the Creator in our daily practices.” (1997: 24/25)

## Annex

## Glossary

A. = artery

Aa. = arteries

Dpt. = dioptres

Lig. = ligament

Ligg.= ligaments

M. = muscle

Mm. = muscles

N. = nerve

NN. = nerves

SBS = sphenobasilar symphesis

SBR = Sidebending rotation

V. = vein

Vv. = veins

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## List of tables in the statistical part

# Proband- Questionaire

**Hereby I agree that my data can be published within the framework of the scientific study: Treatment of myopia through osteopathic techniques.**
**My personal details remain anonymous.**

Age:

Sex: male O female O

My problems of vision are: O shortsightedness
O farsightedness
O irregular curvature of the cornea
O other

How old were you when you first were prescribed your glasses?..................

How strong were your glasses then?...................

How strong are your glasses now?.....................

What were the reasons of why you were prescribed the glasses then?
O general deterioration of vison
O accident
O general disease
O other disease of the eyes

Accompanying complaints (e.g. headaches, dizziness, and shoulder-neck problems, burning eyes) ..........................

Where there any complications at your birth? (e.g. umbilical cord around neck, ventouse, Cesarean section, forceps)

..........................................................

Is there or were there malpositions of the TMJ?

O yes. Please specify:.............................

O no

How often do you wear your glasses?

O always

O irregularly

Do you take any regular medication at the moment?

O yes. Please specify:.............................

O no

Did you have to undergo surgery in the region of your eyes or face?

O yes. Please specify.............................

O no

| Nr. | Treatment | Sex | Age | Age 1st glasses | Complaints: Head | cervical complaints | complaints: Vertigo | complaints: burning, tired eyes | complaints: Tinnitus |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Osteopathie | male | 38 | 14 | no | no | no | no | no |
| 2 | Osteopathie | female | 16 | 15 | no | no | no | no | no |
| 3 | Osteopathie | female | 21 | 14 | yes | no | yes | no | no |
| 4 | Osteopathie | female | 13 | 7 | no | no | no | no | no |
| 5 | Osteopathie | female | 41 | 18 | yes | no | no | no | yes |
| 6 | Osteopathie | female | 33 | 9 | yes | no | no | no | no |
| 7 | Osteopathie | female | 42 | 25 | no | no | no | no | no |
| 8 | Osteopathie | female | 37 | 22 | no | no | no | no | no |
| 9 | Osteopathie | male | 13 | 4 | no | no | no | no | no |
| 10 | Osteopathie | male | 22 | 10 | no | no | no | no | no |
| 11 | Osteopathie | male | 30 | 20 | no | no | no | no | no |
| 12 | Osteopathie | female | 36 | 30 | yes | no | no | yes | no |
| 13 | Osteopathie | female | 49 | 13 | no | no | no | no | no |
| 14 | Osteopathie | female | 33 | , | no | no | no | no | no |
| 15 | Osteopathie | female | 12 | 11 | yes | no | no | no | no |
| 16 | Osteopathie | male | 48 | 18 | no | no | no | no | no |
| 17 | Osteopathie | female | 29 | 18 | no | no | no | no | no |
| 18 | Osteopathie | male | 46 | 17 | no | no | no | no | no |
| 19 | Osteopathie | male | 20 | 13 | no | no | no | no | no |
| 20 | Osteopathie | male | 23 | 15 | no | no | no | yes | no |
| 21 | no | male | 21 | 15 | yes | no | no | no | no |
| 22 | no | female | 43 | 22 | no | no | no | no | no |
| 23 | no | female | 16 | 15 | no | no | no | no | no |
| 24 | no | male | 15 | 14 | no | yes | no | no | no |
| 25 | no | male | 58 | 23 | no | no | no | no | no |
| 26 | no | female | 29 | 24 | no | no | yes | no | no |
| 27 | no | female | 25 | 18 | no | no | no | no | no |
| 28 | no | female | 32 | 17 | yes | no | no | no | no |
| 29 | no | male | 27 | 15 | no | no | no | yes | no |
| 30 | no | male | 24 | 15 | no | no | no | no | no |
| 31 | no | female | 23 | 16 | no | no | no | yes | no |
| 32 | no | female | 19 | 18 | no | no | no | no | no |
| 33 | no | male | 35 | 15 | no | no | no | no | no |
| 34 | no | female | 43 | 18 | no | no | no | no | no |
| 35 | no | female | 25 | 14 | yes | no | no | no | no |
| 36 | no | female | 19 | 13 | no | no | no | yes | no |
| 37 | no | female | 18 | 11 | no | no | no | no | no |
| 38 | no | female | 36 | 9 | no | no | no | yes | no |
| 39 | no | female | 38 | 11 | no | no | no | no | no |
| 40 | no | female | 20 | 13 | no | no | no | no | no |
| 41 | no | male | 21 | 16 | yes | no | no | no | no |
| 42 | no | male | 15 | 14 | no | no | no | no | no |

| birth complications: Sectio | birth complications: umbilical cord | birth complications: Hypoxie | birth complications: Forceps | birth complications: premature infant | TMJ | habbits of wearing glasses |
|---|---|---|---|---|---|---|
| no | no | no | no | no | no | ever |
| no | no | no | no | no | no | sometimes |
| no | no | no | no | no | no | sometimes |
| yes | no | no | no | no | yes | ever |
| no | no | no | no | no | no | sometimes |
| no | no | no | no | no | no | ever |
| no | no | no | no | yes | no | ever |
| no | yes | no | no | no | no | ever |
| yes | no | no | no | no | no | sometimes |
| no | no | no | yes | no | no | sometimes |
| no | no | no | no | no | yes | ever |
| no | no | no | no | no | no | ever |
| no | no | no | no | no | no | sometimes |
| no | no | no | no | no | no | ever |
| no | no | no | no | no | no | ever |
| no | no | no | no | no | no | ever |
| no | no | no | no | no | yes | ever |
| no | no | no | no | no | no | sometimes |
| no | no | no | no | no | no | ever |
| no | no | no | no | no | no | ever |
| no | no | no | no | no | no | ever |
| yes | no | no | no | no | no | ever |
| no | no | no | no | no | yes | sometimes |
| no | no | no | no | no | no | ever |
| no | no | no | no | no | no | ever |
| no | yes | no | no | no | no | sometimes |
| no | no | no | no | no | no | sometimes |
| no | no | no | no | no | no | sometimes |
| no | no | no | no | no | no | ever |
| no | no | no | no | no | no | ever |
| no | no | no | no | no | no | ever |
| no | no | yes | no | no | no | sometimes |
| no | no | no | no | no | yes | ever |
| no | no | no | no | no | no | ever |
| no | no | no | yes | no | no | sometimes |
| no | no | no | no | no | yes | ever |
| yes | no | no | no | no | yes | ever |
| no | no | no | no | no | no | ever |
| no | no | no | no | no | no | sometimes |
| no | no | no | no | no | no | sometimes |
| no | no | no | no | no | no | ever |
| no | yes | no | no | no | no | ever |

| 1st measurement right | 1st measurement left | 2nd measurement right | 2nd measurement left | 3rd measurement right | 3rd measurement left |
|---|---|---|---|---|---|
| 6,25 | 7 | 6 | 6,75 | 6 | 6,75 |
| 1 | 1,25 | 1,25 | 1,25 | 1 | 1 |
| 4 | 8,25 | 3,75 | 7,75 | 3,75 | 7,75 |
| 2 | 1,25 | 2,25 | 1,25 | 2 | 1,25 |
| 2 | 2 | 1,75 | 1,75 | 1,75 | 1,75 |
| 6,5 | 9,25 | 6,25 | 9 | 6 | 9,25 |
| 3,5 | 5 | 3,5 | 5 | 3,25 | 5 |
| 5,25 | 3,75 | 4,25 | 3,25 | 4,25 | 3,25 |
| 1,25 | 1,25 | 1 | 1,25 | 0,75 | 1,25 |
| 6,5 | 6,75 | 6 | 6,75 | 6,5 | 6,5 |
| 1,75 | 2 | 1,5 | 2 | 1,5 | 1,75 |
| 2 | 0,75 | 2,25 | 1 | 2,25 | 1 |
| 4 | 2,25 | 4 | 2,25 | 2 | 2,25 |
| 2,5 | 2,25 | 2 | 2 | 2,25 | 2 |
| 2,75 | 3,5 | 2,75 | 3,5 | 2,75 | 3,5 |
| 4,5 | 5 | 4,5 | 5 | 4,5 | 5 |
| 3,5 | 3,5 | 3,5 | 3,5 | 3,5 | 3 |
| 0,5 | 0,5 | 0,5 | 0,5 | 0,5 | 0,5 |
| 2,5 | 2,75 | 2,25 | 2,25 | 2,5 | 2,5 |
| 2,25 | 3,25 | 2,5 | 3,25 | 2,5 | 3,25 |
| 1,5 | 2 | 1,5 | 2 | . | . |
| 0,75 | 2 | 0,75 | 2 | . | . |
| 3,5 | 5,5 | 3,5 | 5,5 | . | . |
| 7 | 6,5 | 7 | 6,5 | . | . |
| 2,25 | 3,75 | 2,25 | 3,75 | . | . |
| 3 | 3,5 | 3 | 3,5 | . | . |
| 4 | 3 | 4 | 3 | . | . |
| 1,25 | 1,75 | 1,25 | 1,75 | . | . |
| 0,5 | 0,75 | 0,5 | 0,75 | . | . |
| 0,5 | 0,75 | 0,5 | 0,75 | . | . |
| 1 | 1,25 | 1 | 1,25 | . | . |
| 1,25 | 2 | 1,25 | 2 | . | . |
| 1,25 | 1,25 | 1,25 | 1,25 | . | . |
| 1,25 | 1,25 | 1,25 | 1,25 | . | . |
| 0,75 | 1 | 0,5 | 1 | . | . |
| 1,5 | 1,75 | 1,5 | 1,75 | . | . |
| 1,75 | 0 | 1,75 | 0 | . | . |
| 3,5 | 4,75 | 3,5 | 4,75 | . | . |
| 2,75 | 1,5 | 2,75 | 1,5 | . | . |
| 1,5 | 1,5 | 1,75 | 1,5 | . | . |
| 7,75 | 6,5 | 7,75 | 6,5 | . | . |
| 2,5 | 1,75 | 2,5 | 1,75 | . | . |