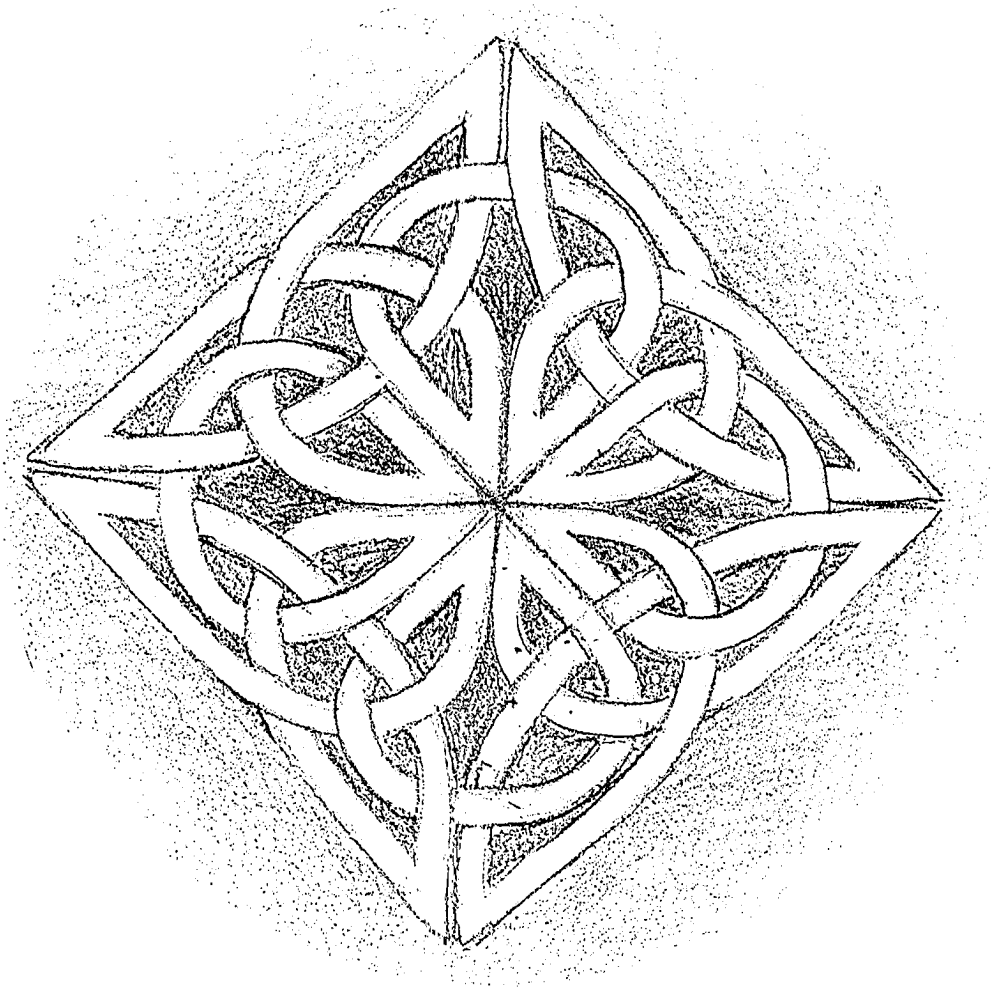
THERMOREGULATION

DIAGNOSTICS



Report of the chosen research of Nanette Fransen and Rob Elns, done in the Physiological Institute of the University Witten/Herdecke during the months April till August 1989.

Chapter 1

INTRODUCTION

For the purpose of our chosen research, which is a compulsory subject in the second phase of the study of medicine at the Erasmus University in Rotterdam, we stayed in Herdecke (West Germany) from April till September 1989.

To broaden our minds we wanted to do our research in a different place than Rotterdam. With the help of Dr. H. Verbrugh and some doctors from the "Gemeinnütziges Gemeinschaftskrankenhaus" in Herdecke we finally contacted Prof. Dr. E. David at the Institute of Physiology, which belongs to the University of Witten/Herdecke.

He provided us the possibility to do research at his institute and made us enthusiastic by offering us the following subjects: Hippotherapy (therapeutic horseriding), Music therapy and the Thermoregulation diagnostic.

Finally we decided to choose the Thermoregulation diagnostic (TRD). In short the TRD tries, by measuring the skin temperature at 60 (in case of women 78) points, to get an impression of the health status of the body. These points on head and the upper half of the body are measured before and after a cold stimulus. The reaction of the body to this stimulus is regulated by the temperature regulation system. Because this system is connected with all the other regulation systems in the body, it might be possible that an internal disturbance has its influence on the temperature regulation system, and makes the body show a different reaction on the cold stimulus as in a healthy state. This principle is the basis for the TRD.

Important arguments to choose the TRD were:

- the fact that this subject seemed most suitable to do scientific research on,
- the fact that the research would take place as well in the institute as in the hospital,
- the possibility to get to know a new, inexpensive, and non-invasive, diagnostic method, which could be directly used in the clinic.

After a period of reading articles about the subject and learning how to do "thermo-measurement" three main questions appeared:

1. What does a thermogram (optical presentation of a temperature regulation measurement) under healthy circumstances look like?

2. Is a group with a certain disease distinguishable from a healthy group, by means of the TRD?

3. How does the skin temperature behave before, during and after the thermo-measurement?

These questions will be answered in chapter 3. First the history and theory of the TRD will be explained in chapter 2. Finally, in chapter 4, we give a summary, a conclusion and an impression of the personal experiences we had during our stay in Herdecke.
This manuscript is written for Prof. Dr. H. Callewijn, physiologist at the Erasmus University Rotterdam, for Prof. Dr. E. David, head of the Physiology Institute of the University Witten/Herdecke, for everybody who is interested in the TRD and for ourselves.

At last we would like to thank the whole staff of the Institute of Physiology, especially:

- Prof. Dr. E. David who invited us to do our research at his institute,

- Dr. M. Pfotenhauer and Lorenz David who were always ready to help with the electro-technical problems,

- Monika Mikler who taught us to measure and also did a lot of measurements for us,

- Rentia van Eldik who organized a place for us to live and did all the administrative matters,

- Werner Eidam (Eidam Medical Technology)who provided all the apparatus for the experiments,

- Dr. A. Planken, gynecologist at the "Gemeinnütziges Gemeinschaftskrankenhaus" in Herdecke, who provided us his patients,

- David Aldridge who advised us concerning the methodology,

- Thomas Schürhalz who gave us his critical and analytical remarks which led to many positive discussions,

- the research department at the "Gemeinnütziges Gemeinschafts Krankenhaus" for their advices and help concerning the statistics.

and everybody who made our stay in Herdecke enjoyable.

Chapter 2

THERMOREGULATION DIAGNOSTICS.

HISTORY AND THEORY

2.1

HISTORY

Since ages people have been trying to get an impression about clinical pictures by measuring the temperature (11). Usually the hand was laid an the forehead to judge the body temperature, or one felt the temperature on joints or other area‘s where an inflammation was suspected. By feeling the temperature the suspicion could then be confirmed.

As time went on more advanced methods were found to measure the body temperature, and of those the mercury thermometer appeared to be the most confident, which is still used in nearly every hospital. Later on there were also research workers who were interested in measuring the skin temperature for diagnostic use. Ipsen (21) was the first of them and he tried to use the mercury thermometer, which was of course unsuited to the purpose, because of its inerta.

Afterwards other methods were developed, like the infrared thermography, the liquid crystal thermography and the electronical thermography. Below follows a short description of these methods.

*****INFRARED THERMOGRAPHY.

This method uses the fact that the body is radiating infrared. This radiation is measured, converted and shown in colours. So a coloured picture is created in which different colours correspond with different skin temperatures.

Later on E. Schwamm (36) developed a bolometer, which could measure a small skin area. The measured temperature is then shown as an absolute value, which is better usable in comparing studies.

*****LIQUID CRYSTAL THERMOGRAPHY.

Using this method the temperature is measured with fluid cholesterol crystals. These crystals change of colour at certain temperatures. Mostly they are packed in foly and placed on the skin where the temperature is to be measured. Nowadays this method is used a lot in the diagnostics of breast cancer. One again gets a coloured picture in which different colours stand for different temperatures.

*****ELECTRONICAL THERMOGRAPHY.

In the last ten years this method has been developed strongly. A thermo-element is used in which are two metal wires of different composition. When the temperature is changing a voltage is created between the two wires, which is a measure for the temperature. The skin is touched with this thermo-element and it takes about one second to measure the temperature.

Obviously there are various methods to measure the temperature, but not every method is suited for scientific research. Because the comparison of two-coloured temperature pictures is more difficult and more subjective than the comparison of figures the infrared body thermography and the liquid crystal thermography are not very suited.

The other two methods differ from each other in that with the bolometer method there is no contact with the skin and with the electronical method there is. The infrared method though has to count with many disturbing factors when measuring the skin temperature. As disturbing factors were found:

- the distance between bolometer and skin (31,36)
- the quantity of hair on the skin (31)
- the quantity of tallow on the skin (23)
- the quantity of sweat on the skin (31)
- the quantity of pigmentation of the skin (31)
- the skin perfusion (31).

Besides the bolometer only measures a certain part of the infrared spectrum, while the body is emitting a much larger spectrum.

These findings were reason enough for us to chose for the electronical method.

In the thermography however had become clear that one single measurement only gave information about a momentary state of the body, which had only a limited diagnostic value. That is why a second measurement was introduced, which took place after the body was exposed to a stimulus. It was found that a cold stimulus was the most effective(4). E. Schwamm was the first who used this stimulus with the infrared method. He let the test persons dip their underarms in water with a temperature of 12°C, till they experienced this as unpleasant. Later on he changed the stimulus into undressing the upper body at room temperature of 20-22°C, because in his opinion a cold stimulus of the whole upper body (dermatomes 04 to L4) would bring a stronger reaction than a cold stimulus in only the dermatomes C5 to Th1. This appeared to be right (3). ROST (7) has introduced this method in the electronical thermography and has reduced the number of to be measured skin points. With this method which is known as the thermoregulation diagnostic by ROST we have been working. How this method is practiced we will describe later. First we will discuss the backgrounds of the general temperature regulation of the human body.

2.2

THEORY

THE TEMPERATURE REGULATION IN THE HUMAN BODY.

The human being is a homoiothermic creature, which means that the body is continuously trying to keep the temperature at a certain level. The information the body uses for this purpose is coming from thermoreceptors in the skin, which are mainly important to detect cold, and in the spinal cord, which are more important to detect warmth (3). This information is compared in the posterior part of the hypothalamus with a set temperature. When the body tends to get to warm the body can use the following controll mechanisms.

1. vasodilatation of the skin bloodvessels. This is accomplished by inhibiting the sympathetic constriction centres in the posterior hypothalamus. The release of warmth can be increased 8 times (8,13,18).

2. sweat secretion. By stimulating the sweat secretion there is more sweat on the skin surface. By evaporation of the sweat 10 times the basic produced body warmth can be released (8,13,18).

3. decrease of metabolism. This occurs mainly in the liver and the muscles so that less warmth is produced, and the body temperature will not rise more.

There are also control mechanisms when the body cools down too much.

1. vasoconstriction. This constriction is caused by activation of sympathetic neurons, which run from centres in the posterior hypothalamus to the blood vessels. It prevents the loss of warmth through blood transport.

2. increase of muscle tonus. Again cells in the posterior hypothalamus are responsible. When the tonus has reached a certain level and the muscle spindles are activated the well known shivering and teeth chatter appear.

3. increase of metabolism. This is caused by an increased sympathetic activity and increased excretion of thyroxine, which both stimulate the cell metabolism, which make the body temperature rise.

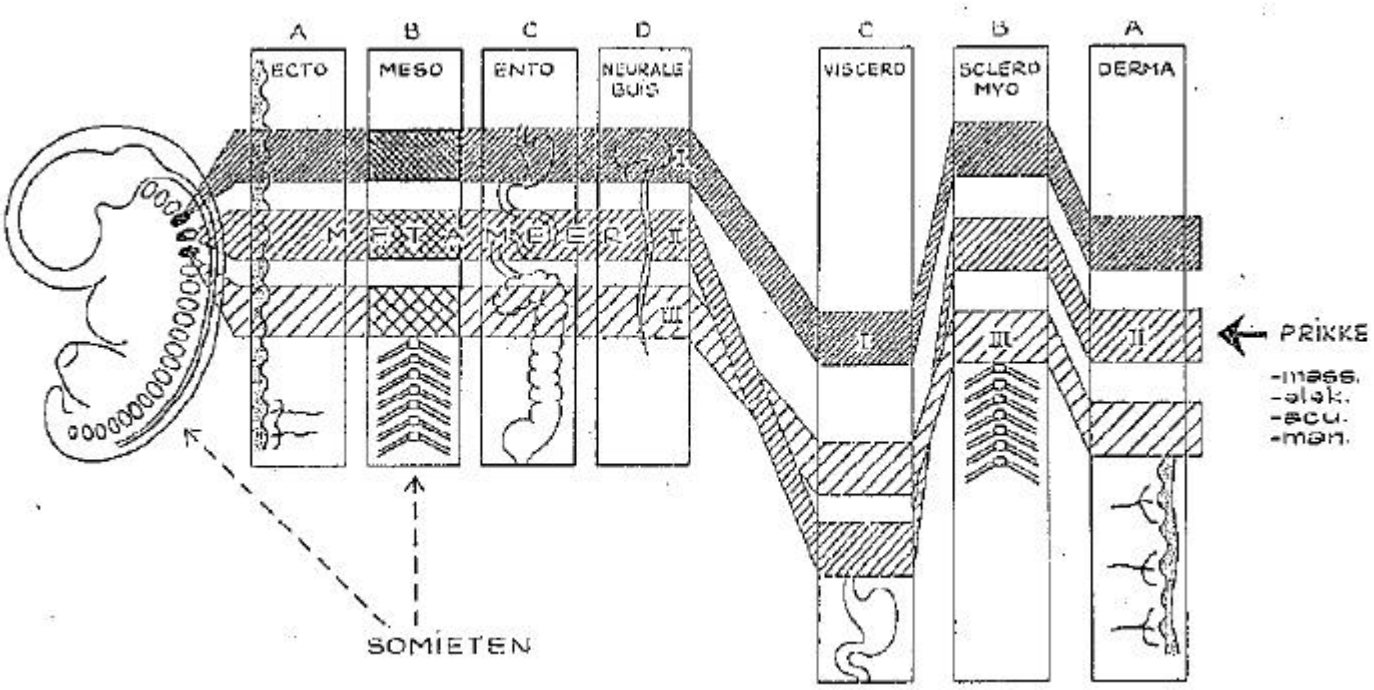
Although the body has a regulation system which controls the temperature throughout the whole body, this does not mean that every skin area has the same temperature. On one hand there are skin areas, e.g. with much hair, which prevent the release of warmth, and on the other hand there are skin areas, e.g. with many sweat glands, which stimulate the release of warmth. Furthermore the skin above active muscles will be warmer than the skin above joints (8).

Research has shown (8) that not everybody uses the above mentioned mechanisms in the same way. Some people react more with an increase in metabolism and less with vasoconstriction on a cold stimulus, and the skin temperature will remain the same. Other people react more with vasoconstriction and the skin temperature will decrease. When the temperature tends to rise too much some people react mainly by decrease in metabolism, some mainly by vasodilatation and others more by increasing the perspiration. Because these different mechanisms are also found at different skin areas one can conclude that everybody has a very personal warmth distribution and regulation. Obviously this is of importance for the thermoregulation diagnostic.

Figure 1. Embryology of the segmentation.

Left: embryo with somites. In the middle: structure of the segment (metamere) from a part of the ectoderm, mesoderm and entoderm.

Right: anatomical movements during the later embryonal development. The shown stimulus can, depending on the depth of its influence (A, B or C), influence different segments (I, II or III). Taken from Crahnenburgh 1985.



2.3

THE RELATION BETWEEN THE FUNCTIONING OF INTERNAL ORGANS AND THE TEMPERATURE REGULATION THROUGH THE SKIN.

In this section we will try to enunciate the theoretical backgrounds of the thermoregulation diagnostic (TRD). The emphasis will be on the relation between the skin points and the different internal organs, and the possible cause why some points get warmer and others get colder after a cold stimulus. Before we will discuss the specific measuring points we will first describe the general relation ketween internal organs and the skin; Crahnenburg (7) en Schifter (34) recently have written very clear books about this subject.

The oldest mode of treatment which connects the skin with the functioning of internal organs is originating from China; the acupuncture. The emphasis of this method is not the diagnosis but the therapy, and several times it has been proved that sticking needles in certain skin points influences the functioning of internal organs (7). During the last century though there also have been several western physicians who brought under attention the relation between internal organs and the skin. Important pioneers who invested this matter were the English researchers Head and Mackenzie and the German researchers Hansen and Schliack, who all pointed at the neural connections, running through segmental reflexmechanisms between skin and internal organs. To make clear how the internal organs and the segments relate we will first have to explain something about the embryological development of the skin and the internal organs.

Early in the embryological development, just after the closure of the neural tube, the mesoderm gets devided into segments, the socalled somites. The number of somites corresponds with the number of vertebra, n.m. 31 (8 cervical, 12 thoracal, 5 lumbal, 5 sacral and 1 coccyegal). Out of this mesoderm originate the muscles, tendons, ligaments, capsulas and bones. Every somite is connected to the embryonal spinal cord through its own neural root. This is called primary segmentation because this segmentation is really extant and forms the stimulus of segmentation of other structures than the mesoderm. Of importance is that these neural connections remain unchanged during the embryonal development. Consequently the segmental innervation does not change, although most organs change their location radically. Because of these extended anatomical movement of organs in the adult human being it is very hard to find back this original segmentated structure (fig. 1). Only thoracal (ribs, vertebra and intercostal muscles) the principle of repeating segments is still clearly shown. Out of the mesoderm of these somites originate:

>> a part of the dermatome (especially the deeper skin layers);

>> the myotome : all muscles innervated by one anterior root;

>> the sclerotome : capsulas, ligaments, connective tissue and bones.

The situation is different in the embryonal entoderm (out of which originate the internal organs) and the ectoderm (skin). The entoderm is originally a long tube, running from mouth till anus, which is anatomically unsegmentated. Because a certain part of this tube becomes innervated by a certain neural root (the nearest by at that moment) a secundary segmentation arises. Also the ectoderm is a continuous covering structure, which only gets segmentated secundarily. Out of this entoderm and ectoderm originate respectively:

>> the viscerotome (or enterotome): all internal structures innervated by one neural root;

>> the dermatome : the skin area belonging to one neural root (in this case onlythe posterior root because only the sensibility is concerned).

It is getting more complicated though because most organs are doubly innervated: sympatheticly and parasympatheticly. About the segmental organisation of these systems the following can be said:

1. the sympathetic innervation is taking place out of 15 segments (C8/Thl-L2) and is segmentally organised; there is a strong overlap though between the adjacent segments.

2. the parasympathetic innervation through the nervus vagus has its origine in the brainstem and is not segmented. (thoracal and abdominal organs).

3. the sacral parasympathetic innervation of the pelvic organs through the nervi splanchnici is more or less segmented (out of S2-S4).

The skin structures (vesseln, sweatglands and hairs) are only innervated sympathetically. This innervation is segmentated, but there is a strong overlap. Those segments are called:

>> angiotome (vasotome): all bloodvessels which are innervated out of one segment. The angiotome comprises vessels in the intestines as well as in the muscles and skin. Anatomically this can result: in many different localizations; e.g. coronary vessels and vessels in the face belong to the same segment.

>> sudotome : all sweatglands which are innervated sympathetically out of on segment.

>> pilotome : all hairs which are innervated sympathetically out of one segment.

After this embryological refreshment we will talk about the reflexes which can occur in these structures.

2.4

REFLEXES.

When there is a reflex in the somatic nervous system (which has mainly to do with the interaction between the individual and his environment) the stimulus from outside the body enters the body through the skin or locomotor system (extero and proprio sensors). The impulses reach the spinal cord or brainstem through somatic afferents and have their effects through somatic efferents. Examples are the knee tendon reflex (propriosensorical) and the draw back reflex (exterosensorical).

Also the reflexes in the autonomic nervous system (which is important to keep the homoeiostasis in the body) have an afferent and an efferent part. The efferent part is subdevided in a sympathetic and a parasympathetic nervous system.

The sympathetic nervous system originates from the spinal cord segments C8/Th7-L2 and serves the ergotrophic functions, i.e. the active functions in the body, which means that certain organ systems are activated and others are inhibited. Furthermore it is important to know that the fibres of the sympathetic nervous system reach every small corner in the body.

The parasympathetic nervous system originates partly in the brainstem and partly in the spinal cord segments S2-S4, and serves the trophotrophic functions, i.e. the functions which are important in rest, recovery and rebuilding processes.

In this autonomic nervous system reflexes are generated by interosensors. The impulses reach the spinal cord or brainstem through autonomic afferents (which are called viscero afferents when coming from internal organs) and have their effects through autonomic sympathetic or parasympathetic efferents. For example:a decrease in blood pressure is percepted by barosensors and centres in the brainstem are reached through autonomic afferents. From there autonomic efferents are stimulated, as well sympathetic (vasoconstriction, tachycardia) as parasympathetic (tachycardia by diminishing the inhibiting influence of the nervus vagus).

Figure 2.

Afferent innervation of the intestines. There are 4 possible routes:

1. through the tr. sympathicus
2. the n. phrenicus
3. the nn. pelvici
4. the n. vagus

There are 2 “empty areas” in the spinalcord; i.e. in that part no stimuli from the intestines are coming in. In case of a sick organ more routes are activated. Taken from Crahnenburgh 1985.

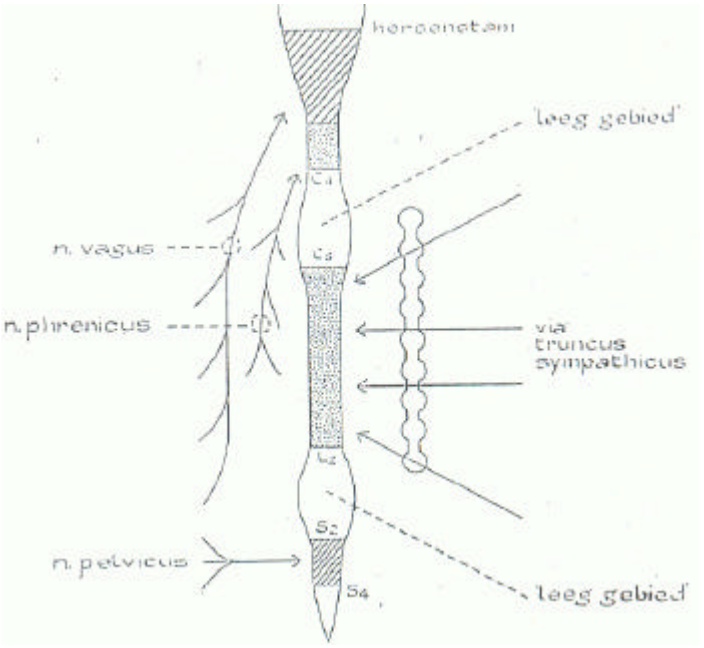
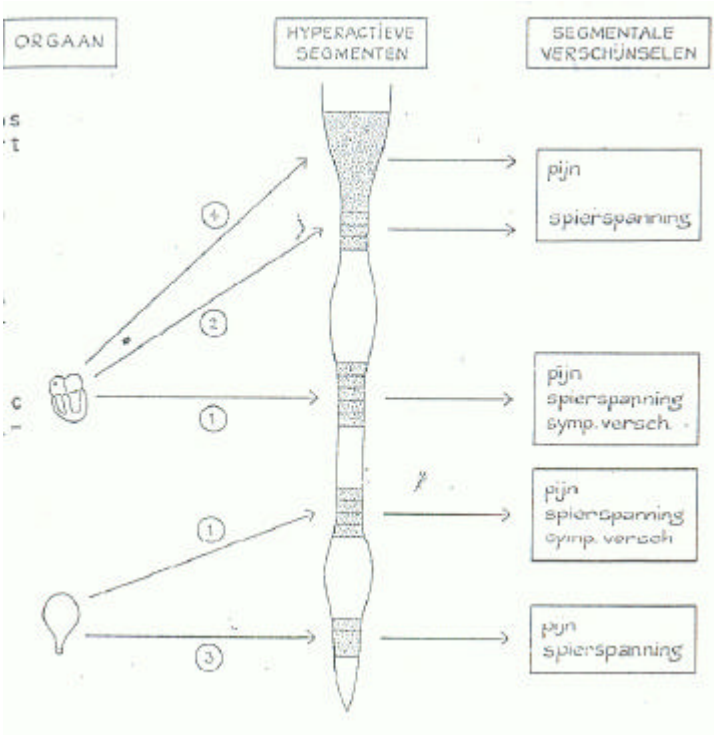


Figure 3.

Afferent projections from the heart. From the heart there are 3 possible routes. The numbers correspond wit those of figure 2. Because of multiple projection spinal cord segments are activated in groups. Segmental symptoms can develop in the corresponding derma-, myo- and “sympathicotomes “: pain, muscle tension and sympathetic symptoms. Because of this multiple projections bizarre localisations are possible. Taken from Crahnenburgh 1985.



To get a good insight in the segmental reflex mechanisms it is important to know the connections between the organs and the nervous system. The viscero afferents generally use four different routes to lead impulses to the central nervous system:

1. The viscero afferents run along with the sympathetic fibres. Consequently they run through the sympathetic trunk, they do not synapiate there, and then enter the spinal cord (segments C8/Thl-L2) through the posterior root. The cell body is situated in the spinal ganglion.

2. The autonomic afferents coming from the peritonea reach the spinal cord segments C2-C4 through the nervi phrenici. As a result many organs from the thorax and the abdomen project to the high cervical segments.

3. Afferent impulses from the pelvic organs reach the segments S2-S4 through the nervi pelvici.

4. Impulses from the thoracal and abdominal organs are led to the brainstem through the nervus vagus.

The dividing line between the innervated areas by the nervus vagus and the nervi pelvici is formed by the pelvic christa.

Figure 2 recapitulates the four routes. One can see that there are some spinal cord segments which do not receive impulses from the intestines; the segments C5, C6 and C7 and L3, L4, L5 and Sl. These segments correspond with the dermatomes and myotomes from the limbs. Knowing this it is clear that organ zones are mainly located on the trunk.

Stimuli coming from internal organs usually activate more afferent routes at the same time. For example (fig. 3) the heart influences more spinal cord segments and as a result segmental symptoms can occur in spots which are far away from each other. In case of heart diseases we know symptoms occur in the following places:

-on the breast
-on the back between the scapula
-around the shoulder
-at the ulnar fore-arm
-in the neck, till the under jaw
-in the face
-the pupil

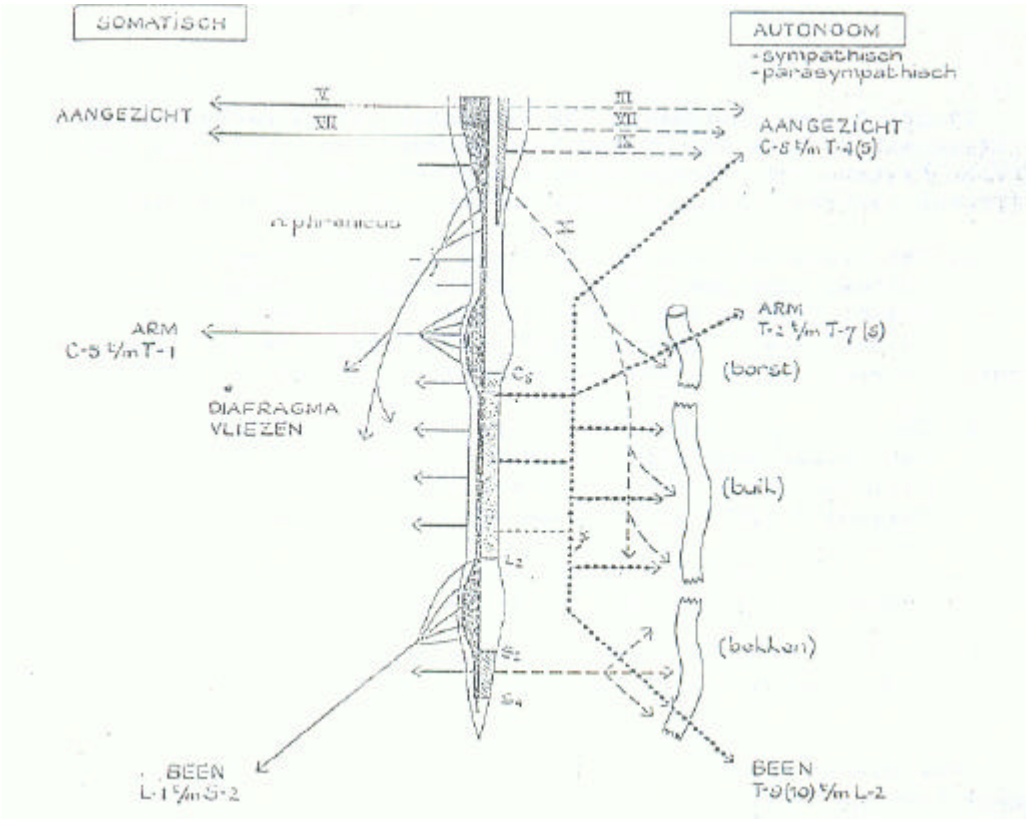


Figure 4. Origin of somatic and Lutonomic innervation.
Left: somatic (incl. n. phrenicus), black.
Right: autonomic. Sympathetical origin: grey; parasympatheticaL origin: shaded. Notice the differences between the autonomic and somatic innervation in the face, fore and hind Limbs.Taken from Crahnenburgh 1985.

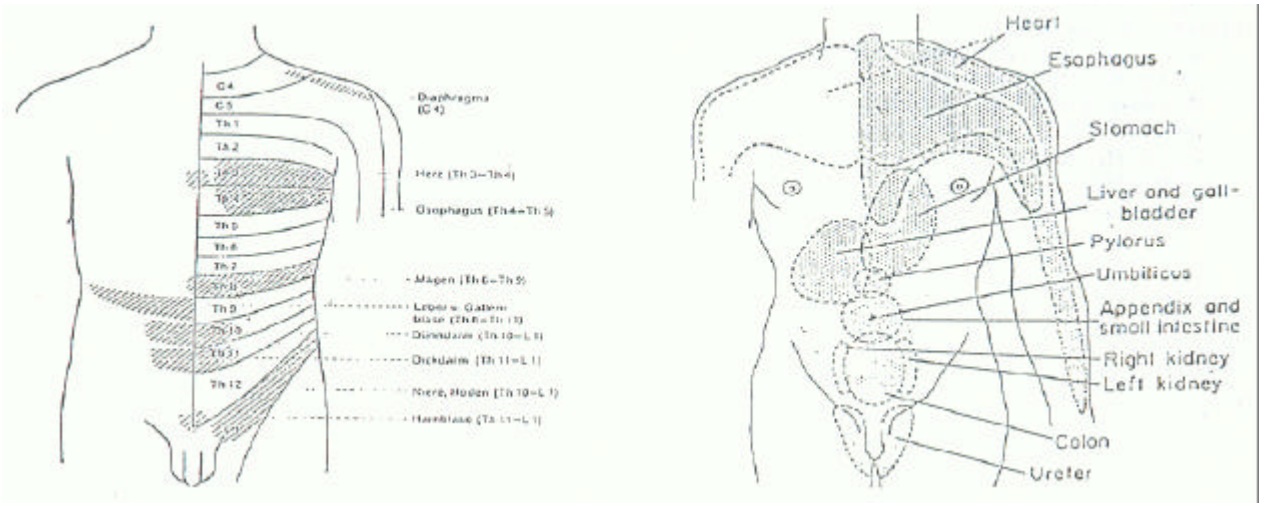


Figure 5. Zones of Head.
Zones of Head according to 2 auteurs (Guyton,1971 and Duus,1980). Obviously there is no agreement about the precise size and Localisation of the zones. Taken from Crahnenburgh 1985.

For a clear apprehension of the segmental phenomena it is of great importance to know that the sympathetically innervated structures have a very different segmental innervation as the somatically innervated structures. For example the neck belongs somatically to the segment C3, but sympathetically to segment Th3. Segment Thl somatically innervates a part of the skin and muscles on the thorax but sympathetically the pupil. This is shown schematically in figure 4:

- the whole body is innervated sympathetically by a limited number of segments (C8/Thl-LZ)

- the thoracal and abdominal organs are innervated parasympathetically from the brainstem

- the pelvic organs are innervated parasympathetically from the segments S2-S4

- the skin, skeleton and the muscles are innervated somatically from all spinal cord segments.

There are two possibilities in which segmental symptoms can develop:

1. Stimuli from the intestines interfere with stimuli coming from other body parts entering the same spinal segments.

That means that nerve fibres from the intestines (viscerotome) and nerve fibres from the skin or muscles (dermatome or myotome) convergate at the same spinal cord segment. This is the commonly used explanation for the phenomenon of “referred pain”; the patient is feeling pain in the skin or muscle areas belonging to the “overstimulated” segment. The brains wrongly interprete the received impulse stream and project the pain to the corresponding skin or muscle area. We want to emphasize that there are no impulses running to those painfull areas. H. HEAD did research on painfull areas which belong to internal organs. Later these zones were called after him and are known as the “zones of Head”.(fig. 5)

Regarding the localisation and extent of these areas there are different possibilities:

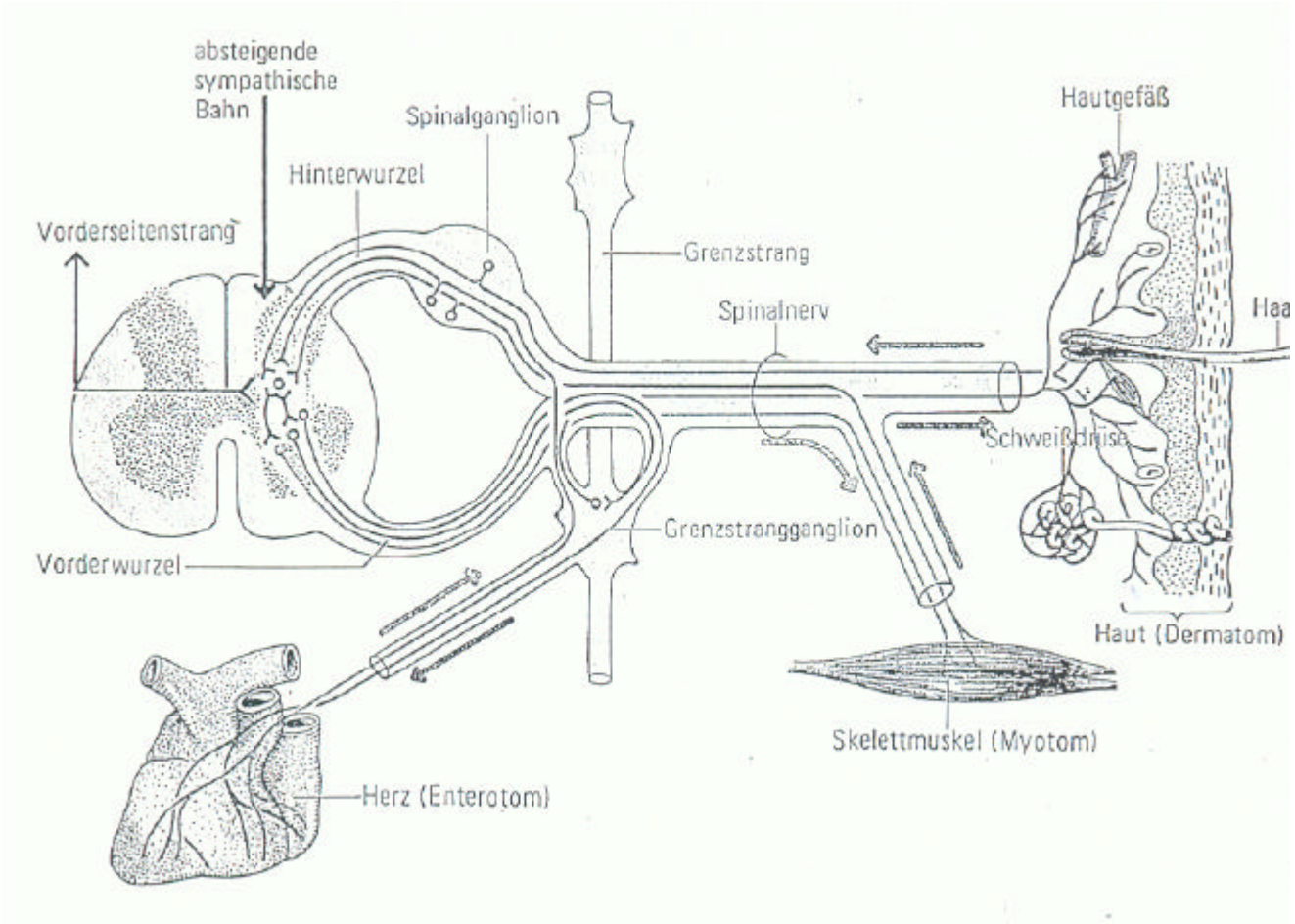
a. The zone does not correspond to the innervation area of a certain peripheral nerve.

b. The zone is situated within a dermatome. Possibly there are one or more hypersensitive centres within a dermatome, the socalled “maximal points”.

c. These zones can be found as well on the ventral as on the dorsal side of the body; They have also been described on the head and in the neck.

Figure 5b.

Scheme of the tracts important for the appearance of sympatheticat symptoms. Taken from Schiffter 1985.


absteigende
sympathische
Bahn
Spinalganglion
Hinterwurzel
Vorderseitenstrang
Grenzstrang
Spinalnerv
Hautgefäß
Haa
Schweißdrüse
Grenzstrangganglion
Vorderwurzel
Haut (Dermatom)
Skelettmuskel (Myotom)
Herz (Enterotom)

2. Stimuli coming from the intestines can generate many reflexes through the spinal cord.

These reflexes are generated through:

a. motor neuron cells.

These are the viscero somatic or viscero motoric reflexes. There are occurring hypertone zones,
e.g. hypertony of the lower part of the musculus pectoralis in heart diseases. MACKENZIE (24) has done a lot of research about this subject and those hypertone muscle zones are known as the ‘zones of Mackenzie’. In this case there are going impulses to the painfull muscle areas.

b. sympathetic lateral horn cells.

These are the viscero sympathetic reflexes (also called viscero cutane reflexes because the effect iis often shown at the skin). The fibres reach the periphery through the sympathetic trunk and the peripheral nerves of bloodvessels and cause there a variety of phenomena (vessels, sweatglands, hairs, ‘trophic’ and pupil). An example is the wide. pupil in heart diseases.

These last group of reflexes are important for the TRD, and so we will discuss these effects more extensively.

INCREASED MUSCLE TENSION.

As distinct from the ‘referred pain’ the muscle tension can be found objectively. It appears that an intestinal disturbance already shows its presence in a very early stage with a discrete hypertonic zone (24). These zones are purely segmental and localised in a certain myotome. HANSEN AND SCHLIACK (14) have done some research in accordance with early diagnostics and describe special palpation tehniques to find these hypertonic zones. The production of warmth in such a zone might play a role in the change of skin temperature.

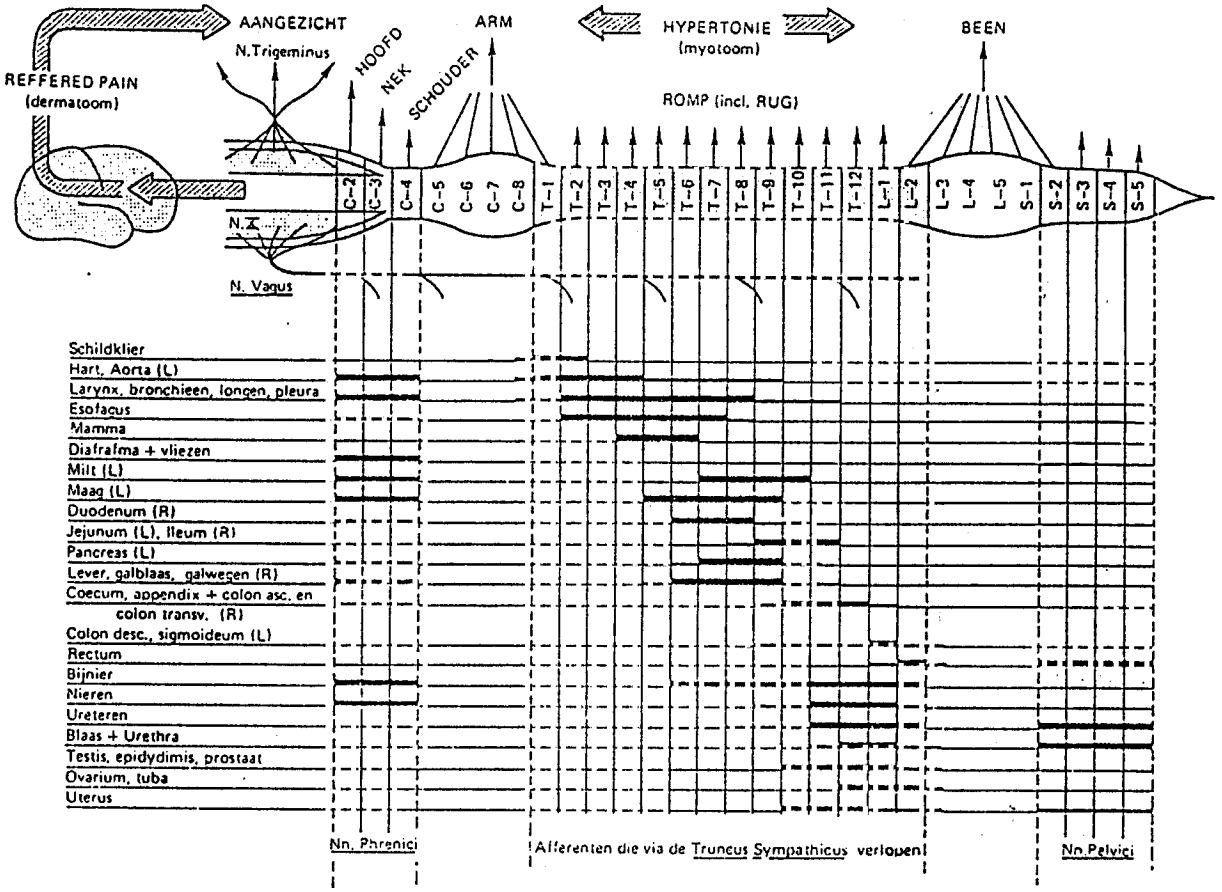


Figure 5c.

Structured representation of the segmental relations according to Crahnenburg (7). Left.organs. Afferent innervation by truncus sympaticus (1), n. phrenicus (2), n. pelvici (3) and n. vagus (4). Normally the impulses out of the organs and/or peritonea use different afferent routes, so seperate levels in the spinal cord and the brain stem are activated. Hypertony is a complete segmental reflex phenomene. Referred pain is felt (brains !) in the segmentally equal dermatome or myotome.

N.B.
The nuclea of the n.vagus and n. trigenimus reach till in the cervical spinal cord.

Thick beams: by almost every author mentioned; thin beams:only by a few authors mentioned. This representation has bee made with help of information of many authors. L: zones on the left. R: zones on the right.

SYMPATHETIC PHENOMENA

Sympathetic phenomena can only arise when stimuli enter the spinal cord between the segments CB/Thl-L2, because those segments contain the preganglionar sympathetic neurons. It appears that almost all internal organs send their stimuli to the central nervous system through these segments (7), (fig. 5c). The most important phenomena are the following:

1. vasoconstriction in the bloodvessels

This is a very important phenomenon in relation to the TRD because the constriction of skin bloodvessels of course influences the skin temperature.

2. increase of sweat secretion

Areas with increased sweat secretion can be shown with certain colouring substances (34). With the help of these zones diagnostics can be made.

3. pilo erection

When there is an increased sympathetic activity one can see a locally increased and extended area of goose-flesh.

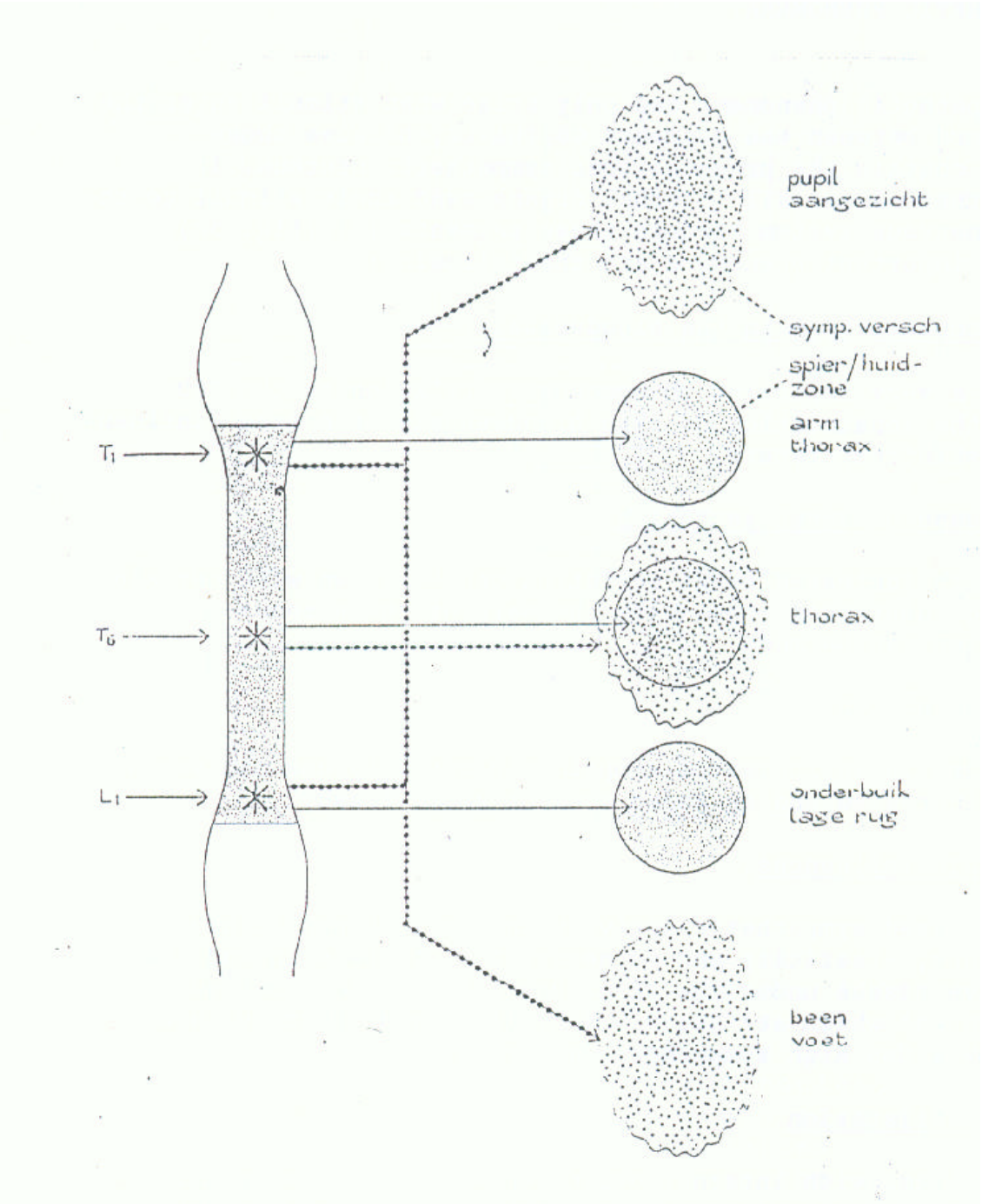
4. trophic influences

The increased sympathetic activity causes a change in a.o. consistency, elasticity and vulnerability of the skin and the connective tissue under the skin. Possibly the “connective tissue zones” which are described by DICKE and LEUBE (9) are caused by a too high sympathetic activity.

5. pupil dilatation

Many problems with internal organs show a midriasis (pupil dilatation) as an accompanying symptom. This symptom is very suitable to determine on which side of the body the disturbance is situated.

Figure 6.



Location of sympathetical and somatical symptoms. Sympathetical symptoms do not have to appear necessarily in the zones of Head. Three cases are shown: Hyperactive segment in Th1, Th6 and L1. Only incase of projections to the middle thoracat part the localisations of sympathetic and somatic symptoms correspond. Taken from Crahnenburgh 1985.

There are still more sympathetic symptoms but these are beyond the aims of our manuscript. Important to mention is that these sympathetic phenomena do not always occur in the zones of Head and Mackenzie. When the impulses enter higher or lower situated segments the sympathetic symptoms are seen in higher or lower situated skin areas than in the zones of Head and Mackenzie (see fig. 6). Only impulses entering the spinal cord in the middle situated segments cause symptoms in the corresponding zones of Head and Mackenzie, but these symptoms mostly extend the dermatome bounderies (14).

Now we have come to the point that we can combine the theory between skin and internal organs with the TRD. It appears that the measuring points from Rost (32) belonging to the internal organs are indeed situated in the zones where sympathetic symptoms and discrete hypertony can occur, albeit that they do not correspond with the “maximal points” (fig. 7a, b, c and d). It is also possible that given an ill organ the corresponding measured point does not show an abnormality, because the sympathetic symptoms present themselves in another part of the dermatome. Normally the measuring points related to the internal organs should cool down about 0,6 - l,0°C after a cold stimulus. It appears however that some points just get warmer or cool down too much or do not react at all (the socalled fixed or non-reacting values).

With regard to the points cool down too much we can think about the following explanation:

Irritated organs generate segmental reflexes which express themselves a.o. by means of sympathetic symptoms. Because of the vasoconstriction of the skin vessels caused by the increased sympathetic activity the skin area related to these organs cools down more than the surrounding skin areas. And so an abnormal temperature is developing.

It is more difficult and speculative to explain the fact that points are getting warmer after a cold stimulus. One possibility is that the skin is heatened up by the underlying muscles, which have a higher tonus than the surrounding muscles. As mentioned before this could be explained by the fact that muscle area is representing a zone of Mackenzie, related to the sick organ. The increased tonus causes more warmth production (only 33% of the energy in the muscle is really used to increase the tonus (8)), the rest gets lost as warmth, and so an increase of the skin temperature has come into being.

In the figures 7a,b,c and d on the left organzones as described by HANSEN and SCHLIACK are shown. On the right the measuring points related to the internal organs by ROST are shown. The shaded part is the zone in which sympathetical appearences can occur. Notice that aLmost all measuring points of ROST are situated in the corresponding organzones.

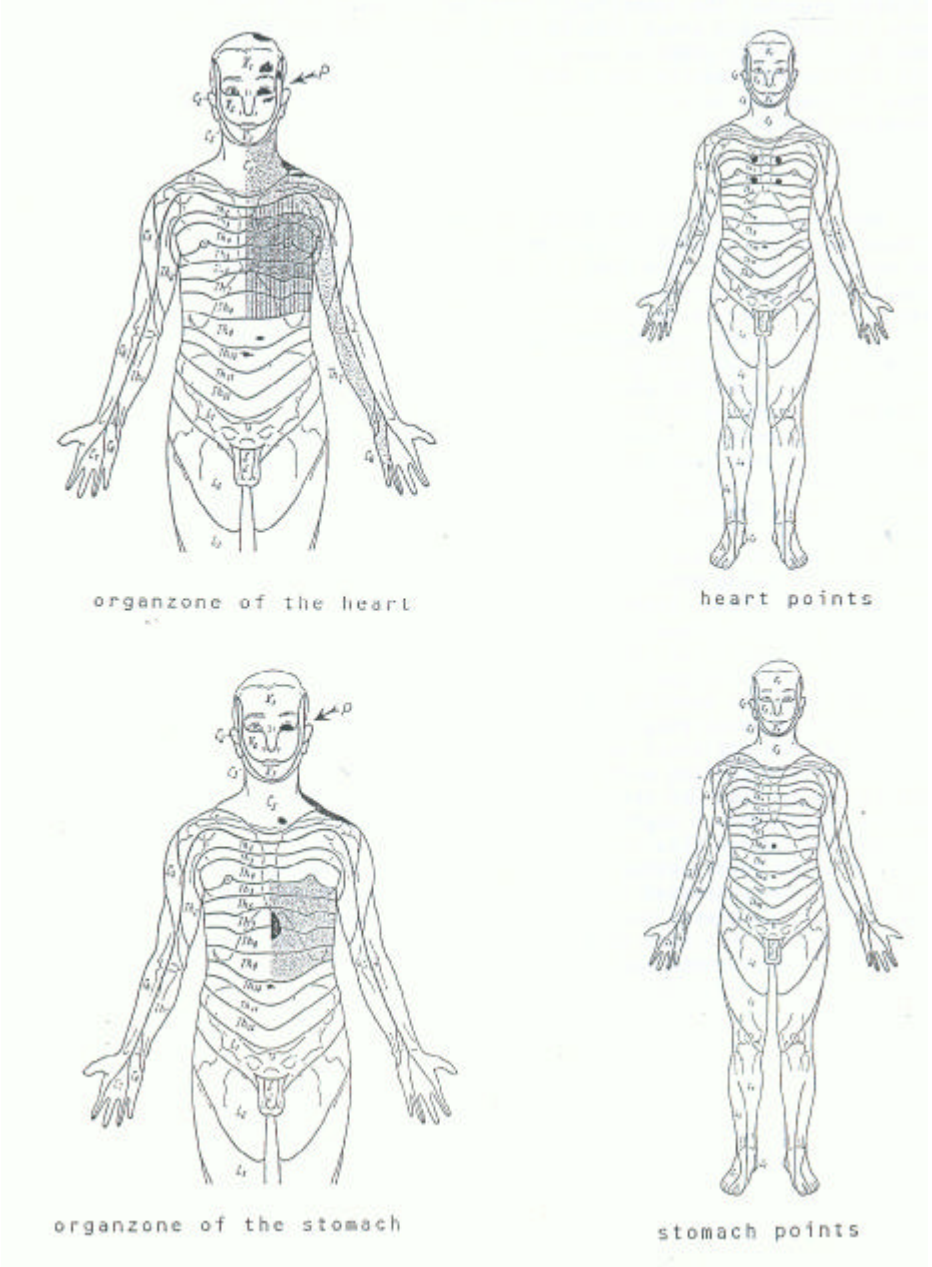
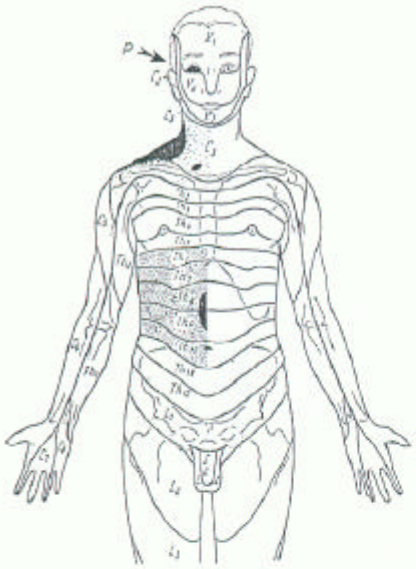
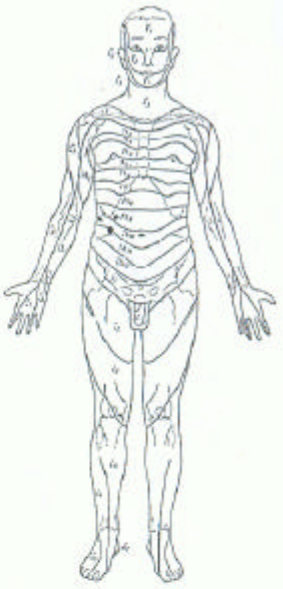


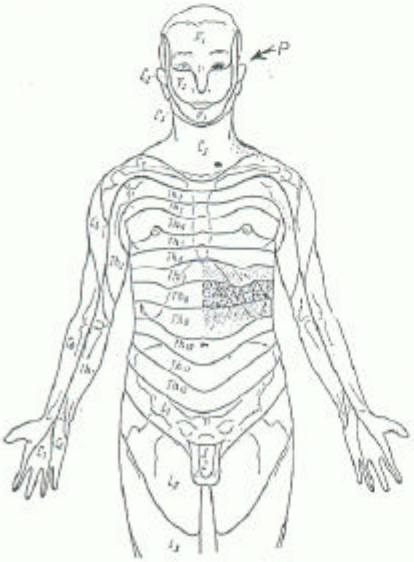
Figure 7b.



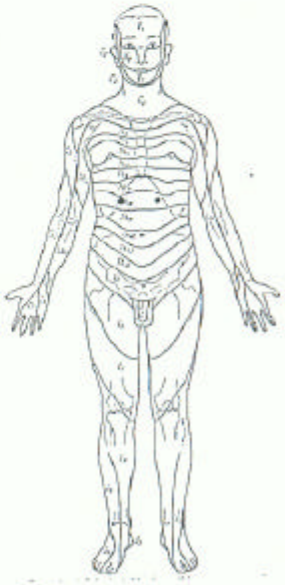
organzone of the liver



liver points

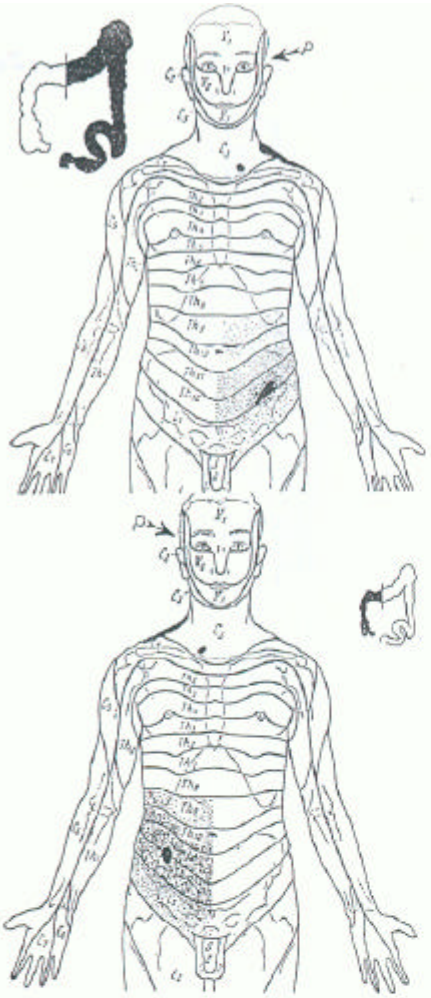


organzone of the pancreas

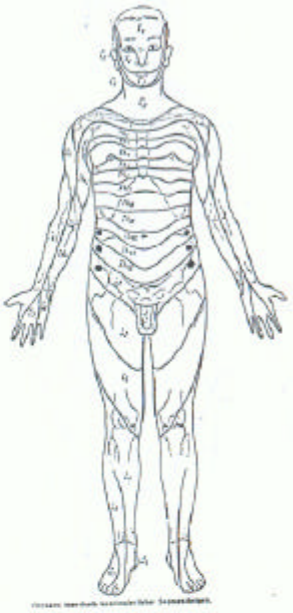


pancreas points

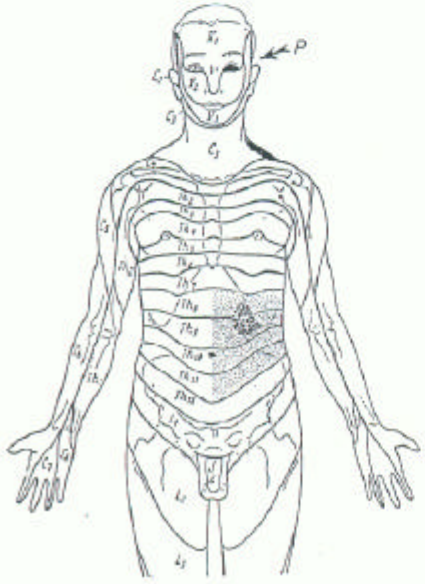
Figure 7c.



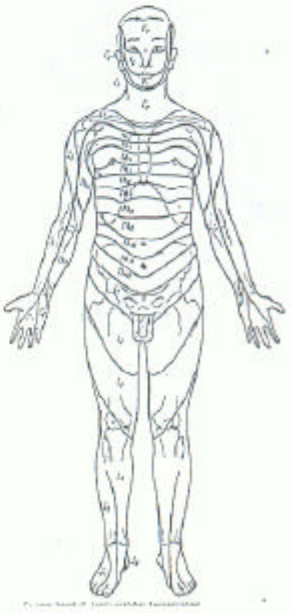
organ zone of the large intestine



Large intestine points

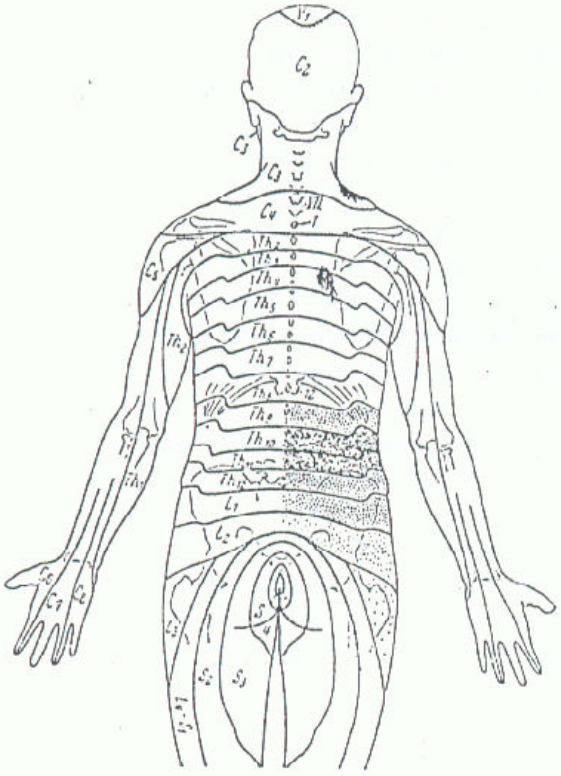


organzone of the intestinum

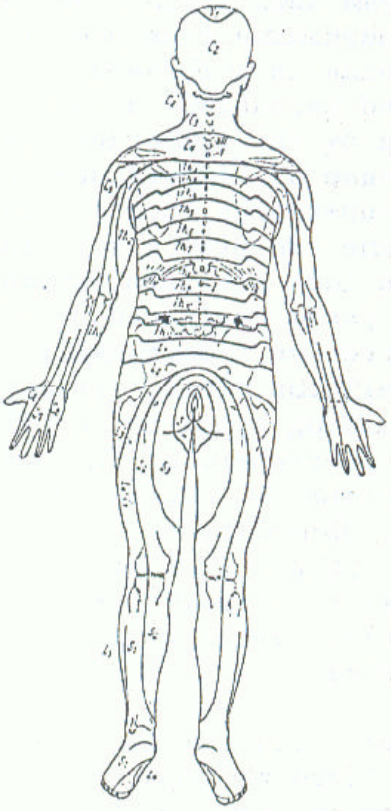


intestinum points

Figure 7d.



organzone of the kidney



kidney points

Another possibility would be that an increased sympathetic activity causes an increased sweat production in a certain skin area. The increased sweatgland activity causes the secretion of the enzyme kallikreine, which in its place splits off a polypeptide bradykinine from the globulines in the interstitium. Bradykinine is a forcefull vasodilatator which can cause an increased perfusion in the skin vessels despite the constriction mediated by the sympathetic activity. This of course results in an increase of temperature. Also ENGEL (10) thinks that vaso active substances, such as kinine, prostaglandine, histamine and serotonine can play a role in the rising of the skin temperature.

The last possible explanation has to do with the connective tissue system described by PERGER (27). With this system is ment the connective tissue cells in the loose connective tissue, the extra cellular fluid, the capillaries and the in the connective tissue ending sympathetic efferent neurons. This system is present everywhere in the body, especially in the upper layers of the skin and the mucosa. Since the skin temperature probably is not only depending on the skin perfusion but also on other factors (18,19) it might be possible that an increased sympathetic activity has such an influence on the metabolism and the humoral processes in the connective tissue system that the skin temperature is rising in the zone related to the sick organ.

Apart from the above mentioned hypothetic explanations it appears from the empiry that some points justt become warmer. When the results from the TRD are compared with those from conservative diagnostic tools it turns out that they really often correspond with the final diagnosis (2,35). Till so far the theoretical part. The results out of the praxis we describe in chapter 3.

Chapter 3

OWN RESEARCH

SUBJECT 1

Problem: "What does a thermogram under healthy circumstances (normthermogram) look like?"

3.1.1

INTRODUCTION

To be able to use the TRD as a diagnostic tool, it is important to know what a thermogram under healthy circumstances looks like. To determine a normthermogram there are two possibilities (30):

1. One measures a great number of apparently healthy persons and takes a mean value out of these values.

2. One relies on a limited number of histological and physiological facts and gets an ideal value.

Prof. Rost (30) prefers the second possibility, because, in his opinion, the most frequent values do not have to be the most healthy ones. For example one can make the statement that caries, which is very common in our population, is not a healthy state. Furthermore he suggests that nowadays, with the abundant burdening environmental factors, like pollution, stress, bad nutricial habits and drugs, nobody is perfectly healthy. Consequently Prof. Rost has constructed a normthermogram using the second method.
On the other hand one can also have the opinion that a normthermogram with ideal values is not ideal to compare other thermogram with, because compared with an ideal thermogram everybody is abnormal. A normthermogram constructed out of the measurements of many healthy persons is probably more like the realistic situation.

Berz (3) has tried to verify the normthermogram from Rost, investigating 10 healthy persons, aged 16 till 35 years, with thermography. His results reasonably confirmed the normthermogram of Rost, but:

1. temperatures of nasal bone and sini maxillari were colder than Rost had found,

2. in the abdomen often too high and non-reacting temperatures were found, compared to Rost's measurements.

As an explanation he points out for the nasal temperatures, the occurrence of many subclinical or chronic sinusitis, and for the abdominal differences subclinical appendicitis, prostatitis or inflammations of the sexorgans as perhaps a sign of coming problems in that area.

Because there did not exist, as far as we know, a statistically constructed normthermogram, we decided to try to develop one.

3.1.2

MATERIAL AND METHODS.

The measurements were partly done at the Institute of Physiology in Herdecke and partly at the “Deutsche Sporthochschule in Köln. At the institute there is a climate-room, in which the temperature can be kept at a constant level. In Köln we also tried to keep tho temperature as suitable as possible by cooling down the room with ventilators and by opening the windows, but only in between the measurements.

Our test persons applied themselves on a voluntary base and had to feel healthy, consequently they were “subjectively” healthy. Small complaints like hayfever and allergy for dust were accepted, as well as not recently performed operations.

To make a thermogram reproducible it is necessary to work under certain conditions, before and during the measurement. The most important conditions are (32):

* Time of the measurement: between 8.00 and 12.00 a.m., because the reaction of the body on a cold stimulus is most strong at that time (20,32)

* Food The patient should not have had a heavy meal just before the measurement, but should not be empty either. The ideal situation is a light breakfast with herbal tea. Coffee, black tea, alcohol and nicotine are not allowed, because of their influence (vasodilatation/vasoconstriction) on the blood vessels.

*The person to be measured:

- should not be cooled down or heated up
- should be relaxed
- should not have used cosmetics
- concerns homeopathic medicines.
- medication with corticosteroids should be stopped two or three weeks before the measurement
- Rö-pictures should not be made during two or three days before the measurement

* The waiting room:

- should not be full
- should be without draughts
- should have a temperature of 20-23°C
- should have a humidity of 60 %
- should have a relaxing atmosphere
- spectacles should be removed; the forehead must be free from hair
- narrow clothes should be loosened
- ellbows should be covered
- the person to be measured is to stay at least 30 minutes in this room to acclimatiae

* The examination room:

- temperature and humidity should be as in the waiting room
- no draughts, no ventilator, no air-conditioning
- seating should not be in the direct surroundings of a window, heating or wall
- seats should be without back support
- peace, conditions with no conversation

- The method of the measurement:

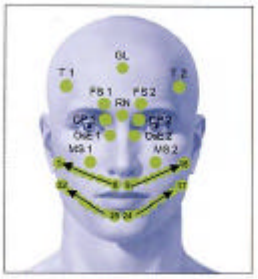
- The forehead is measured several times and serves as a reference value. Only when this point has reached a constant temperature (+/- 0,1°C), can the measurement be started.
- The measurement has to be completed without any pauses, so no conversations and no telephone interruptions.
- The face and neck are measured while the subject is clothed, then the subject takes off his clothes (only upper part of the body) and breast and abdominal points are measured.
- After the first measurement: the subject remains undressed and the surrounding temperature works as a cold stimulus.
- Ten minutes after the end of the first measurement the second measurement follows with the same sequence of points.

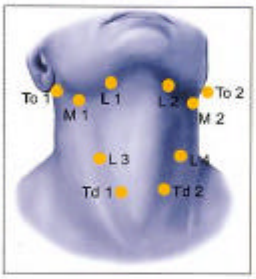
N.B. It is important not to measure on visible veins, sweat glands, pathologically changed skin or on red pressure spots caused by clothes. Furthermore, it is better not to measure in hot weather and conditions of high humidity.

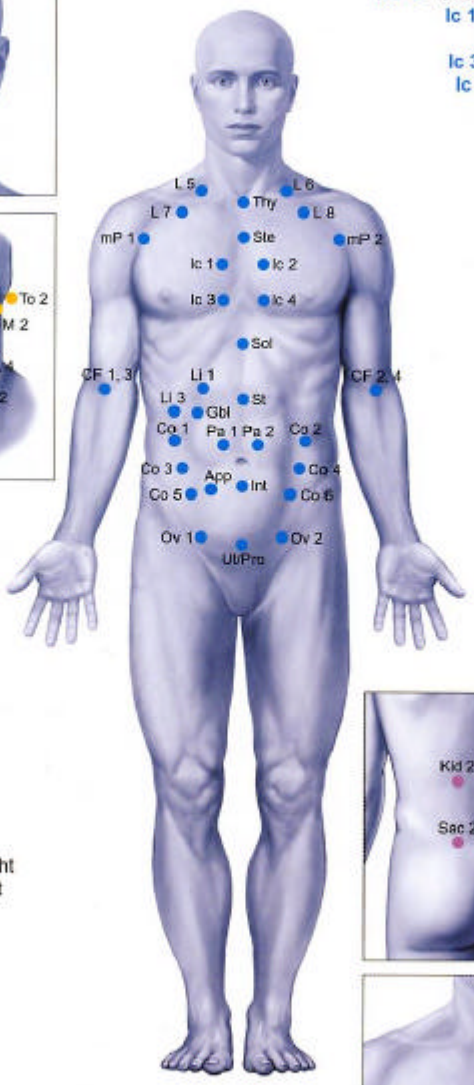
* The values of the first measurement are drawn in black, those of the second in red and those of a potential third measurement in green on the printed sheet.

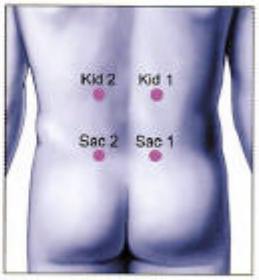
THE POINTS OF MEASUREMENT USED IN COMPUTERIZED REGULATION THERMOGRAPHY

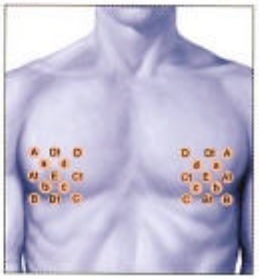
GL - glabella
8 - upper jaw right
7 - upper jaw right
6 - upper jaw right
5 - upper jaw right
4 - upper jaw right
3 - upper jaw right
2 - upper jaw right
1 - upper jaw right
9 - upper jaw left
10 - upper jaw left
11 - upper jaw left
12 - upper jaw left
13 - upper jaw left
14 - upper jaw left
15 - upper jaw left
16 - upper jaw left
25 - lower jaw right
26 - lower jaw right
27 - lower jaw right
28 - lower jaw right
29 - lower jaw right
30 - lower jaw right
31 - lower jaw right
32 - lower jaw right
24 - lower jaw left
23 - lower jaw left
22 - lower jaw left
21 - lower jaw left
20 - lower jaw left
19 - lower jaw left
18 - lower jaw left
17 - lower jaw left
GL - glabella
RN - radix nasi
CF 1 - cubital fossa right
CF 2 - cubital fossa left
FS 1 - frontal sinus right
FS 2 - frontal sinus left
T 1 - temple right
T 2 - temple left
CP 1 - commissura palpebrarum medialis right
CP 2 - commissura palpebrarum medialis left
M 1 - mastoid right
M 2 - mastoid left
OsE 1 - os ethmoidale right
OsE 2 - os ethmoidale left
MS 1 - maxillary sinus right
MS 2 - maxillary sinus left
To 1 - tonsil right
To 2 - tonsil left
L 1 - inframandibular gland right
L 2 - inframandibular gland left
L 3 - ventral edge of m. sternocleidomastoideus right
L 4 - ventral edge of m. sternocleidomastoideus left
L 5 - supraclavicular fossa right
L 6 - supraclavicular fossa left
L 7 - infraclavicular fossa right
L 8 - infraclavicular fossa left
Td 1 - thyroid right
Td 2 - thyroid left











Thy - thymus
Ste - sternum
mP 1 - lateral edge of muscle pectoralis major right
mP 2 - lateral edge of muscle pectoralis major left
Ic 1 - intercostal space III right (reference)
Ic 2 - intercostal space III left (atrium)
Ic 3 - intercostal space V right (reference)
Ic 4 - intercostal space V right (myocard)
Sol - solar plexus
St - stomach
Li 1 - liver 1
Li 3 - liver 3
Gbl - gallbladder
Pa 1 - caput pancreatis
Pa 2 - cauda pancreatis
Int - intestine
Co 1 - ascending colon 1
Co 3 - ascending colon 3
Co 5 - ascending colon 5
Co 2 - descending colon 2
Co 4 - descending colon 4
Co 6 - descending colon 6
App - appendix
Ut/Pro - uterus/prostate
Ov 1 - ovary/groin right
Ov 2 - ovary/groin left
Kid 1 - kidney right
Kid 2 - kidney left
Sac 1 - sacroiliac joint right
Sac 2 - sacroiliac joint left
CF 3 - cubital fossa right
CF 4 - cubital fossa left
A - mamma right
A1 - mamma right
B - mamma right
B1 - mamma right
C - mamma right
C1 - mamma right
D - mamma right
D1 - mamma right
a - mamma right
b - mamma right
c - mamma right
d - mamma right
E - mamma right
A - mamma left
A1 - mamma left
B - mamma left
B1 - mamma left
C - mamma left
C1 - mamma left
D - mamma left
D1 - mamma left
a - mamma left
b - mamma left
c - mamma left
d - mamma left
E - mamma left

*The thermogram should contain the following data:
- name of the patient
- birthday and age
- room temperature, pressure and humidity
- height and weight of the subject
- in case of women the cyclus day
- use of the pill
- use of other medicines

***** Apparatus

All thermograms were constructed with the use of the purpose made EIDATHERM-apparatus, produced by the firm Eidam.

Werner Eidam
Medizin-Technologie GmbH
D- 61348 Bad Homburg
Germany

The Eidatherm is connected to a plotter which directly draws the measured temperature. Further a thermo element is connected, with which the skin is touched. It contains two metal wires of different composition which contact the skin when measuring. As a result of the sudden rise of temperature, when touching the skin, a voltage is created between the two wires. This is amplified and shown on a digital display. The thermo element needs about one second and the measuring fault is in the range +/- 0,2 - +/- 0,4°C.

***** Measuring programs

Different programs for measurement are available. For us only the standard thermoprogram and the mammaprogram are important.

The standard program gives a broad insight into the whole body status and includes all important inner organs. This program is used most generally. The points to be measured are shown in fig.8.

The mamma program is only meant for women and follows directly after the standard measurement. It is always judged in combination with the standard thermogram. The mammapoints are shown in fig.9.

- Processing of data

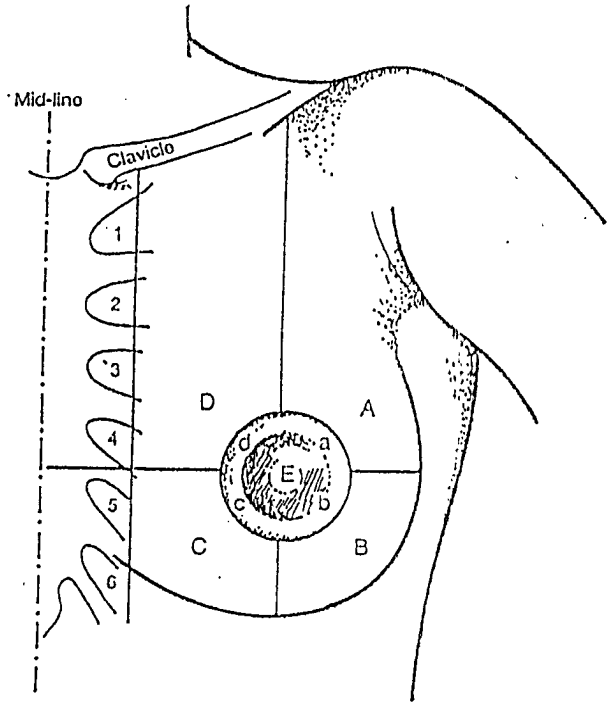
The measured temperatures are entered into the computer by means of a graphic digitizei: and are processed afterwards.

We have made:

1.scatter diagrams with mean value and standard deviation for each point,
2.symmetry tests,
3.a t-test to compare the corresponding points of men and women.

We will now describe the norm thermogram of Prof. Rost, the normthermogram constructed by us and the difference between the thermograms of men and women.

Figure 9. Measuring points manma measurement by ROST. One
starts in the upper lateral quadrant and ends in the upper medial quadrant (A—D). The mammilla is measured in the sequence (a—d). The last point is the centre of- the mammilla (E). Taken from ROST.



Zono in
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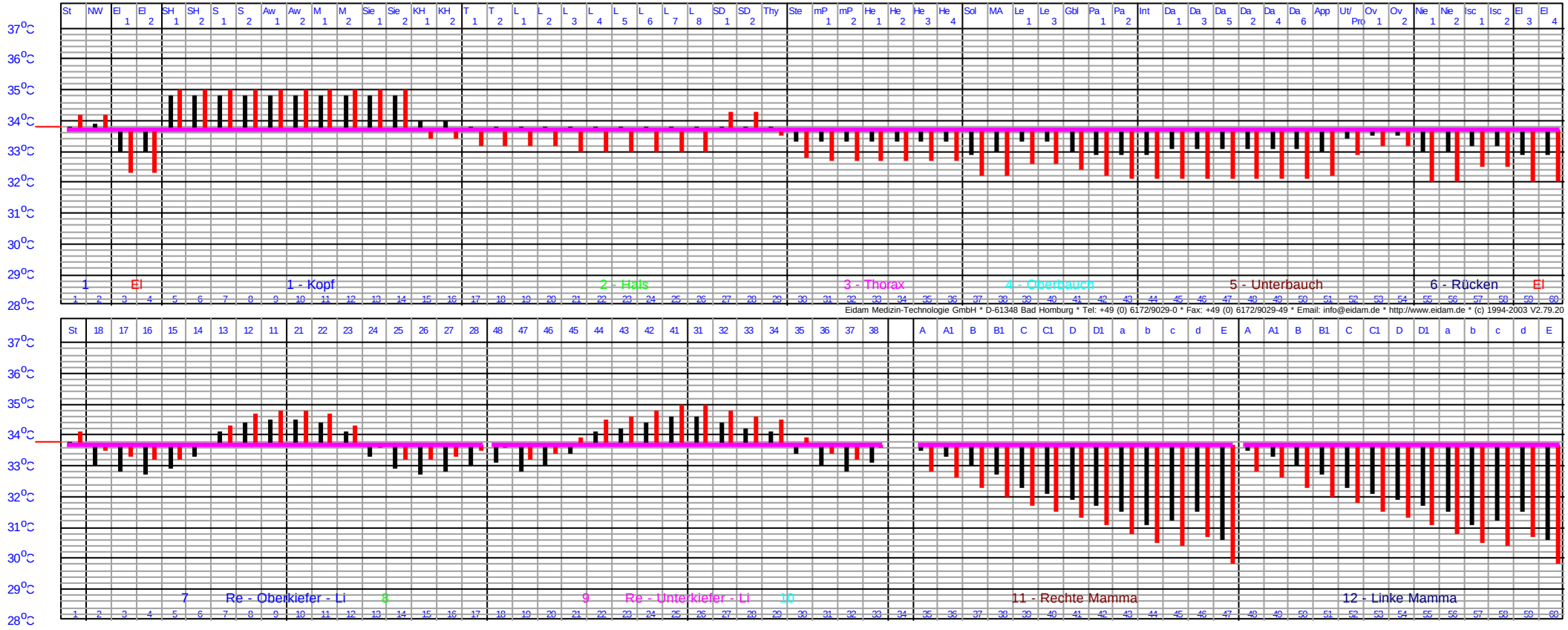
Figure 10. Normthermogram by ROST-EIDAM.



3.1.3

RESULTS.

THE NORMTHERMOGRAM OF ROST

As mentioned before, this normthermogram (fig. 10) has resulted from physiological and histological facts and from Rost's long experience with the idea. In his point of view it should be seen as a help to the judgement of thermograms.

Out of the physiological facts the following rules are created:

- There is a temperaturefall from the inside of the body to the outside
- There is a temperaturefall in the body from cranial to caudal.
- The temperature is left and right symmetrical.
- After a cold stimulus the peripheral temperature is seen to fall.
- A rise in temperature is only to be seen in the face and thyroid gland region. The forehead temperature is one of the most constant temperatures of the body and is used as a reference value, which means that this temperature is seen as a reference axis. All warmer temperatures are drawn upwards and all colder temperatures downwards from this axis.
- The mammatemperatures are normally under the reference axis, like the other thoraxtemperatures (33). After a cold stimulus all the temperatures should fall. The nipple is always the coldest point.

To judge a thermogram the following criteria are used (32):

- the thermic profile, which means warmer or colder than the normtemperature
- the thermic level, which means the temperaturefall in the body from cranial to caudal
- the thermic reaction, which means the absolute temperature fall, rise or no reaction at all
- left-right comparison, which means a symmetry or an asymmetry in the body

Temperatures in the face should be 1,0°C above the reference axis, thoraxtemperatures about 0,5°C beneath and abdominal temperatures about 1,0°C beneath the reference axis.

The temperature difference between the first and second measurement is as follows:

- 0 - 0,2°C : inflexible regulation
- 0.3 - 0,5°C : unsatisfying regulation
- 0,6 - 1,0°C : normal regulation
- 1,1°C : overdone regulation

Furthermore Prof. Rost has developed an extensive judgement system. Interested persons are directed to his “Atlas der Regulationsthermographie”.

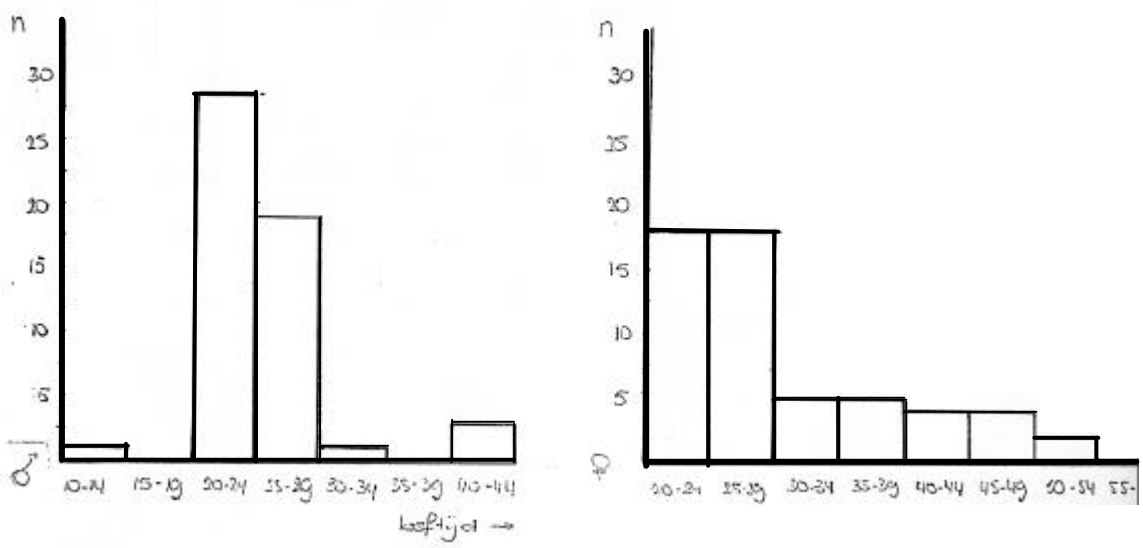


Figure 11. Age distribution of the femaLe and male healthy groups.

THE STATISTICAL NORMTHERMOGRAM.

We measured 110 healthy persons, 58 women with a mean age of 31,1 years (standard deviation = 10,7) and 52 men with a mean age of 24,9 years (standard deviation = 4,9) (fig.11). With these data dispersion diagrams were made, and out of those we constructed the normthermograms (fig.12a, b,c,d and e).

In our normthermogram the following can be seen:

- There is a temperature fall from cranial to caudal, but the difference between thorax and abdomen is unclear. Temperatures in these areas, at the first measurement, are around the level of the reference axis, and at the second measurement about 1°C below.
- Trunk temperatures commonly fall 0,5 -1,0°C, after the cold stimulus.
- The temperature is left-right symmetrical.
- After a cold stimulus the temperature falls. A rise of temperature is seen in the face, tonsils, submandibular salivary glands and thyroid gland.
- The lymphglands in the neck (L3, L4) show little response.
- The mammatemperatures are all below the reference axis, are left- right symmetrical and fall after the cold stimulus. The nipple is always the coldest point.

COMPARISON BETWEEN NORMTHERMOGRAM ROST AND STATISTICAL NORMTHERMOGRAM

The most obvious in the statistical normthermogram are the relatively cold nasal bones and sini maxillari and to a less extent, the noseroot. Further can be seen that the lymphnodes in the neck till L4 are reacting in the same way as the fate by getting warmer. From L5 the reaction is a fall in temperature.

Thorax temperatures are ± 0,8°C warmer as in Rost's thermogram during the first measurement, but fall more, reaching the same level as in Rost's thermogram during the second measurement.

Temperatures of plexus solaris, stomach, liver, gallbladder and pancreas are in the statistical normthermogram 0,8°C higher, and in the intestinal region 1,0°C higher.

Concerning the mammathermogram there is a total conformity between, the Rost thermogram and the statistical normthermogram. Remarkable is the complete symmetry, which is also shown in the symmetry tests.(fig. 14)

Figure 12 a. Scattering diagram from the standard measurement of healthy women.

Institut for Physiologie der Universität Witten/Herdecke

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Das File ist : B:\THERMOGR.
Datum :17.07.89 Zeit: 16:02:50

Institutsleiter: Prof. Dr. E. David
Tecnologie: Dr. M. Pfotenhauer**.**
Meßtechnik:M.Mikler,Th.Schürholz
Meßgerät: Eidatherm
Meßmethode: nach Rost

Anzahl Thermogramm: 59
Ausgabe : Normiert

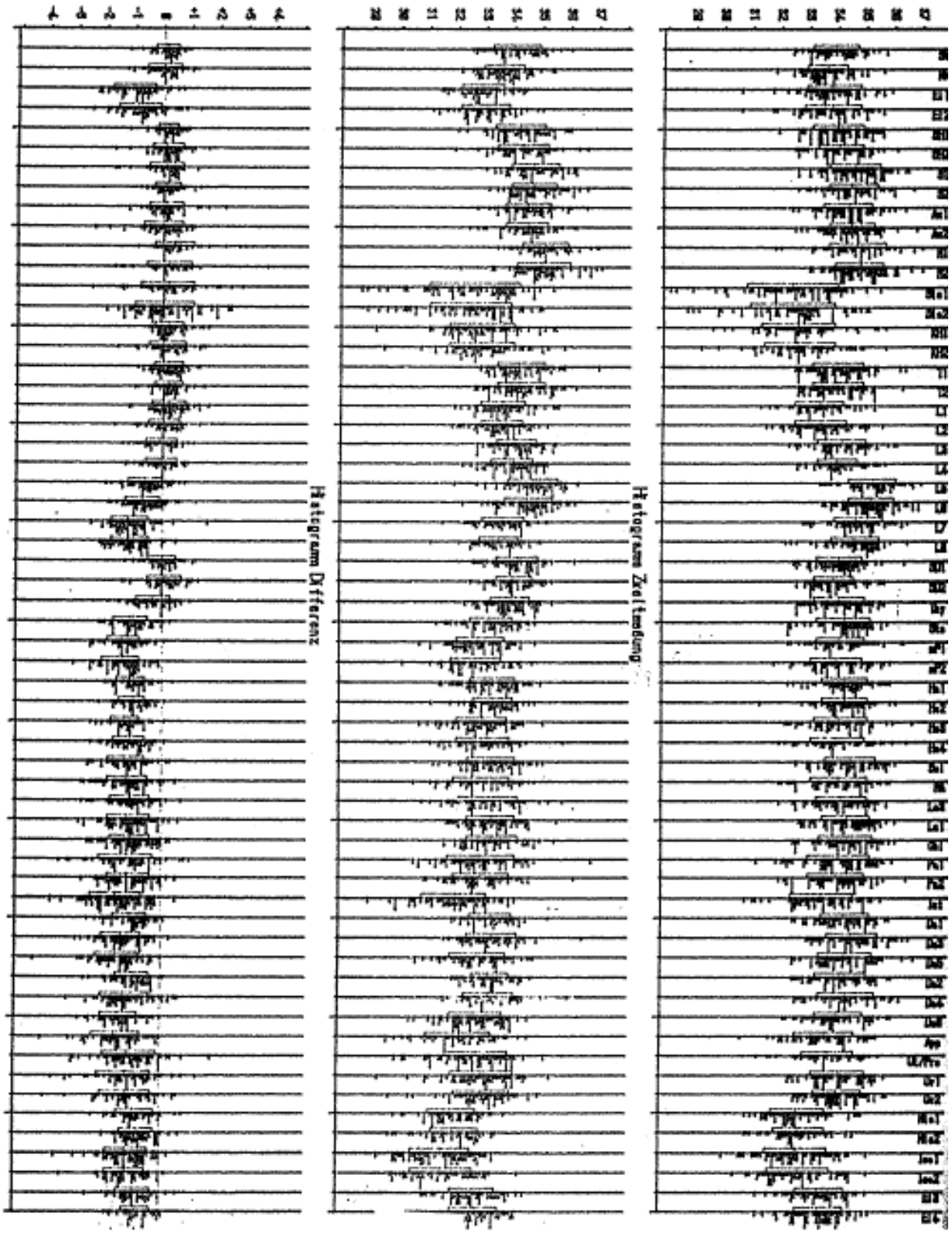


Figure 12c. Statistical determined normthermogram for healty women (n=59)

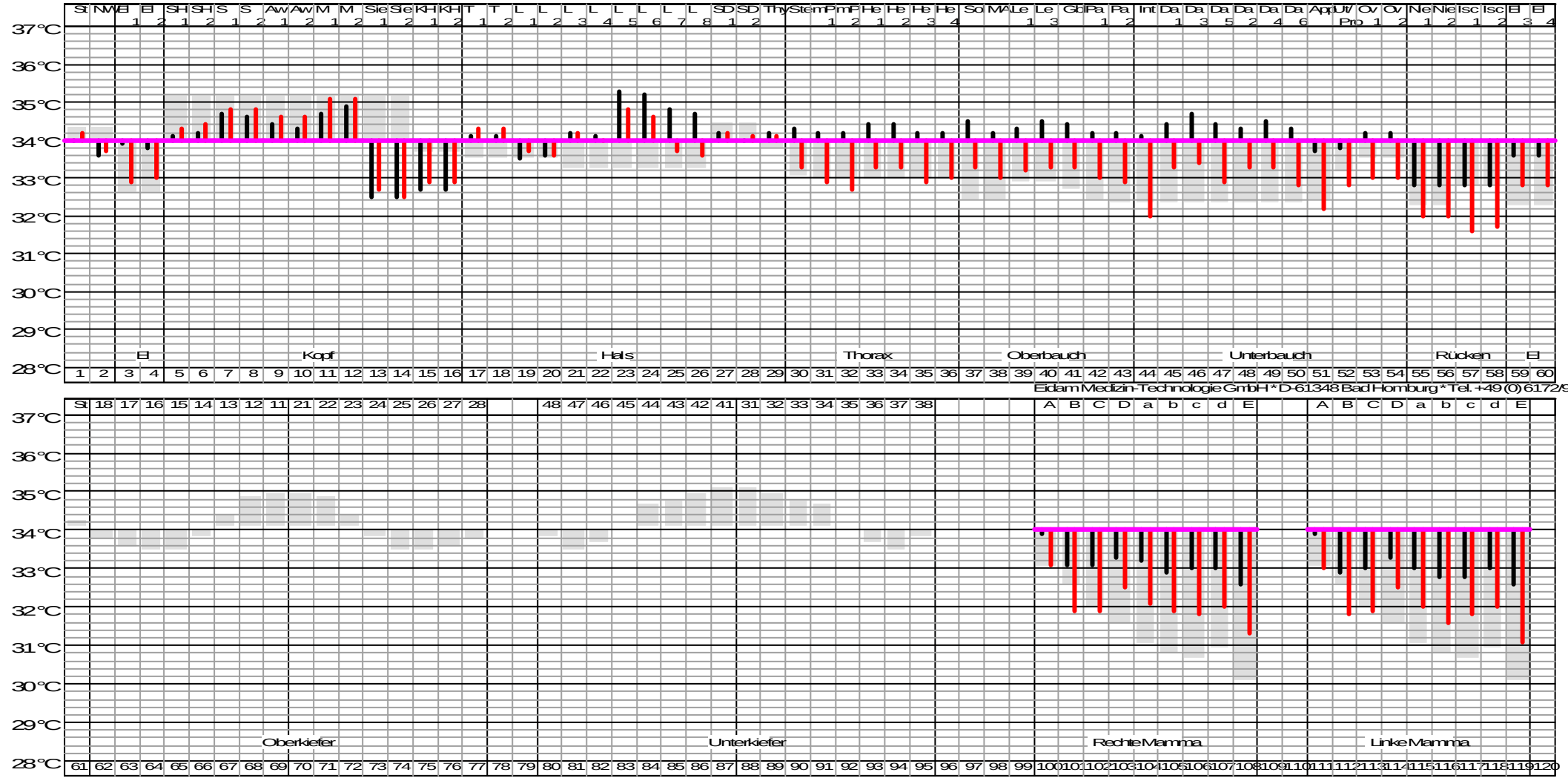


Figure 12 d. Scattering diagram from the standard measurement of healthy men.

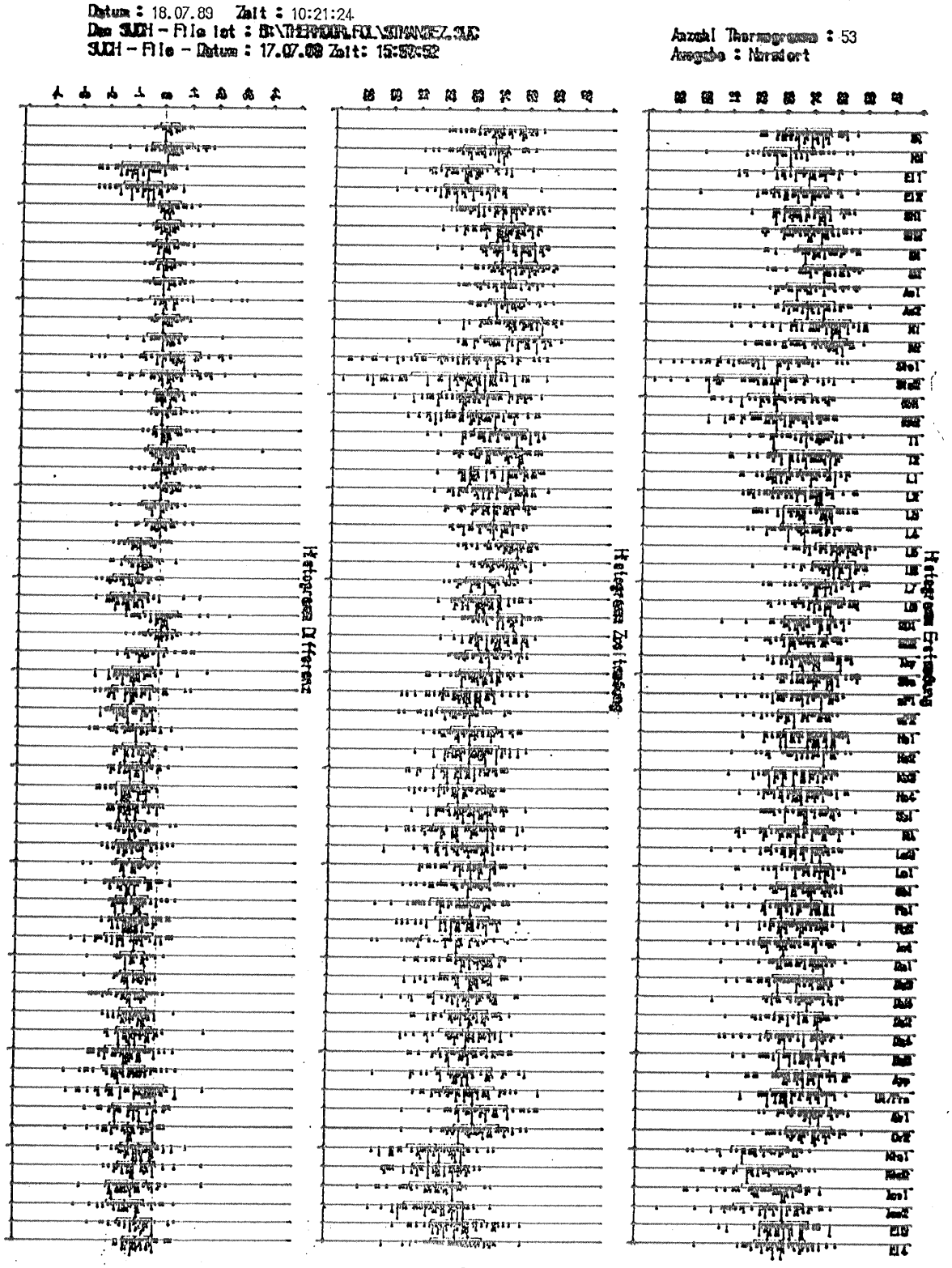
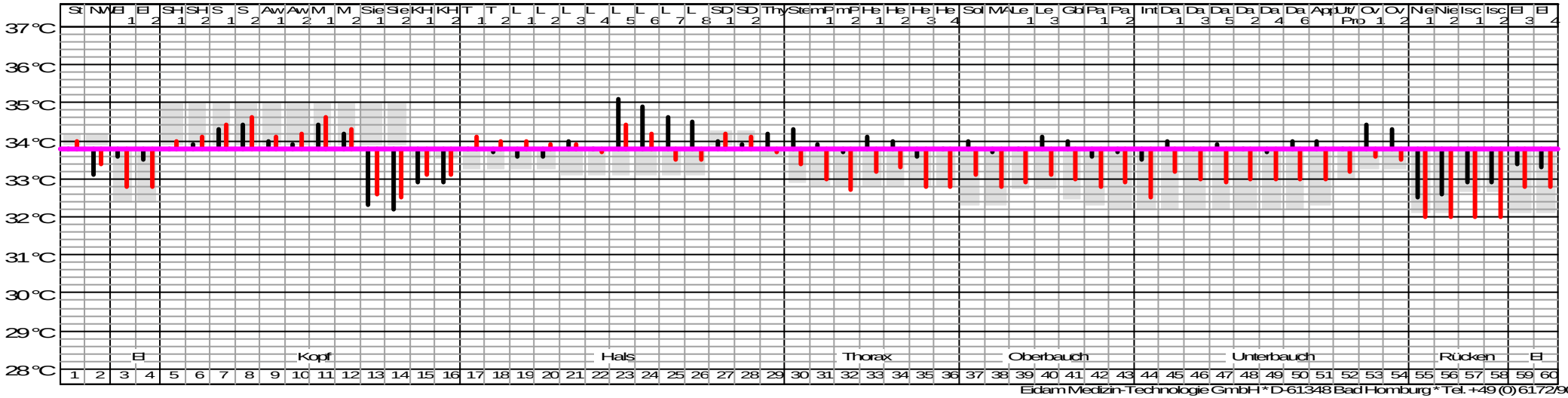


Figure 12.e Statistical determined normthermogram for healty men (n=53)



DIFFERENCE BETWEEN MEN AND WOMEN

A t-test was performed for all data of first, second measurement and the difference between them (the regulation). A t-test determines whether there Ls a significant difference between points, using the mean, the standard deviation, the population size and the distribution of values. So all corresponding points of men and women were compared. We will only mention those differences with a significance level of at least 0,05.

first measurement:
Women are warmer than men. This applies to 21 out of 60 points, namely 5 points in the face, and further the thorax, the upper abdominal organs and the large intestines. The difference varies between 0,3 and 0,85°C, with a mean of 0,5°C.

second measurement:
Women are warmer in the face and in the lymphe nodes in the neck (7 points), except for the tonsils, which are warmer in men, 0,7°C (right) and 0,55°C (left).

In the first mentioned points women are average 0,4°C warmer (varies between 0,3 and 0,75°C).

Furthermore men are warmer in:

the small intestinuxn	(0,45°C)
the appendix	(0,70°C)
right femoral lymphe nodes	(0,60°C)
left femoral lymphe nodes	(0,40°C)
right ilio-sacral joint	(0,40°C)

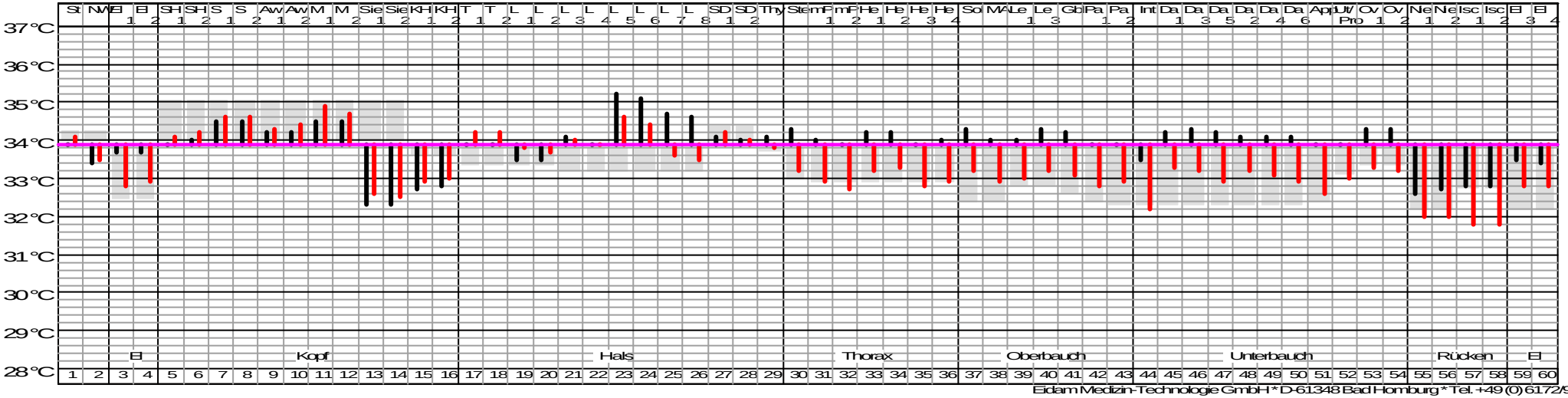
regulation:
Women react more in all points from 31 till 60, except for the liver, gall-bladder and the left ellbow, i.e. that these points cool down more as in men, with a mean of 0,4°C (varies between 0,2 and 0,65°C).

In the first 30 points there are no significant differences in regulation between men and women.

In summary we can say that women are originally warmer (first measurement), but that they cool down more at the trunk, after a cold stimulus, so that at the second measurement there are only few differences left.

In the face and neck women are warmer during the first and second measurement.

Figure 13. Statistical determined normthermogram standard measurement for healty women and men together



3.1.4

CONCLUSION / DISCUSSION.

Like Berz (3), we also found colder nasal bones and sini maxillari. Rost too mentions that 80 % of his testpersons had too cold temperatures at those points, but believes that those values are not normal nor healthy. Too cold nasal bones would be a sign for immunity weakness, too hot nasal bones for acute sinusitis or rhinitis. Too cold temperatures of the sini maxillari would be a sign for chronic inflammation or degenerative or polypous mucosa, while too high temperatures refer to acute sinusitis.

Schmauser (35) did some research about cold nasal bones. He had 36 persons with resistant cold nasal bones operated (radical operation) with no indications other than the thermogram. Two groups could be recognised. The first group had thermographically “cold”, non-reacting nasal bones. During operation a fibrosed mucosa with only few inflammatory appearences was found. The second group had cold but reactive nasal bones and during the operation a polypous thickened mucosa with abundant inflammation was found.

Taking these results in account, it could very well be that those frequently appearing cold temperaturess of nasal bones point to an underlying pathology.

During the period we took our measurements the number of persons with heyfever was remarkable (8%), which also could play a role in this matter.

We did not observe the hot, non-reacting points in the abdomen found by Berz (3), although in the single thermograms there are often one or more warm non-reacting points in the intestinal region.

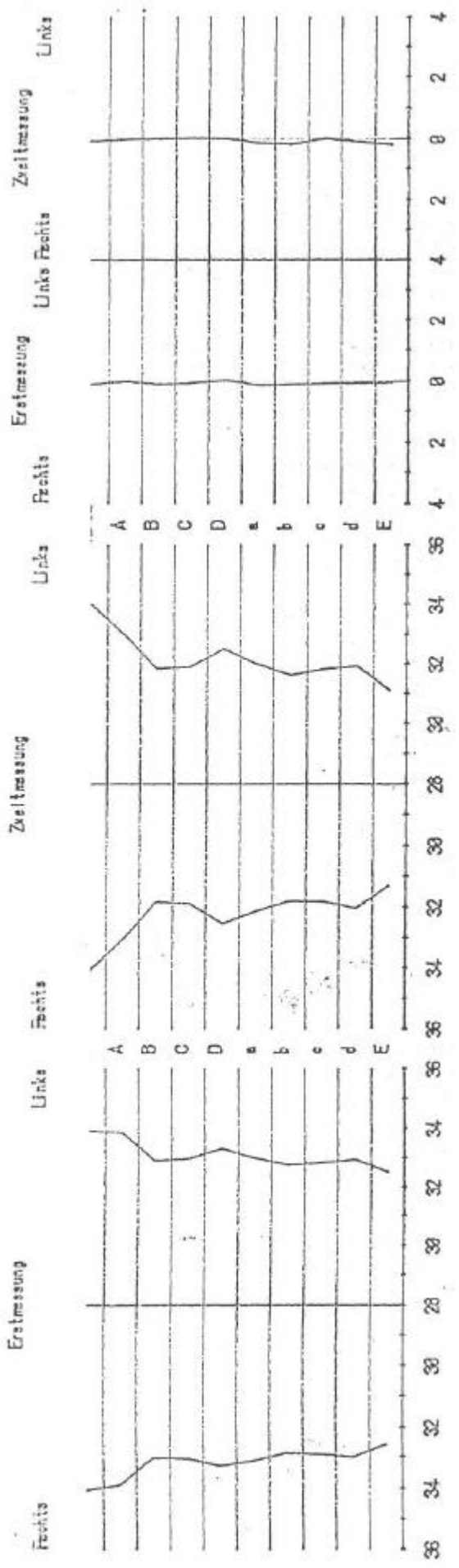
The differences in the tonsils and submandibular salivary glands could be explained by their location. These points are, like the face-points, not covered by clothes and therefore probably react like the face. In the statistical normthermogram there is a confluent blending from face to trunk, whereby the upperpoints of the neck react like the face and the lower points like the trunk.

The difference in reaction to a cold stimulus between men and women may be explained by the fact that men react more by increasing their metabolism and women more by vasoconstriction. ‘Why women are warmer during the first measurement is not clear to us. It could be that the metabolism of women is set at a somewhat higher level, but that it is more static than in men, and is not able to react as strong as in men.

Our experiment could certainly be improved. We only had four months and started without any knowledge or experience. Although our results are rather satisfying we advise that the research is continued with a larger group of subjects.

Figure 14.
Symmetry test of the Breast measurement in healthy women.

In the 2 left columns the absolute temperatures are shown. In the right column the difference in temperature is shown in such a way that the line is drawn on the side which is warmer.



Concerning our population of healthy persons we would like to give the following comment. Our healthy group is rather young, n.m. average 27 years old. This has the advantage that probably only few chronic diseases have developed, but the disadvantage that perhaps older people are not comparable with our normthermogram. Blohmke (5) reports the temperature of the forhead decreases 0.3°C, every decade. Only this was determined with the method of infrared thermography. If this is really the only influence of increasing age it would be easy to correct.

Another point is the criterium of “subjectively healthy”. It would be better if the test persons would be subjected to a medical examination and could be classified as “objectively healthy”.

Strikingly, many people who considered themselves “healthy” frequently had many minor complaints. We conclude that with our experiment the normthermogram from Rost has been controlled and that this thermogram in general can be used as a norm, except for the nasal bones, the sini maxillari and the lymphtract in the neck.

3.2

SUBJECT 2

Problem: Is a group with a certain disease distinguishable from a healthy group, by means of the TRD ?

3.2.1

INTRODUCTION

To investigate this problem wo decided to take a group with malignant processes in the breasts. We have chosen this group because we could easily get patients from the gyneacologic ward and because we wanted to contribute to the research which investigates whether the TRD is a suitable pre-screening method to detect breastcancer in an early phase.

Before we will give our results we will first mention shortly some earlier performed researches of importance in this field.

No existing screening method to discover breastcancer in an early phase is sufficient enough to really find all the cases (11). At the moment mammography is the method with the highest sensitivity and specifity (1). If the mammogram is suspect for breastcancer there is always needed an operation to proove cancer definitely. Although mammography, combined with clinical examination, is still most succcesfull (22,26,28) this method also has its disadvantages, of which the most important one is the radiation exposure, certainly now that many more women under 50 years also join the screening programs (26). Moreover this method is relatively expensive and the number of missed breastcancers is still substantial, caused by the subjective judgement of the X-ray photos and the sometimes great growingrate of the tumours. Because of the radiation exposure women are not more frequently examined as once a year. In this period fastgrowing tumours can double their seize eight times (12). If a screening method could be done without any risk every three months, these tumours, and of course also other tumours, could be recognised in time.

These facts stimulated to search for new, inexpensive, patientfriendly screening methods. Of sonography (visualising and diagnosing by means of ultrasound), the diaphanography (visualising and diagnosing by shining light through the breasts) and the thermography, the thermography is the most investigated method.

As mentioned in chapter 2 there are various methods to measure the skin temperature. In the literature we found, almost for all these methods has been tried to find out whether they could be used to detect breastcancer in an early phase or not.

It is beyond our aim to discuss in this manuscript the liquid crystal thermography and the total body infra-red thermography. We will only mention those researches which show strong resemblences to our experiments. In these researches the temperature has been measured with infrared radiation and with a bolomeasuring apparatus. The results are not directly comparable with ours, but give a good impression of how thermoregulation diagnostics can be used in the early detection of breast cancer.

Rost (31) has done research to find out the difference between his method and the infrared method with the bolometer, and he found that both methods principally measure the same temperature, albeit that the infrared method is more precize than the method of Rost. The infrared method however is subjected to more disturbing factors and is less practical in the clinical situation.

R.E. Snyder (37) et al has measured the skin temperature of 315 women, before and after a cold stimulation. She measured the forehead, of each breast the nipple and eight surrounding points, and again the forehead. After the first measurement the women had to hold their hands in cold water (12^0C) for 15 seconds. Then the second measurement was performed. The results were graphically shown and a computeralgorithm made a score between 0 and 99, which pointed at a situation which was suspicious or not suspicious for malignant processes in the breasts (0 **=** not suspicious, 99 **=** very suspicious). Afterwards the breasts of these women were operated. It appeared that 11 women (7 %) with a malignant process had a too low score (<40; false-negative) and that 116 women (88 %) with benignant processes had a too high score (>40; false-positive). This number of false-positives is of course too high for a good screening test.

Also G. Heim (17) measured the skin temperature before and after a cold stimulus at 300 women. 100 women had a histological prooved breastcancer, 100 had mastopathy and 100 women served as a controll group. At these women certain points on the body and breasts were measured, before and after a cold stimulus. By using discriminant analysis was tried to distinguish the three groups.

Comparing the controll group with the mammopathy group the percentage of false-negatives was 14 % and of false-positives 15 %. Comparing the breastcancer group and the controll group the judgement was in 10% false-negative and in 8% false-positive. The percentage of false-positive and false-negative comparing the breastcancer group and the mastopathy group were the highest; respectively 25 % and 35 %

Remarkably the breastcancer group was distinguished by means of the breast values for 70 %, the mastopathy group only for 30 %. Compared with the research from Snyder it is an important difference that Heim uses also points which are not located on the breasts. He also achieves a smaller number of false-positives.

In 1982 P.C. Brooks (6) published an article in which he measured 1013 women, using the method of Snyder. The women were accepted if they had no complaints in the breasts, were older than 35 and if they had cases of breast pathology in their families. When a suspicious thermogram was found the woman was examined more thoroughly with mammography and/or operation.

94 % (240) Of these women appeared to have a kind of breast pathology. Finally 61 women were operated, after mammography, thermography and palpation turned out to be suspicious. (The other 179 were followed up every three months.) Six of them appeared to have a carcinome. Five out of these six women had a high score (>40). After the computeralgorithm was changed all women with breast cancer had a high score.

Because Snyder and Brooks worked with the same method (Graphic Stress Telethermography) the computeraigorithm has been substantially improved during a period of three years. The number of false-positives has been reduced to 6 %, while Brooks still had a number of 88 %. On the other hand the predicting value of this test with regard to the presence of breast cancer when having a score of over 40 is rather low (0,3 %). That is why the Graphic Stress Telemetry is not suitable as a pure screening method, but should be used as a pre screening method, so that an abnormal thermogram should be seen as a risk factor for having breast cancer. That is why Brooks means that Graphic Stress Telethermography is a reliable pre-screening method, which could be used as a help to detect breastcancer in an early phase.

We could not find any literature about statistical research done with the TRD method from Rost to screen for breastcancer. Rost (32,33) though, published some critera of importance to discover breast pathology.

A mamma thermogram is suspicious if:

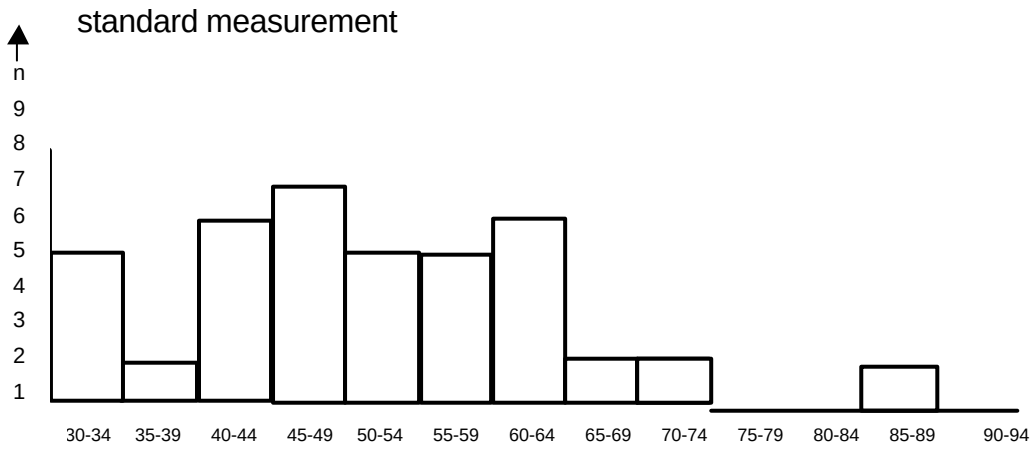
- the temperatures of one breast are much higher than those of the other one,
- there occur hot, non-reacting Vemperatures (“hot spots”),
- the temperature regulation is abnormal

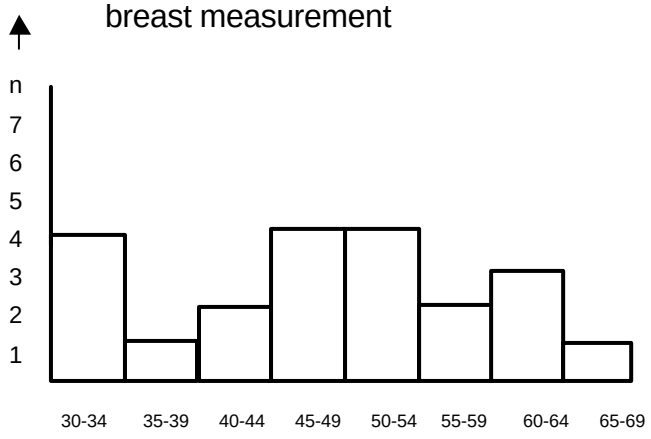
The mamma thermogram should always be judged in combination with the standard thermogram. The probability of malignancy is increasing if there occur:

- one or two hot, non-reacting temperatures in the ovaria or uterus,
- one or two hot, non-reacting temperatures supraclavicular,
- one or two non-reacting tonsil temperatures,
- two cold nasal bone temperatures,
- pathological ovarial temperatures opposite the side of the breast tumour (“crossed pathological ovarial values”).

Rost stresses that by means of the TRD only, a malignancy in the breast never can be diagnosed, but that the TRD can be used as a pre screening method. We have tried to investigate, by means of statistical methods, retrospectively, if the TRD can distinguish a group of healthy women from a group of women with a histological proven breastcancer.

Figure 14 b. Age distribution of breast cancer patients.





3.2.2

MATERIAL AND METHODS.

In a period of three months we measured 32 women with breastcancer. We performed a standard measurement and a mamma measurement under the same conditions as mentioned in the first experiment. The mean age for the standard measurement was 50,7 years with a standard deviation of 12,5 years. The mean age for the breast measurement was 48,2 years with a standard deviation of 10,8 years. The age distribution is shown in figure 14 b. The breast cancer of these women was histological proven and we did not differentiate between the different sorts of cancer. Besides this heterogenity there also was a heterogenity in treatment. Many women had had an operation to remove the tumour (women with. a total mammectomy were excluded from the mamma measurement, but not from the standard measurement); most women had received mistle therapy (immune system stimulating medicine). Some women also had had radiation or hormone preparates.

Unfortunately we could not create a homogenous group in the time we had. Nevertheless we wanted to try to investigate the diagnostical value of the TRD and so we took the heterogenous group as the diseased group and the female healthy subjects as a control group.

Because the malignant processes were present in both left and right breasts we changed the left and right breast temperatures of the women with breast cancer on the right side to get one bigger group. Because of mammectomy we do not have the mamma measurements of 11 women. As a result we had 32 women with breastcancer left of which we had 32 standard measurements and 21 breast measurements, and a control group of 57 healthy women, with 57 standard measurements and 54 breast measurements. The temperatures were entered into the computer by means of the graphic digitizer and on these data we performed two tests.

In the first place we did a symmetry test to compare the temperatures left and right, for each group. In the second place a linear discriminant analysis was done on a selection of points of the standard measurement and the breast measurement. By means of this test can be checked if two or more groups can be distinguished. In our case all temperatures of the given groups of variables were compared with eachother.

Discriminant-coefficients were determined for every single variable (measuring point). The higher the absolute value of the discriminant-coefficient the more important is the variable in question for the distinction of the different groups. After these discriminant-coefficients are determined the program estimates whether a single person belongs in one or the other group; i.e. in the breast cancer group or the control group. In this way we assessed which variables (measuring points),in our case, are important in the distinction of the groups. We took all measuring points of the breast measurement into the discriminant analysis, but out of the standard measurement we made a selection of points, having in mind the innervation area of the female breast (C8-Th3) and the literature about this matter (32,36). Finally we took the following 29 points:

- forehead
- nose root
- ellbow r/l
- mastoid r/l
- the 8 lymph points
- thymus
- musculus pectoralis
- the 4 heart points
- the 4 lower large intestine points
- appendix
- uterus
- the 2 ovarial points

We performed the discriminant analysis on the first and the second measurement and on the difference between them (the temperature regulation). For all our calculations we used the Statgraphic Software Program of the Statistical Graphics Coorporation 1986.
With the symmetry test we have been looking whether the temperatures of symmetrical measuring points differ from each other. This was done for the following points:

1. ellbow 1 r/l sinus
2. sinus frontalis r/l
3. os temporalis r/l
4. eye corner r/l
5. mastoid r/l
6. nasal bone r/l
7. sinus maxillaris r/l
8. tonsils r/l
9. the 8 lymph point
10. thyroid r/l
11. musculus pectoralis r/l
12. the 4 heart points
13. pancreas r/l
14. the 6 large intestinal points
15. ovaria r/l
16. kidneys r/l
17. S.I.joint r/l
18. ellbow 2 r/l
19. the 9 breast points in women r/l

The final results are graphically shown; in the third column the difference between right and left is drawn in such a way that the temperature is higher on the side where the line is drawn.

Figure 15 a. Results discriminant analysis of the standard measurement, first measurement.

Standardized Discriminant Function Coefficients

	1		
var2	0.27551	var32	0.76522
var3	0.38478	var33	0.38468
var4	0.18442	var34	-0.52033
var5	-0.36687	var35	0.65065
var12	-0.40819	var36	0.54153
var13	-0.17551	var37	-0.62264
var20	-0.54023	var47	-0.49879
var21	0.68557	var48	-0.80405
var22	1.11074	var50	0.12052
var23	-0.58648	var51	-0.03012
var24	-0.39209	var52	0.51550
var25	-0.21082	var53	0.15847
var26	-0.03340	var54	-0.39072
var27	-0.57403	var55	0.15457
var30	0.90570		

Discriminant Function	Eigenvalue	Relative Percentage	Canonical Correlation
1	.8270365	100.00	.67280

Functions Derived	Wilks Lambda	Chi-Square	DF	Sig.Level
0	.5473344	43.695406	29	.03921

Classification Results

	Predicted Group (count,percentage)				
Actual Group	1		2		TOTAL
1	25	78.13	7	21.88	32 100.00
2	12	21.05	45	78.95	57 100.00

Figure 15 b. Results discriminant analysis of the standard measurement, second measurement.

Standardized Discriminant Function Coefficients

	1		
var2	-0.41876	var32	-0.11597
var3	0.27148	var33	-0.01942
var4	0.07940	var34	-0.97429
var5	0.11128	var35	-0.19599
var12	0.09256	var36	-0.14667
var13	0.49702	var37	0.15475
var20	-0.50780	var47	-0.10188
var21	0.52078	var48	0.35839
var22	0.01522	var50	0.38952
var23	-0.06624	var51	-0.23553
var24	0.67673	var52	-0.02765
var25	-0.30744	var53	0.69931
var26	-0.54177	var54	-0.75659
var27	0.42857	var55	0.49371
var30	0.25586		

Discriminant Function	Eigenvalue	Relative Percentage	Canonical Correlation
1	.7835434	100.00	.66281

Functions Derived	Wilks Lambda	Chi-Square	DF	Sig.Level
0	.5606616	41.948650	29	.05676

Classification Results

	Predicted Group (count,percentage)				
Actual Group	1		2		TOTAL
1	28	87.50	4	12.50	32 100.00
2	13	22.81	44	77.19	57 100.00

3.2.3

RESULTS OF THE DISCRIMINANT ANALYSIS.

STANDARD MEASUREMENT.

The results are shown in figure 15 a, b and c. Except for the second measurement all analyses are significant. As contrasted with the breast measurement it appears that the temperature regulation has the smallest false negative percentage, n.m. 3,0 %, while the first and the second measurement have a false negative percentage of respectively 21,8 % and 12,5 %. The first measurement had a false positive percentage of 21,0 %, the second of 22,8 % and the regulation 15,7 %. In table 1 the sensitivity, the specificity and the predicting value of this measurement are shown.

BREAST MEASUREMENT

The results of the discriminant analysis are shown in figure 15 d. All, analyses have a high significance. Using the determined discriminant coefficients in the first measurement it appears that 4 women with breast cancer are missed (19 % false negative), in the second measurement 2 women with breast cancer are missed (9 % false negative). With the temperature regulation 5 women are missed (23 % false negative). The percentages false positives for the first measurement was 16,7 %, for the second 9,3 % and for the regulation 14,8 %. The sensitivity , specificity and predicting value are shown in table 2.

Figure 15 c. Results discriminant analysis of the standard measurement, the difference between the first and second measurement, i.e. the regulation.

Standardized Discriminant Function Coefficients

	1		
var2	0.38676	var32	-0.29434
var3	0.51600	var33	0.01969
var4	-0.66855	var34	-0.45813
var5	-0.18278	var35	0.74985
var12	-0.58645	var36	0.66025
var13	0.23243	var37	-0.30882
var20	-0.55486	var47	0.09025
var21	0.26544	var48	0.97633
var22	0.09093	var50	0.18814
var23	-0.07760	var51	-0.33403
var24	0.15030	var52	-0.28523
var25	0.28947	var53	0.06839
var26	-0.20249	var54	-0.08693
var27	-0.63932	var55	0.22419
var30	-0.11209		

Discriminant Function	Eigenvalue	Relative Percentage	Canonical Correlation
1	.8458188	100.00	.67693

Functions Derived	Wilks Lambda	Chi-Square	DF	Sig.Level
0	.5417650	44.436914	29	.03335

Classification Results

	Predicted Group (count,percentage)				
Actual Group	1		2		TOTAL
1	31	96.88	1	3.13	32 100.00
2	9	15.79	48	84.21	57 100.00

Tabel 1

standaardmeting	meting 1	meting 2	regulatie
sensitiviteit	78 %	88 %	91 %
specificiteit	79 %	11 %	84 %
voorspellende waarde positieve test	68 %	68 %	18 %
voorspellende waarde negatieve test	87%	92 %	98 %

Figure 15d. Results discriminant analysis of the breast measurement. First, second measurement and the difference between them.

Standardized Discriminant Function Coefficients

	1
var41	0.37402
var42	0.89698
var43	-0.52045
var44	0.46401
var45	0.00946
var46	-0.40289
var47	0.02694
var48	-0.04397
var49	0.79678
var52	0.03831
var53	-0.43859
var54	0.04854
var55	-0.48067
var56	0.77334
var57	-0.23164
var58	-0.77091
var59	-0.57325
var60	-0.18245

Measurement 1

Discriminant Function	Eigenvalue	Relative Percentage	Canonical Correlation
1	.3556274	100.00	.67904

Functions Derived	Wilks Lambda	Chi-Square	DF	Sig.Level
0	.5389013	39.566264	18	.00239

Classification Results

	Predicted Group (count,percentage)				
Actual Group	1		2		TOTAL
1	17	80.95	4	19.05	21 100.00
2	9	16.67	45	83.33	54 100.00

Standardized Discriminant Function Coefficients

	1
var41	-0.69952
var42	-0.07336
var43	0.54138
var44	-0.85349
var45	0.40518
var46	-0.05307
var47	-0.30448
var48	0.22388
var49	-0.47156
var52	-0.48246
var53	0.64746
var54	-0.33202
var55	0.35201
var56	-0.25669
var57	0.48613
var58	-0.10992
var59	0.92594
var60	0.23208

Measurement 2

Discriminant Function	Eigenvalue	Relative Percentage	Canonical Correlation
1	.9847689	100.00	.70439

Functions Derived	Wilks Lambda	Chi-Square	DF	Sig.Level
0	.5038370	43.872158	18	.00060

Classification Results

	Predicted Group (count,percentage)				
Actual Group	1		2		TOTAL
1	16	76.19	5	23.81	21 100.00
2	8	14.81	46	85.19	54 100.00

Difference between the first and second measurement

Standardized Discriminant Function Coefficients

	1
var41	0.19174
var42	-0.33504
var43	-0.51482
var44	0.99416
var45	-0.15627
var46	0.28133
var47	0.13050
var48	-0.38880
var49	-0.12212
var52	-0.09855
var53	0.04773
var54	-0.00265
var55	0.48980
var56	-0.33026
var57	0.04501
var58	0.06123
var59	-0.03336
var60	-0.09086

Difference between the first and se

Discriminant Function	Eigenvalue	Relative Percentage	Canonical Correlation
1	.5777442	100.00	.60513

Functions Derived	Wilks Lambda	Chi-Square	DF	Sig.Level
0	.6338163	29.183751	18	.04618

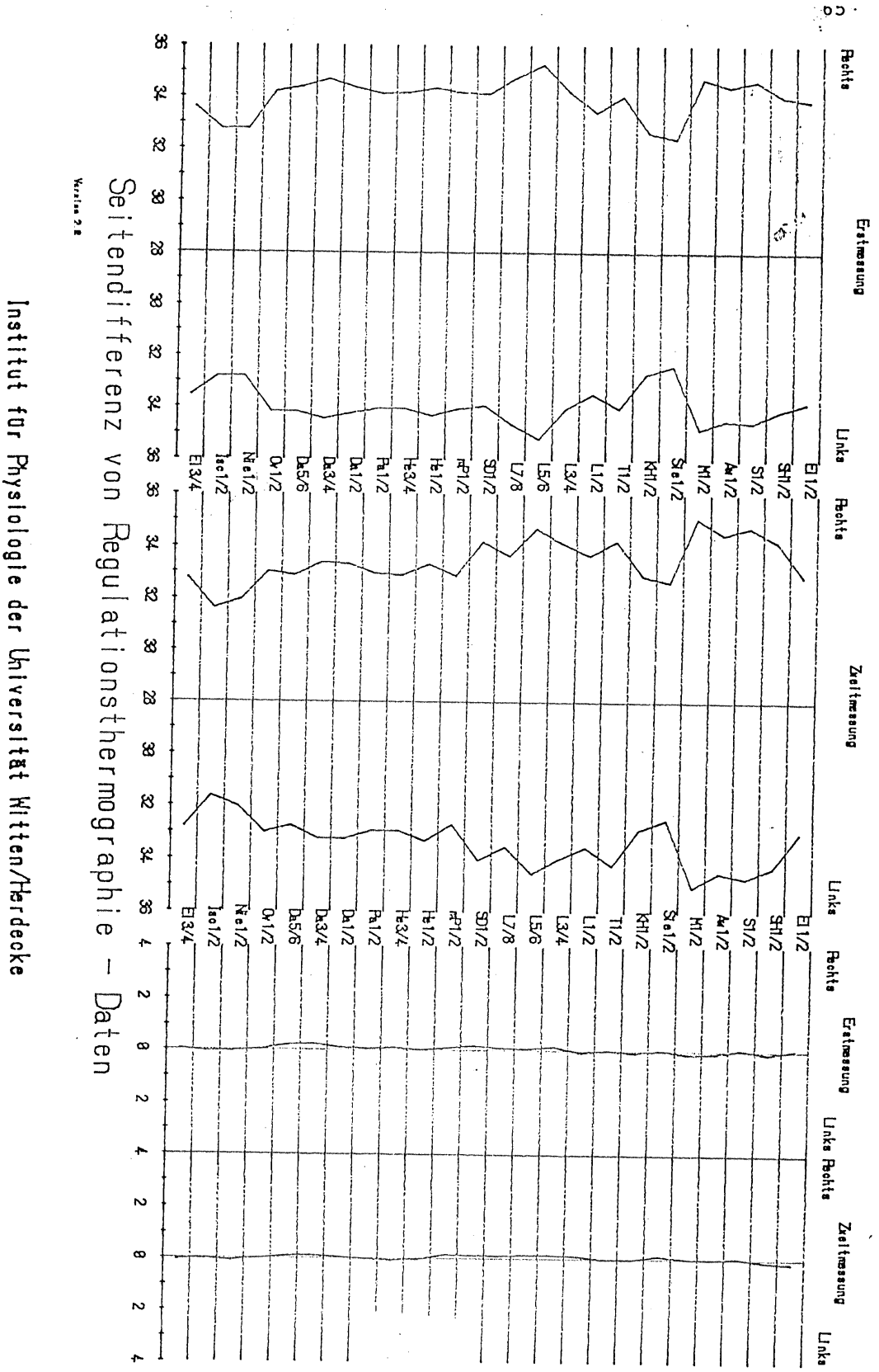
Classification Results

	Predicted Group (count,percentage)				
Actual Group	1		2		TOTAL
1	16	76.19	5	23.81	21 100.00
2	8	14.81	46	85.19	54 100.00

Tabel 2

borstmeting	meting 1	meting 2	regulatie
sensitiviteit	81%	90%	76%
specificiteit	83 %	90%	85%
voor'spel lende woarde positieve test	65%	79%	67%
voorspellende waarde negatieve test	92%	96 %	90%

Figure 16 a. Symmetry taststandard' measurement control group.



3.2.4

RESULTS SYMMETRY TEST.

STANDARD MEASUREMENT.

The results of the symmetry test are shown in figure 16 a, b and c. We additively performed a student.t test on the results. Remarkable is that the musculus pectoralis in women with breast cancer on the right side is significantly warmer on the right side, after the cold stimulus (p=0,07) compared with the control group. This is also valid for the glandula submandibularis on the left side (p=0,007).

For the group with breast cancer on the left side the same was valid for the measuring point in the intercostal area 5 left (p=0,02).

For both groups applies that compared with the control group the left pancreas point is much warmer after the cold stimulus than the right pancreas point (p=0,008), and that the lower right large intestinal point is much warmer than on the left side (p=0,0033). It might be possible that these areas are characteristic zones for breast cancer in general, no matter where, right or left, the breast cancer has developed.

Figure 16 b. Symmetry test standard measurement in a breast cancer left group.

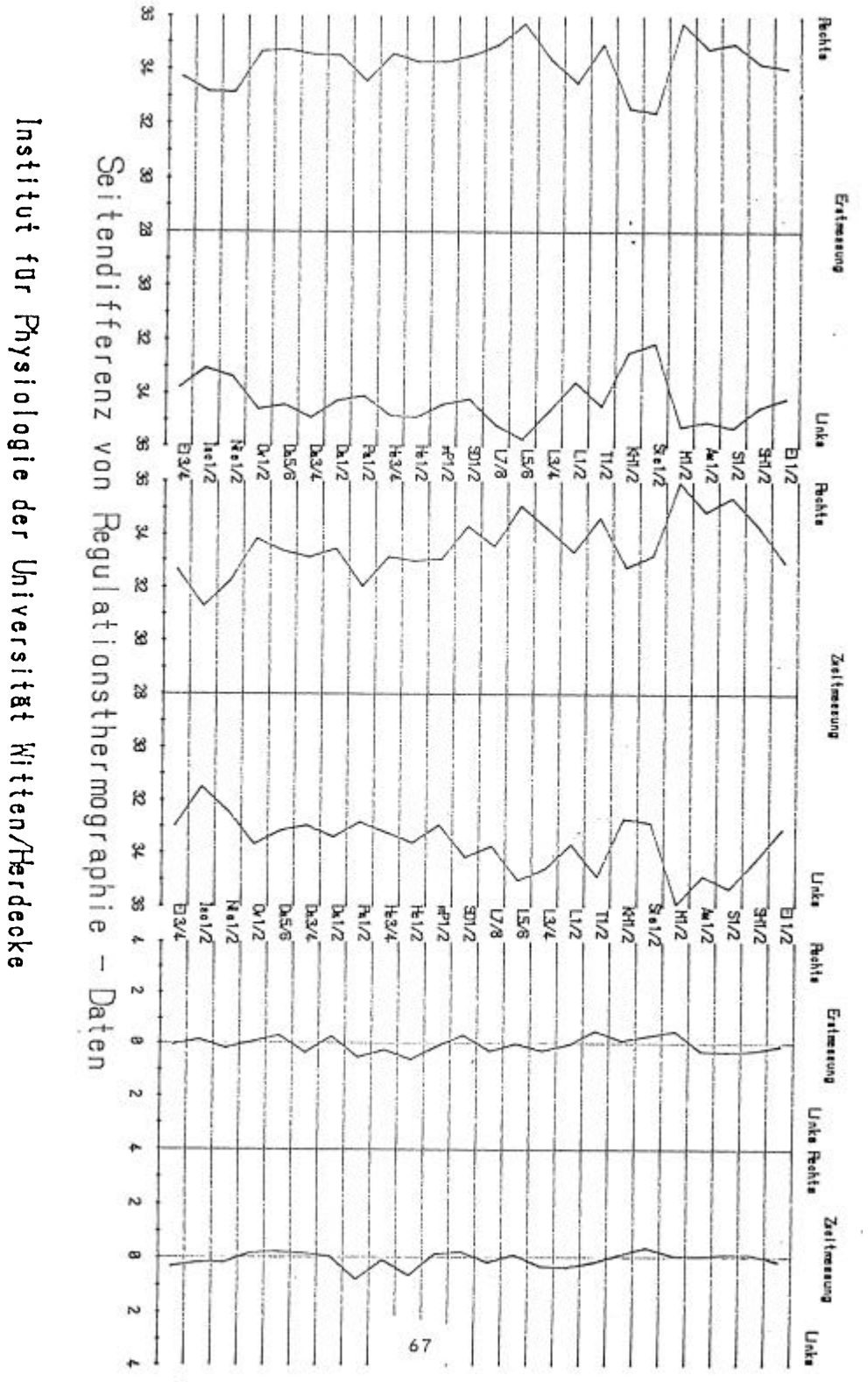


Figure 16c. Symmetry test standard measurement in a breast cancer right group.

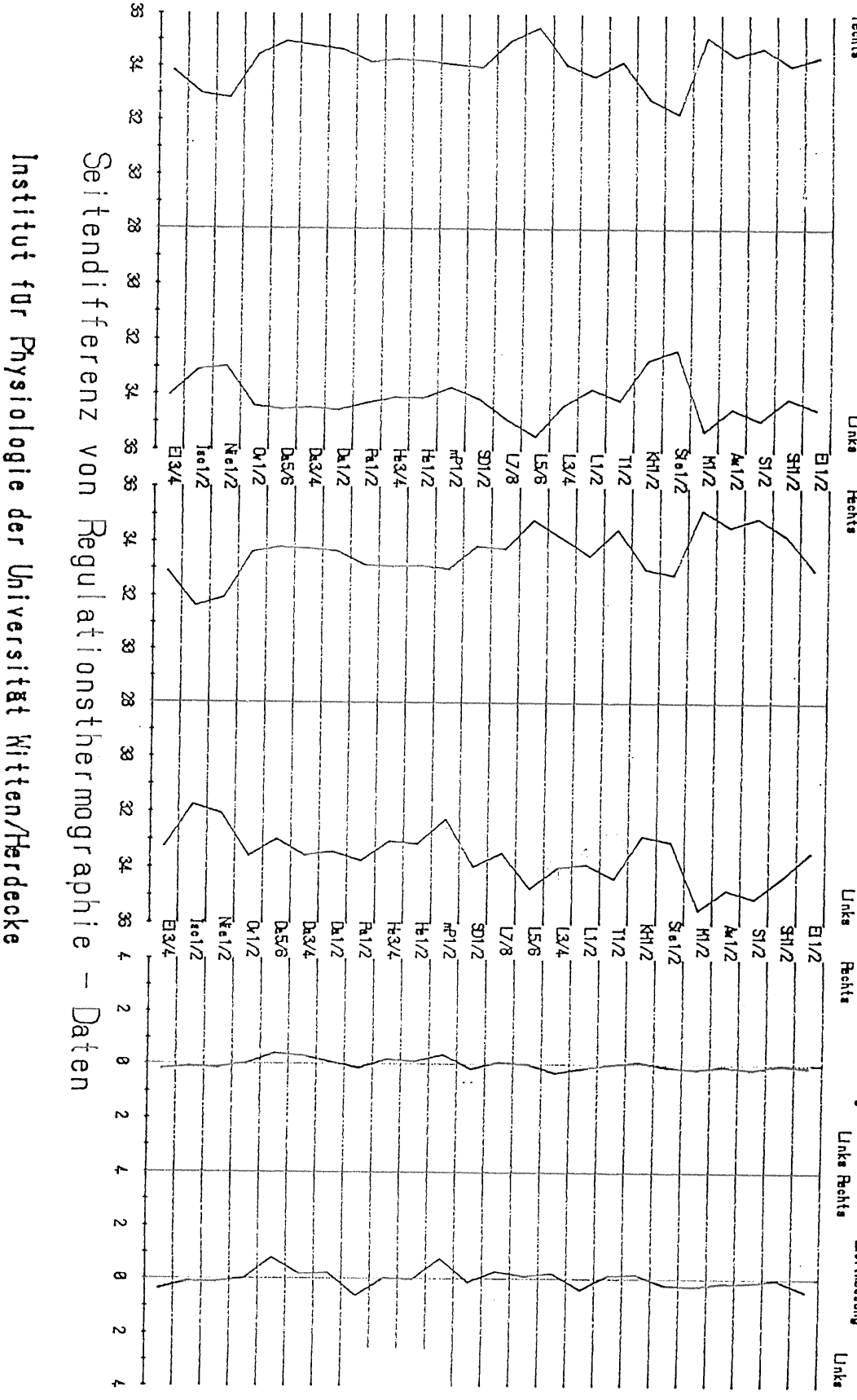
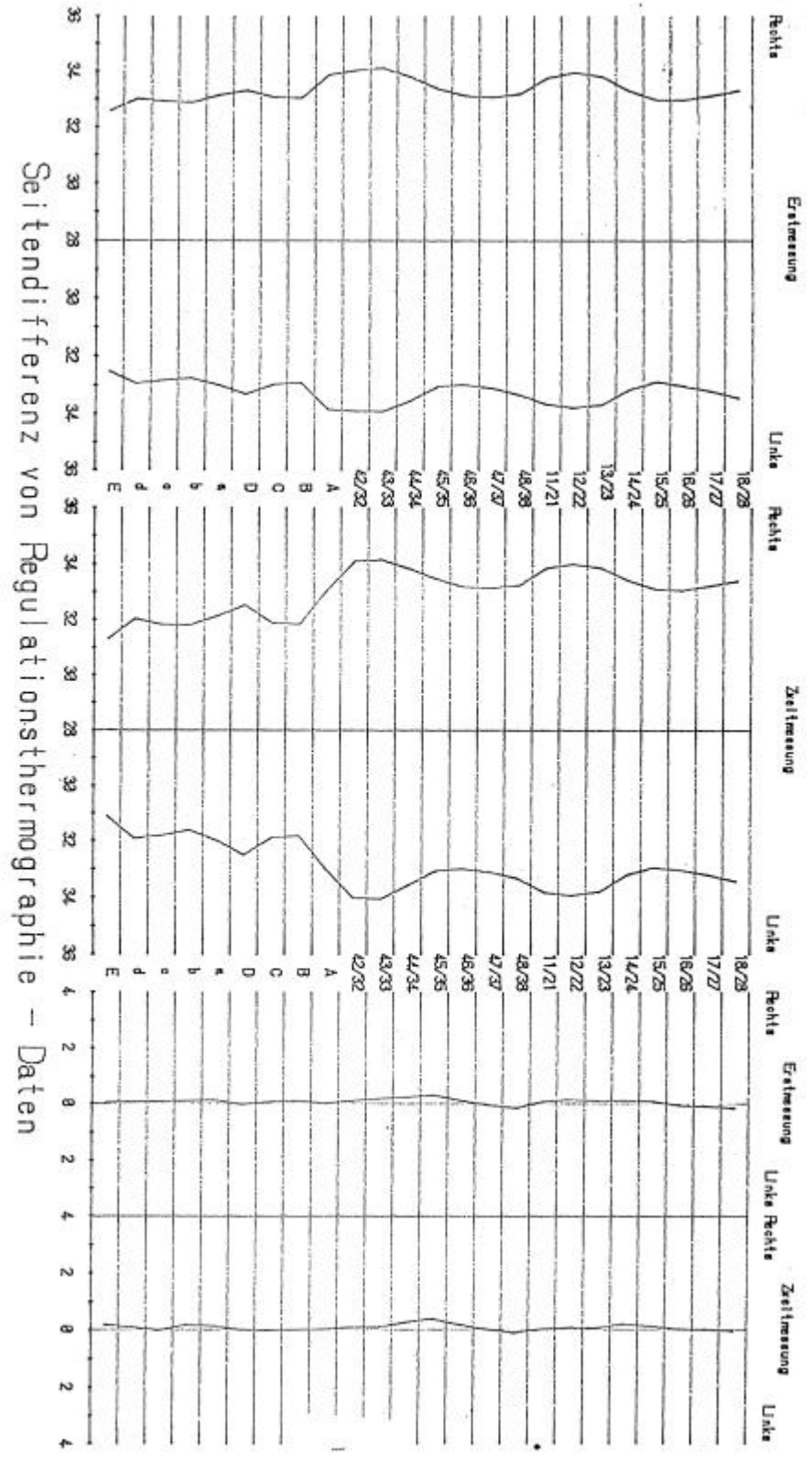


Figure 17a. Symmetry test breast measurement control group.



BREAST MEASUREMENT.

In this case too the two breast cancer groups were compared with the control group (n=54). The results were again tested on their significance by means of a student.t test.

It appears that there is first a significant difference between the two breast cancer groups and second between the breast cancer groups and the control group ($p<0,005$). The breast with cancer is clearly warmer than the breast without cancer. This applies both for the left and right side. The graphics are shown in figure 17 a, b and c.

Figure 17b. Symmetry test breast measurement breast cancer left group.

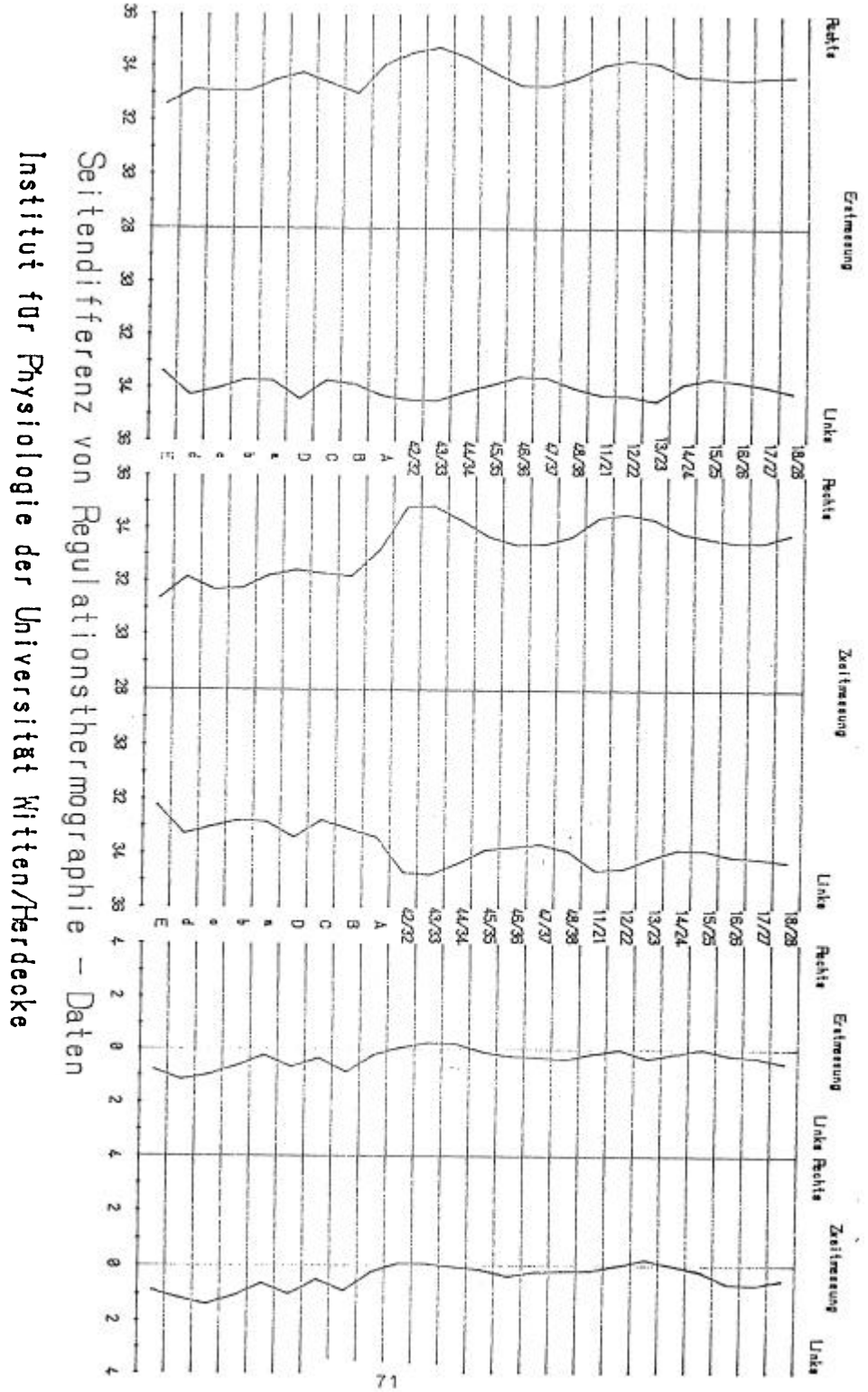
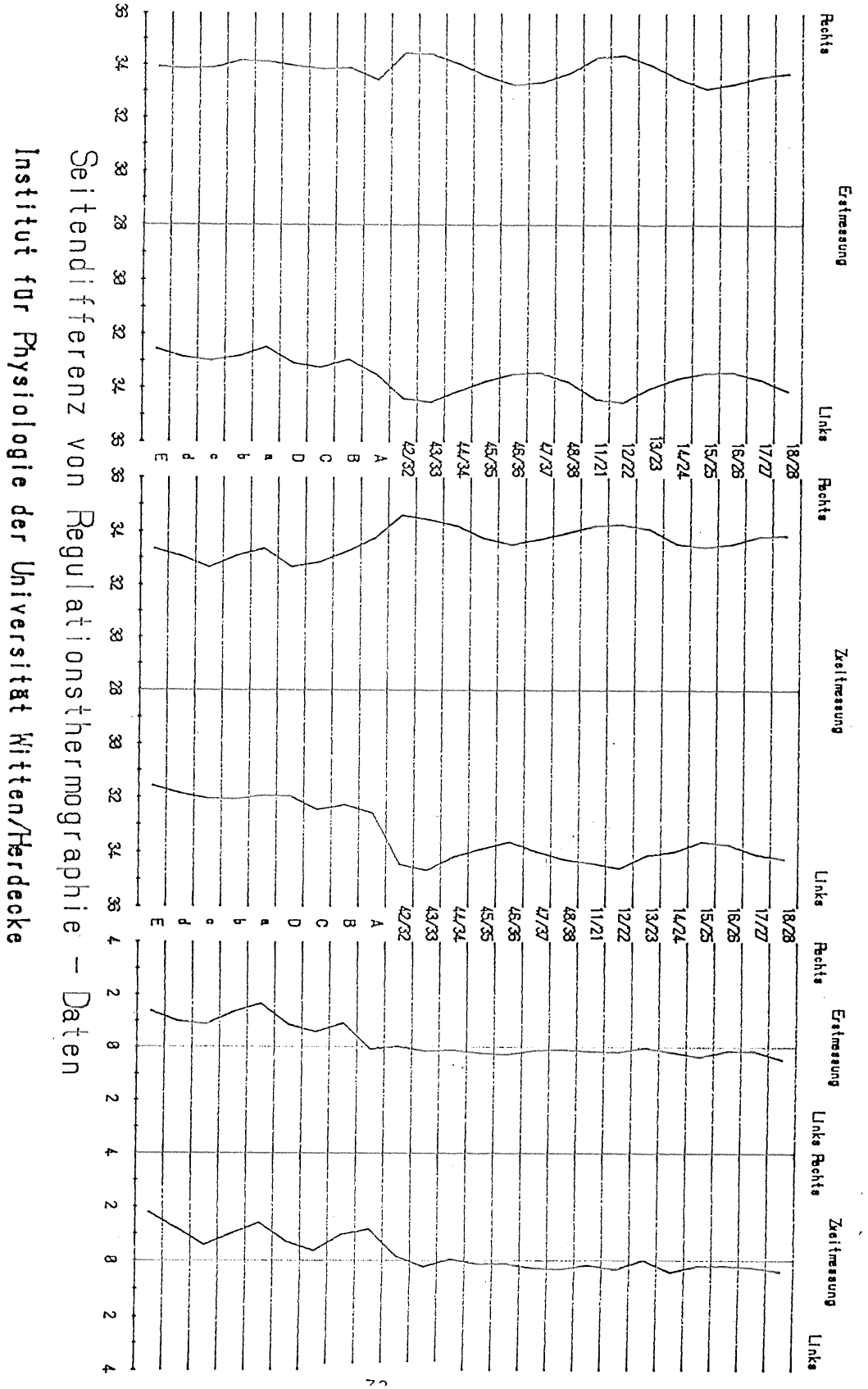


Figure 17 c. Symmetry test breast measurement breast cancer right group.



Tabel 3. Frequency distribution of the crieria from ROST for the:

— standard measurement; n 32.

criteria	percentage
• one or more warm, non- reacting ovarium or uterus temperature	31
• one or more warm, non- reacting Supraclavicular temperatures	28
• one or more non- reacting tonsil temperatures	47
• 2 cold nasal bones	41
• crossed pathological ovaria temperatures	3

- breast measurement; n = 21

criteria	percentage
• the measuring points of one breast all warmer than those of the other one	67
• one or more warm, non- reacting points on the sick breast	28
• abnormal temperature regulation	14

3.2.5

RESULTS TEST CRITERIA ROST

The results of the comparence between the criteria for breast cancer according to Rost (32) and the temperatures measured by us are shown in table 3. It appears that 3 out of 8 of the criteria of Rost are actually found in more than 40% of our patients.

These are:

criterium 1: In the mamma thermogram all temperatures of one breast are warmer than those of the other one (67% n=21)

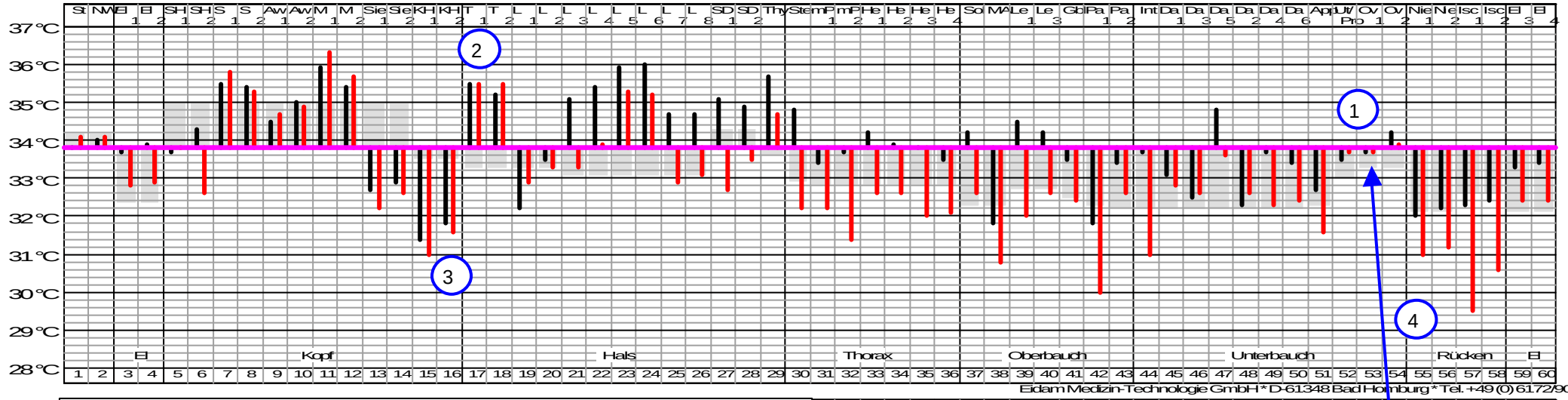
criterium 2: At least one tonsil temperature is hot and non-regulating (47% n=32)

criterium 3: Both sinus maxillaris temperatures are cold (41% n=32).

In figure 18 a and b two thermograms are shown of which one has many of the criteria of Rost and the other has only two. Both women suffer from histological proven breast cancer.

Ultimately one can draw the conclusion that for the diagnostics of breast cancer the above mentioned criteria are most important.

Figure 18 a. Thermogram of a breast cancer patient which shows many of the criteria from Rost



Date thermogram: 17-10-1998
Diagnosis: mamma-ca left
Operation: none
Therapy: Mistle therapy (Iscador) s.c. since 5-10-1988
Rost criteria: standard thermogram

1. warm and non-regulating ovaria and uterus temperatures
2. non-regulating tonsil temperatures
3. two cold nasal bones
4. "crossed" pathological ovarium temperature

breast thermogram

5. the temperature left are all warmer than the temperature right

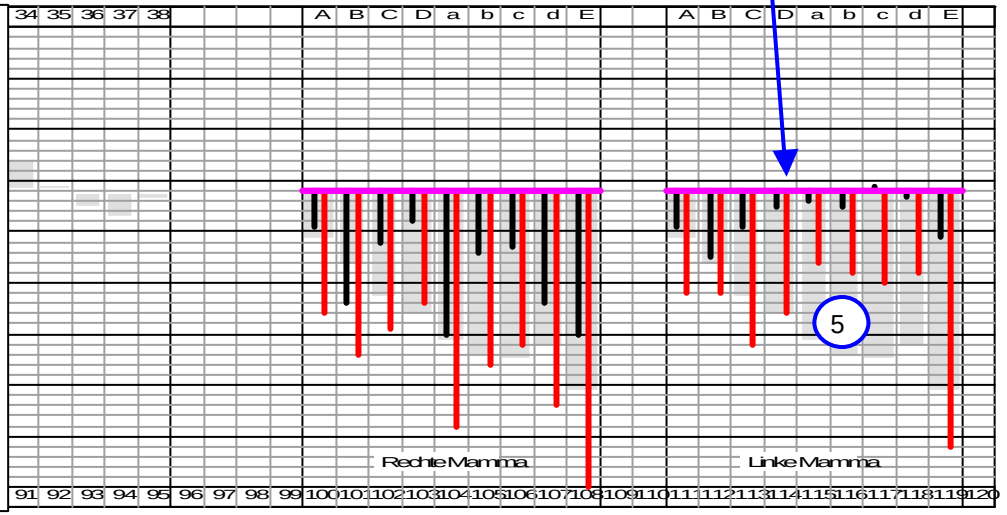
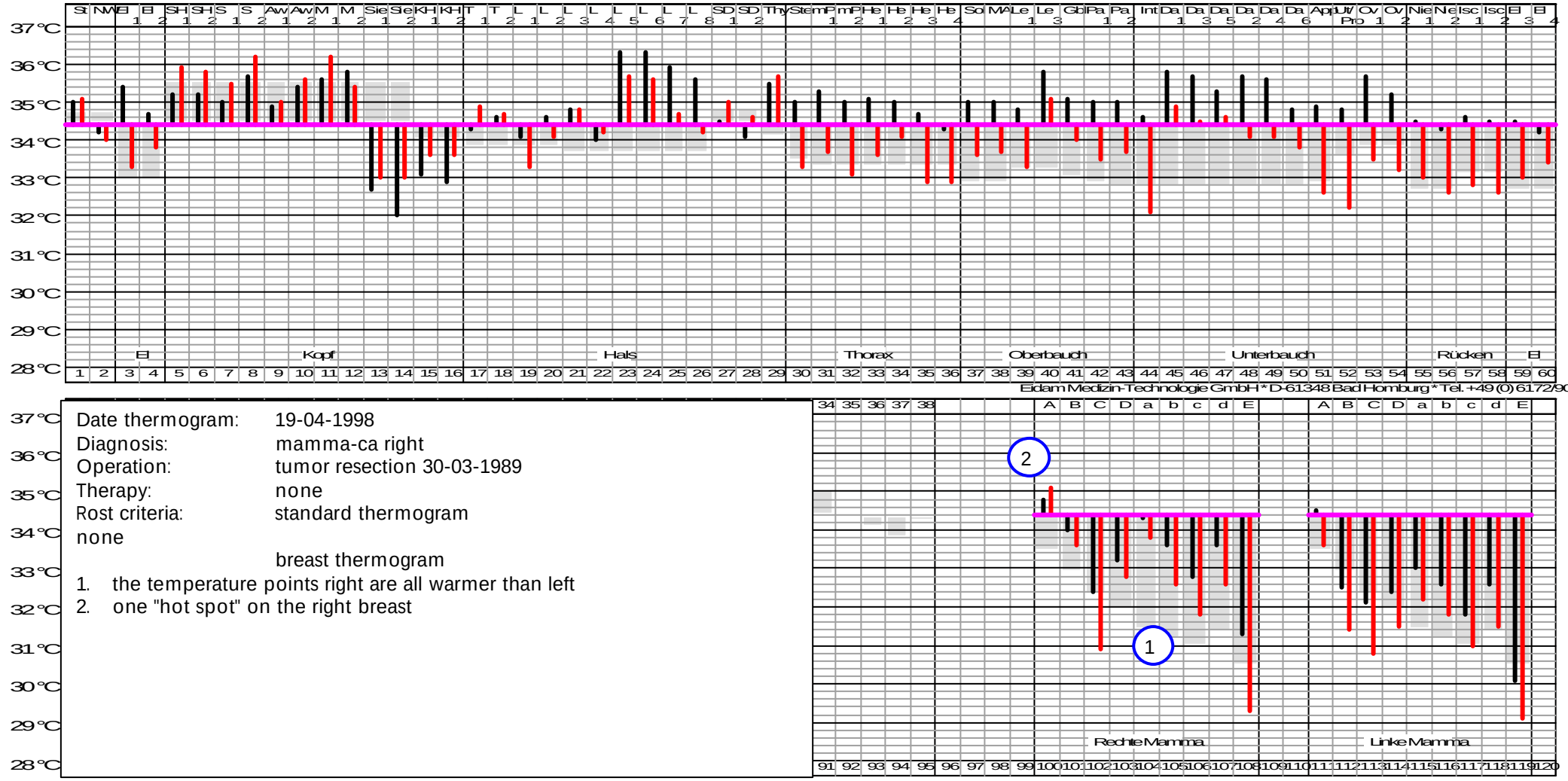


Figure 18 b. Thermogram of a breast cancer patient which does show any of the criteria from Rost



3.2.6

CONCLUSION AND DISCUSSION

Although our patient group was heterogene with respect to undergone operations and treatment it appears from the discriminant analyses and the symmetry tests that the thermograms of our patients are clearly distinguishable from the control group.

As the discriminant analysis makes clear the breast temperatures are of great importance but are not the only variables which make the difference between sick and healthy. This agrees with both the assertion of Rost (32,33) who says that the mamma thermogram should be judged in relation with the standard thermogram and the research of Blohmke (5). For the measuring points which are not located on the breasts the reaction on the cold stimulus is more important than the absolute temperature. For the measuring points located on the breast, on the contrary, the absolute temperature is most important as appears from the symmetry test, the discriminant analysis and the comparence with the criteria from Rost. From the results of the testing of the criteria from Rost one could conclude that the areas around the tonsils and the nose are, as the left pancreas point and the right lower large intestinum point, zones which are characteristic for the disease breast cancer in general. For the last two mentioned points the absolute temperature is most important while for the other zones the temperature regulation is more important. It should be kept in mind though that chronic or acute colds, as mentioned in 3.1, can also affect the temperatures from tonsils and nose.

The above mentioned distinction between breast cancer and the control group could be caused by the disease breast cancer, but on the other hand might be caused by the therapies. Especially from operation and mistle therapy is known that they can affect the body temperature. What has caused the temperature change in our patients is not quite clear. To find out more research is needed, as we will plead for later.

The results of the three tests are of importance for the eventual development of a computer algorithm, which could be a very usefull tool in the discovery of breast cancer in an early stage (5,6). Such an algorithm can best be developed out of a homogenous group of patients, without many disturbing factors.

For this reason it is better not to use our group to make such an algorithm. It would be better to measure a homogenous group of about 200 women who are suspected to have breast cancer before they have received any operation or other treatment. Out of the thermograms of those women who really appear to have breast cancer an algorithm can be calculated and this algorithm can then be tested in a prospective research program, in which women with a reasonable risk for breast cancer are screened.
Moskowitz (25) too pleads for well planned prospective clinical trials to investigate what is the distribution of thermography in general in the diagnostics of breastcancer.

Taking into account the results of the research of stress-infrared thermography in the breast cancer screening (5,6,26,37) and our own results we think the TRD can play a role in the prescreening of breast cancer. Pflanzer (28) is pleading for a screening method in which the women when coming for the first time are investigated with themography, physical examination and mammography. If there is no suspicion for breast cancer the women get physical examination and thermography every half year. Only when one of those are suspect a mammography and eventual a surgical examination will be performed. For many women this would mean they would be exposed much less to radiation. This is especially of importance for women younger than 50 years old, who at this moment account for 30 % of the screening population (37). We think that the TRD best should be used in this way of full value besides the other accepted screening methods for breast cancer.

3.3

SUBJECT 3

Problem: How does the skin temperature behave before, during and after the thermo measurement ?

3.3.1

INTRODUCTION.

To specify this problem we can ask three additional questions:

1. Is an acclimatising period of 30 minutes sufficient?

2. Is there a death period after the cold stimulus?

3. How much time, after undressing, is needed to reach a new temperature balance?

The method of measuring, which is used when making a thermogram, is based on several assumptions (32):

1. Whithout a cold or hot stimulus the skin temperature has a constant value.

2. After a cold stimulus (undressing) it takes one to two minutes till a measurable temperature change appears, the so called death period or latent period.

3. Maximal 10 minutes after the cold stimulus the temperature has reached a new constant value, which holds on for at least 30 a 40 minutes.

From the literature is also known (4,29) that the body is not a static system, but that all life processes move rhythmically. The skin also has a quasi constant temperature. In fact the skin temperature varies in a rhythmical way, congruent with the pulsations of the peripheral perfusion, which has a period of about a minute. The peripheral perfusion rhythm is one of the rhythms which play a role in the circulation. The others are the heart rythm, the ventilation and the bloodpressure. These rythms combine harmoniously with eachother in a relation of about 4:1, which is particularly clear in the sleep.

heart rythm :	ventilation	bloodpressure :	peripheral perfusion
± 72/min.	± 18/min.	± 4/min.	±1/min.

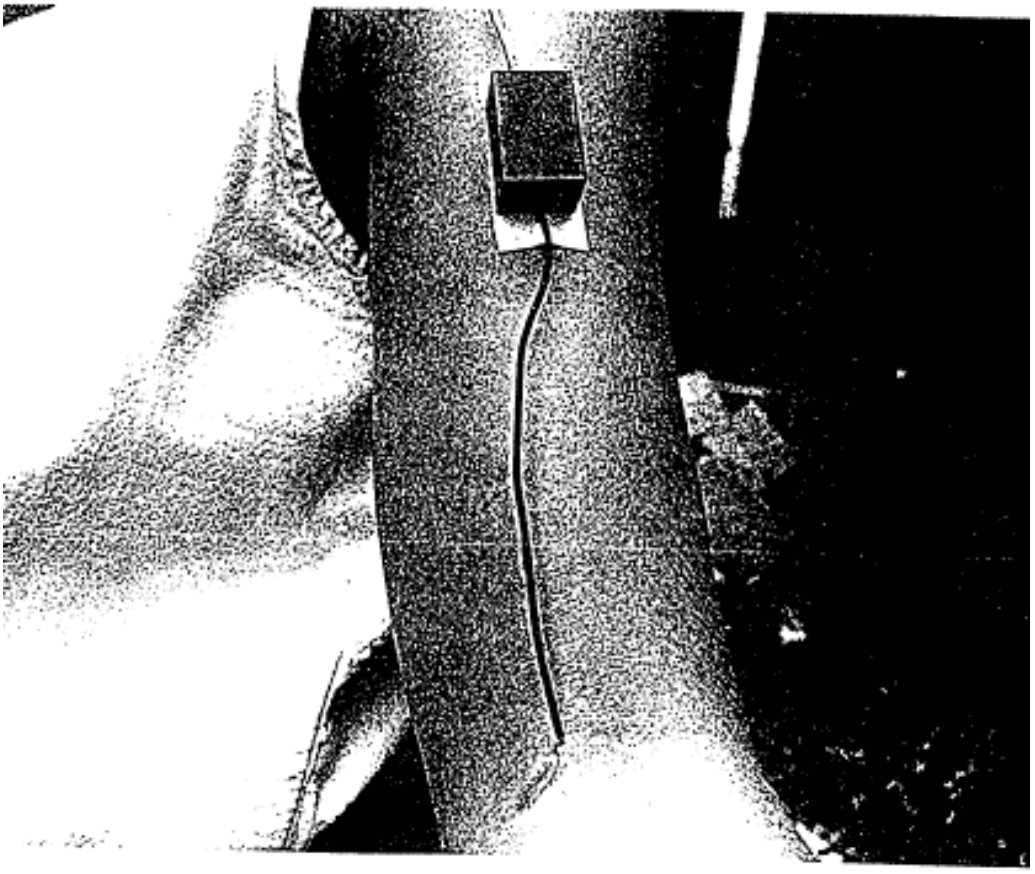
If the peripheral perfusion rythm has a strong influence on the skintemperature, stronger than the influences caused by the cold stimulus, the temperature would not be constant and the thermogram would not be reproducable.

Berz (4) has done a very small orientating research. He photographed three healthy men (age 35-54 years) with infrared cameras, to get an overall impression, and furher he measured one point every ten seconds with a electrical contact thermo element, at each test person. These points were: the plexus solaris at ‘the first person, the stomach at the second and the left ellbow at the third person. He observed a continuous temperature fluctuation of 0,2 - 0,3°C within a period of about a minute and after the cold stimulus of undressing he noticed there was a death period of some minutes before the temperature reacted and reached a new level of about 0,5 – 1,0°C lower.

Priebe (29) also speaks about these temperature fluctuations. In his opinion the temperature fall caused by a cold stimulus is not hidden by those spontaneous temperature fluctuations.

To obtain more security about this matter we carried out ourselves a continuous temperature measurement at 8 skin points, with prompt reacting thermo-elements.

Figure 19. Photograph of an applied thermo-element



Thermoelement for Eidam Medical Technoloy

3.2.2

MATERIAL AND METHODS.

The experiment, as we carried it out, is completely new, and is till now only carried out as an experimental measurement. All the measurements took place at the Institute of Physiology in Herdecke. As testing subjects we took four members of the staff of the institute, three men and one woman, aged 27 till 42 years. They were measured under the same conditions as mentioned in the first experiment. Eight wire formed thermosensitive elements were pasted on with collodium (a swift drying glue), which can be easily removed with aceton (fig. 19). At each point the temperature is continuously measured and shown on a display. At the same time the information was stored on a tape, so that later the information could be graphically shown. The thermo-elements were tested in a warm water bath to show the absolute temperature and reaction promptness. The experiment had a duration of 90 minutes. The room temperature varied from 20 to 24°C. We did four experiments and no statistical analysis was performed.

The experiments were done as follows:

1. The thermo-elements were applied at eight points, agreement with Prof. Rost and Dr. Pfotenhauer.

a. forehead
b. right ellbow
c. left ellbow
d. intercostal area 5 right
e. intercostal area 5 left
f. plexus solaris
g. pancreas right (pancreas head)
h. pancreas left (pancreas tail)

2. The tested person acclimitised in a dressed state for 40 minutes.

2. The tested person undressed the upper part of his body, and was measured in this situation for another 50 minutes to react to the cold stimulus of the room temperature.

3.3.3

RESULTS.

The following appearances were seen (tab. 4):

1. During the acclimatising period a stable temperature set in after 0 till 40 minutes, depending on the measured point and the person, Only two (out of 32) points needed more than 30 minutes to get stable (ic-5 right of subject 1 and pancreas left of subject 4). The temperature balance is usually reached not by oscillation around the end temperature but by slowly approaching the end temperature.

2. After undressing there is a dead period of 0 to 120 seconds, also depending on the point and the person. E.g. test person 1 mostly has no dead period, the other three have one of about 60 seonds.

3. After ten minutes the most important temperature fall has taken place, but the new balance has not been reached yet. Testperson 1 reacts till about 40 minutes after undressing, the others have finished after 15 - 20 minutes.

4. Striking is the forehead, which does not or only minimally reacts, in all four test persons.

5. Concerning the symmetry, the heart points are reacting most symmetrically. Testperson 4 is symmetrical in every point. If there exists an asymmetry this is most clear in the first 10 minutes.

3.3.4

CONCLUSION/DISCUSSION.

We can conclude that most points do not arbitrarily oscillate, but systematically react during adaptation and after cold stimulus, in such a way that is strived towards a steady equilibrium temperature. Most of the time not more than 30 minutes is needed to reach a stable temperature, and so an acclimatising period of 30 minutes should be sufficient.

After a cold stimulus the body needs more than ten minutes to reach a new temperature balance, although the most important reaction takes place during the first ten minutes. It seems to be justified to do the second measurement after ten minutes. To standardise though, it is important to measure then always after ten minutes, because the reaction is still going on afterwards. If the second measurement is done after varied length of time, every person does not get the same time to react.

Like Berz (3) we also found small temperature oscillations with a period of about one minute or more. These oscillations are rather small (0,1-0,3°C) and do not always appear. They are standing apart from the temperature reaction after a cold stimulus.
The experiment appeared to have some errors.

First it was rather difficult to apply the thermo-elements. It cost a lot of time and sometimes they fell off during the experiment.

Second the absolute temperature measured by the thermoelements was not correct. As a consequense we cannot make any statement about the absolute temperatures.

Third it was a problem to keep the room temperature steady. We could not ventilate during the experiment, because this would result in a direct cooling down of the skin, in stead of a cooling down as a reaction of the body. Room temperatures raised up till 24°C.

At last we should mention the graphics. The temperatures are not shown very accurately, so that it was difficult to analyse and judge them.

In the future these problems should and could easily be solved.

Chapter 4

LAST REMARKS

As mentioned before we did not know anything about this diagnostic method before we came to Herdecke. Therefore in the first weeks we read literature, learned the measuring method and joined a three days congress about thermography. During that time our questions as discussed in this manuscript have developed. For example we were very curious whether this method was such a good diagnostic as described in some books and articles. Of course this could best be investigated by means of a prospective study, but because we did not have the time to do that we tried it through a retrospective research. If we assume that the change in temperature regulation was not caused by the operation or mistle therapy the results of our research were remarkable. Furthermore it appears from the continuous measurement and the statistical determined normthermogram that the method of Rost concerning the normthermogram and the cold stimulus of 10 minutes, in broad outline, can be scientifically supported. In our research we only investigated one disease, but by means of the TRD many diseases can be diagnosed, as some auteurs positively believe. The TRD is also very suitable for the follow-up of treatment of patients. In the autumn of 1989 a new research will be started to investigate the influence of mistle therapy on the thermogram.

If more research is done in all aspects of the thermography we believe this method could be very well used in the general praxis, as a help for diagnostics.

About our time in Herdecke we can say we have been working rather independently, which we appreciated very much. The staff of the institute of Physiology always was very ready to help us with any problem or in any situation in which we needed more people, as e.g. with the measurement of our test persons in Cologne.

What we liked very much was the fact that in our research besides the processing of data at the institute we also had much contact with patients and test persons, because we did most of the measurements ourselves. The difficulties we met were in the domain of the statistics, the organisation of the measurements of patients and the writing, also because we wrote our essay in two languages.

For all that we have liked it very much to work in the Institute of Physiology in Herdecke and we hope that reading this essay gives a clear image of this rather new diagnostical method.

Chapter 5

SUMMARY

In this essay the different aspects of the thermoregulation diagnostics by Rost are investigated. This method is trying to judge the health status of a person by measuring the reaction of the body on a cold stimulus. To do that the skin temperature is measured at at least 60 points. The relation between skin temperature regulation and internal diseases is made clear by means of the occurring segmental sympathetic reflexes, which forms a hypothetical explanation to these phenomenons.

Our research consists of three parts. First we verified in broad outlines the constructed normthermogram of Rost by using statistical methods. Second we showed that the cold stimulus of 10 minutes, as used by Rost, is a suitable cold stimulus. And third we tested the TRD retrospectively on breast cancer patients. Our results show that the breast cancer group is well distinguishable from the healthy control group by means of a symmetry test, a discriminant analysis and with the help of the criteria from Rost.

We think this method can be developed into a reliable, patient friendly and inexpensive diagnostic tool, to be used in the general praxis as a help in diagnostics.

CHAPTER 6

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