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Thermal imaging as a non invasive application in the field of diagnostics and treatment of varicosis and succeeding symptoms

by W. Wild, S.R. Schütte, M. Grosse

University Rostock, Institute for Measurement and Control,
Albert-Einstein-Str. 2, 18119 Rostock, e-mail: walter.wild@mbst.uni-rostock.de

Abstract

Infrared thermography is successfully introduced to medical practice. Within the diagnostics of varicosis this is not yet very common, although varicosis with all its side effects represents a wide-spread human disease especially occurring at progressive age. The methods used at present are sonography and invasive angiography. In connection with these two methods the infrared thermography can contribute much as a non-invasive, picture-giving procedure to the diagnosis of this illness. Within the scope of this study first examples are presented.

1. Introduction

In the meantime the application of infrared thermography in the field of human medicine is very common. Numerous applications are described in literature. Own investigations in co-operation with the specialists of the medical faculty of the University of Rostock in the areas of heart surgery, eye medicine and head and neck surgery acknowledge the experiences that infrared thermography is everywhere well applicable as an operation-accompanying method, where it is important to detect temperature dependent disease processes.

Directly after an aortocoronary bypass surgery e.g. it is possible with an IR-camera to detect and monitor the restart of blood flow through the coronary blood vessels. This method can help significantly to decide whether this operation is successful and the heart muscle is again sufficiently supplied with fresh blood.

By the employment of thermography during laser cutting of the cornea, the ophthalmologist receives for the first time an objective determination of the heat development of this critical area [1].

Using the IR-camera the ear specialist can determine temperatures fast and securely when drilling the pars petrosa (rock bone, part of the os temporale) [2] and can perform post operational investigations on the blood circulation situation of the skin covering a cochlea implant [3].

Varicosis is a wide spread disease in the western civilization. In the following it is described how thermography can helpfully be used in connection with the common procedures ultrasonic scanning and phlebography.

2. The venous system of the legs and vein defects

After the arteries led the blood into the legs, the veins take care of the return motion. The blood must be pumped against the force of gravity from the legs upward to the heart. A combination of single-side opening vein flaps and the muscle pump ensure this process. Beforehand small blood vessels collect the blood and transport it to the two large veins of the legs, the v. saphena magna (superficial vein) and the v. poplitea (deep vein of the leg). Both are connected by v. perforantes (perforans veins) (fig. 1).

In the course of life it often comes to an extension of the diameter of these blood vessels, with the consequence that the vein flaps do not close properly any longer and a

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backflow of blood occurs. Causes for this phenomenon can be related to the changing civilization habits, like long time sitting and standing, false nutrition, predominance or modifications of the hormone household.

Due to the backflow toward the feet and the so dammed up blood it comes to the formation of cramp veins (varicosis). Small cramp veins (diameters below 4 mm) are not tactile and only visible if they are located close to the surface of the skin. Large cramp veins (diameter more than 4 mm) are usually noticeable and superficially visible. They are not only regarded as aesthetically unattractive, but can also cause severe pain and finally lead to ulcus cruris (open-leg syndrome).

It is the function of the physician to diagnose and if crucial initiate further treatment or surgery, in order to contain or terminate the complaints.

3. Diagnostic procedures for vein defects

The use of ultrasonic sensors within a range of 2 to 12 MHz is state of the art in the medical practice. They are put with a coupling gel onto the skin. The reflected signals are converted to a black-and-white picture. On the basis of this picture position and size of the cramp veins are closed down. In extension of the ultrasonic diagnosis Doppler-sonography is used, which simultaneously displays the direction of blood flow.

A less frequently used method is phlebography. With this invasive procedure a contrast medium is injected into the bloodstream. A radiograph then gives a high-resolution and detailed picture of blood vessel system.

The third, newer procedure is the infrared thermography. This non invasive procedure is simple, fast, high-resolving and favourably applicably [4]. It should be used as a primary procedure, because with the created thermograms a fast overview can be obtained. First conclusions must be drawn together between thermographer and treating physician. Unique individual blood vessels below the surface of the skin can be localized and extremities badly supplied with blood can doubtless be detected and assigned.

4. Results

The infrared photographs are executed with the camera system *FLIR 550* (3.6 to 5.0 µm) equipped with standard object lens, whereby for close-ups the additional lens 40° is used. The emission coefficient is determined and adjusted at 0.98. Ambient temperature, air humidity and distance are stored to correspond the conditions.

At the same time, together with each thermogram, a digital photo of the scanned area is taken and inserted into a report. With this procedure a good allocation is possible. The analysis of the thermographic pictures is executed with the software *ThermaCam Reporter 2000*.

Figure 2 shows a thermogram and the corresponding digital photo of the lower leg of a female patient, which does not show the extent of the cramp veins illustrated saliently in the thermogram. The unification of thermographic, sonographic and patient data results in the final diagnosis and leads to the direct, successful handling.

In Figure 3 it is shown that blood no longer reaches the toes of the foot. This is a preliminary stage of an illness, which can lead to the amputation of extremities.

5. Conclusion

Clinical investigations of varicosis patients are executed apart from groping and eye detection objectively by the use of ultrasonic sonography. For a fast, wide overview the also non invasive infrared thermography is very well suitable. The colored thermograms can be analysed very fast. Modifications of the veins not visible to the human eye show themselves promptly. They stand out clearly visible from the normal skin picture and are suitable beyond that to show the patient the disease situation plastic before eyes. A medical treatment is placed more surely, the more exactly the diagnosis is.

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The data collected during the study are promising that thermal imaging is suited as an additional method of diagnosis in the field of varicosis and post symptoms. The succeeding study may also be spread out to general blood flow insufficiency symptoms like arteriosclerosis.

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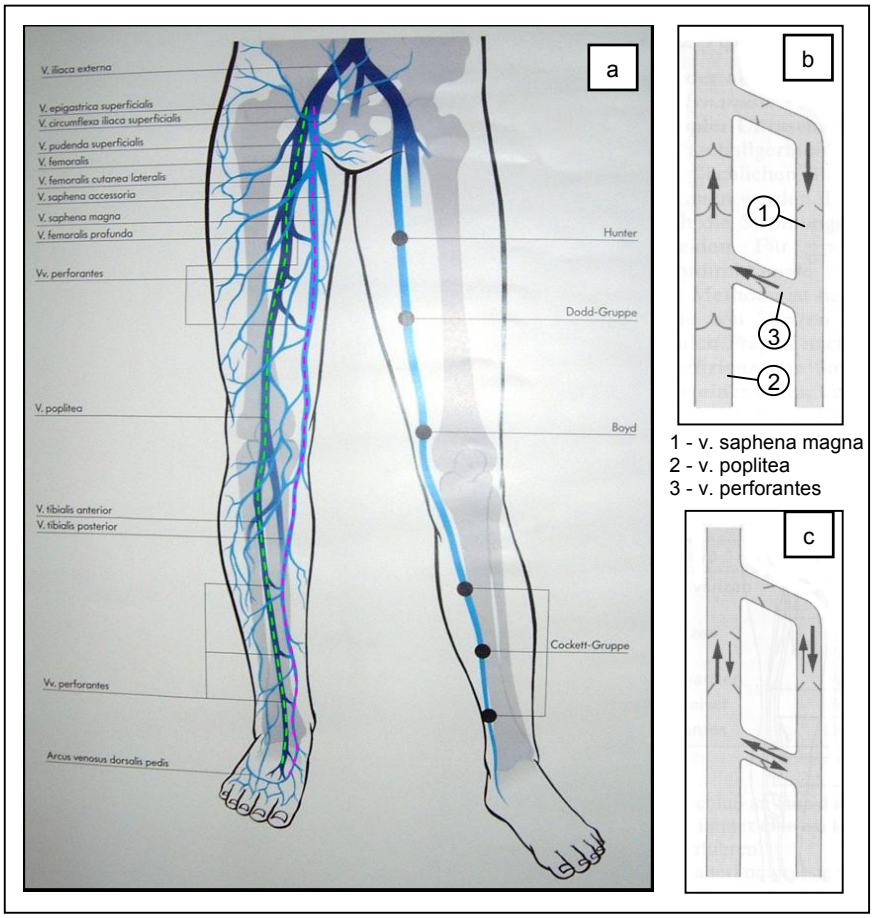

Fig. 1. *Venous system of the human leg (a); schematic view of normal (b) and example of insufficient (c) blood flow*

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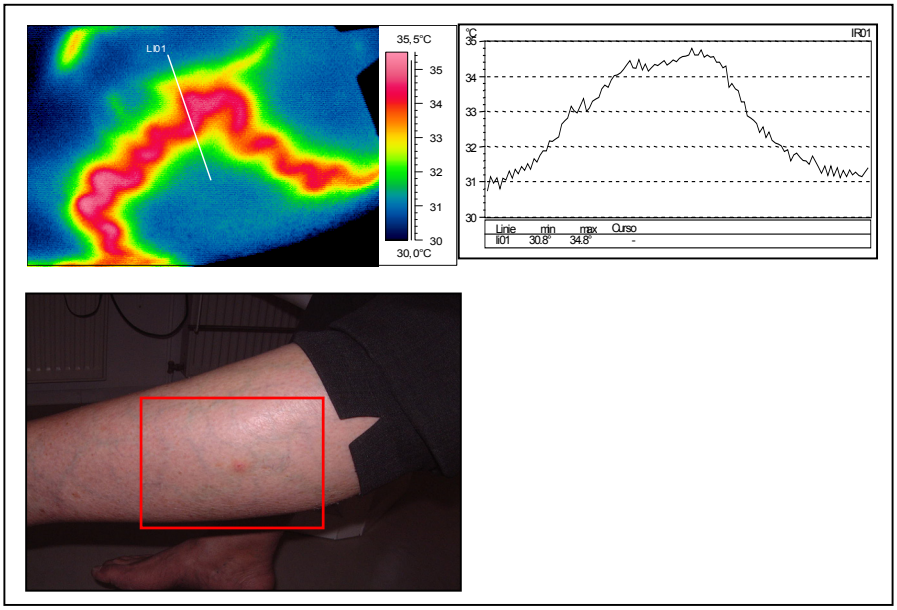

Fig. 2. *Thermogram and corresponding digital photograph of a patients lower left leg; view from outside. Diagram showing the temperature distribution across the cramp vein (LI01)*

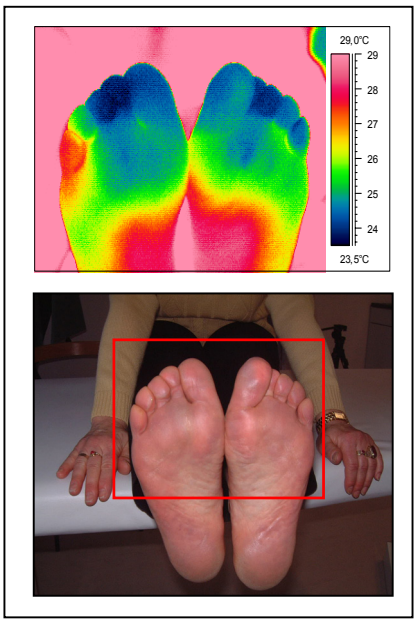

Fig. 3. *Thermogram and corresponding digital photograph of a patient's feet with insufficient blood supply of individual toes; view from bottom*