

Information brochure for patients and consumers

MICROCIRCULATION

**The importance of tiny vessels for
healthy blood circulation**

Federal Association for
Health Information and
Consumer Protection,
Germany



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FOREWORD

Dear Reader,

The importance of the tiniest vessels in the body and the impact of functioning microcirculation on our health is underestimated. Although the relationship between impaired microcirculation and various diseases and disorders is readily apparent, this information has not yet received due attention in diagnostics and therapy. One of the reasons for this is that the complex processes involved, and the interactions between the small blood vessels and the cells of the target organs, are not yet fully understood, hence the paucity of therapeutic approaches.

We want to create an awareness of the topic of microcirculation and help ensure that the processes in the smallest blood vessels get more attention. Currently, the therapeutic means of stimulating an impaired microcirculation to improve the health and wellbeing of the persons affected are still limited.

We support sharing of information among scientists, physicians and decision-makers in the field of healthcare policy with an eye to promoting research into microcirculation. This is the precondition for gaining further knowledge and developing new therapeutic approaches in this field.

Erhard Hackler



Erhard Hackler

Managing Director of the
Federal Association for Health
Information and Consumer
Protection, Germany

FOREWORD



Prof. Dr. Dr. med.
Ralf Uwe Peter

Medical specialist in dermatology and venerology, allergology, phlebology, proctology, laboratory investigations, dermatooncology, outpatient surgeries, Dermatological Centre Munich West

Dear Reader,

If blood cannot flow freely into even the tiniest blood vessels of our organs and tissues, their supply of oxygen and the most important nutrients will be insufficient. This has negative effects on the body's performance levels. We do not regenerate as well, feel weak and are more susceptible to disease. The malfunction of the affected organ systems may also worsen over time. Diseases and symptoms such as chronic wound healing disorders, chronic metabolic disorders, vascular

diseases and chronic pain are possible consequences of, or are exacerbated by, impaired blood circulation.

In this brochure we would like to explain to you the importance of good blood circulation and in particular the role played by microcirculation in various diseases. The term microcirculation refers to the part of blood circulation that takes place in the branched network of the very smallest blood vessels. In many cases, it is possible to improve our well-being and health status with targeted stimulation of microcirculation. In this brochure we will show you how physical vascular therapy is used in this sense as a complementary measure.

Prof. Dr. Dr. med. Ralf Uwe Peter

FOREWORD

Dear Reader,

The field of microcirculation is being researched by scientists all over the world. Some of the areas that particularly interest us are the functioning of microvessels, the role of microcirculation in various diseases and the means of stimulating microcirculation. We have gained a great deal of new knowledge on these topics in recent years. For instance, we know that impaired microcirculation – known in technical terms as microvascular dysfunction (MVD) – is associated with diseases such as diabetes and can result in damage to the eyes, the kidneys and the nerves. Conversely, more recent studies show that our lifestyle also has an effect on the microcirculation – for example, it can be adversely affected by obesity and lack of exercise. Against this scientific background, our objective is to standardize methods of measuring MVD and to establish and further develop new diagnostic and therapeutic procedures.

This booklet explains the importance of properly-functioning microcirculation, without going into too much scientific detail. It will show you that if we pay more attention to the microcirculation, it can contribute to the prevention, early detection and effective treatment of many diseases. With this in mind, I hope you find it stimulating reading!

Associate Prof. Dr. Alfons J.H.M. Houben

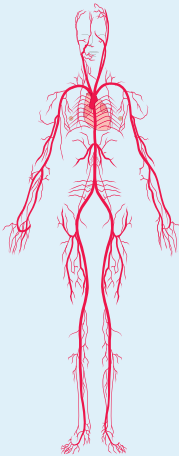


Dr. Alfons J. H. M. Houben,
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OUR BLOOD CIRCULATION

Our hearts pump between 4 and 6 litres of blood per minute through our circulatory systems in a resting state. An extensive network of blood vessels ensures that the body is supplied with blood, supplying all organs and tissues of the body down the very last cell with oxygen and vital nutrients, at the same time carrying away products of metabolism and degradation.



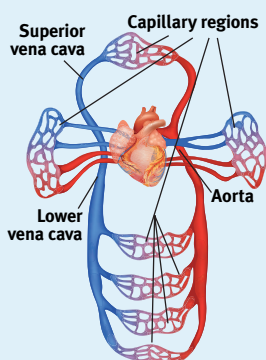
- The main artery (aorta) carries oxygen-rich blood out of the heart and through the arteries. These branch out into the smaller arterioles and further into the capillaries. The capillaries transition into the venules, which carry blood to the veins which, with every-increasing diameter, finally empty it into the superior and inferior vena cava in which it is returned to the heart.
- About 74 percent of blood circulation takes place in the very fine network of the smallest blood vessels, 11.5 per cent in the arteries and 14.5 per cent in the veins.

■ Vascular system

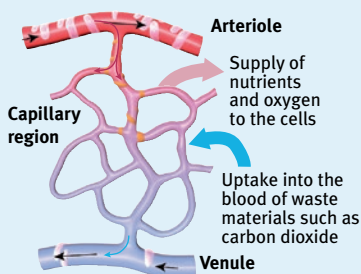
Blood vessels become more branched and smaller in size the farther away they are from the heart. Blood vessels with large diameters serve mainly to transport the blood and ensure constant blood flow, whereas the small vessels – also referred to as **microvessels** – supply needed substances to the cells of the body and carry away the products of metabolism and degradation.

Microvessels include arterioles, capillaries and venules (see Figure). The capillaries are the vessels of our body in which

CAPILLARY NETWORK AND MICROCIRCULATION



- Capillaries through the entire body.



- In contrast to larger blood vessels, capillaries have a thin vascular wall that is permeable to certain substances. This characteristic facilitates substance exchange between blood and body tissues in the capillary region.
- Together with arterioles and venules, capillaries form the microvascular network in which microcirculation takes place.

gases and other substances are exchanged. They form a netlike structure, the so-called **capillary region**. When the blood, arriving from the larger arterioles, is distributed in the capillary region among the many capillary vessels, blood pressure drops and the blood flow rate is considerably slowed.

Gases and other substances can then be exchanged through thin, semi-permeable vascular walls of the capillaries between the blood and the surrounding tissues. The blood then flows on into the postcapillary venules into which the capillary region transitions. Blood pressure and flow rate then rise again as the blood moves into the ever larger branches of the venous system and is finally returned to the heart.

Movement of the blood in the vessels is known as **blood flow**. The blood flow in the blood vessels with diameters of less than 0.1 millimetre is known in the medical field as **microcirculation**.

■ Regulation of blood flow

The flow characteristics of the blood follow the laws of physics, with influences coming from a variety of factors. Crucial roles are played by blood pressure, vascular diameter, vascular resistance and blood thickness (viscosity).

Our body has a variety of control mechanisms for the individual factors so as to keep the various organs and body segments supplied with blood according to their fluctuating performance requirements. For example, when we are engaged in sporting activities, our musculature temporarily demands a higher supply volume, i.e. more blood must flow into the microcirculation there.

The arterioles contribute decisively to blood flow regulation. When the vascular musculature contracts and relaxes this changes the vascular cross-section (lumen), thus determining the blood pressure and flow rate in the capillary region. If more blood supply is needed, e.g. due to an increased performance load, the blood pressure and flow rate in the capillary region should be as low as possible.

REGULATION OF BLOOD FLOW

Blood flow regulation may vary from one vascular segment to another. There are numerous control mechanisms, both centralized and local.

The signal to change the vascular lumen width may originate from vascular nerves, hormones or due to local mechanical effects of muscle contraction (autoregulation).

IMPORTANCE OF MICROCIRCULATION

The importance of fully functional blood flow in preserving our health is obvious. Unreliable microcirculation at one location impairs the substance exchange between blood and tissue there. This means the surrounding cells may not be sufficiently supplied with oxygen and nutrients and that products of metabolism and degradation are not being removed. This affects the function and performance of these body cells and the organ systems they are part of. It is therefore justified to state that the functional status of an organ system is determined to a large extent by the functional status of its microcirculation.

■ Causes of impaired microcirculation

Several factors can affect our blood circulation. The condition of the blood vessels plays a crucial role. Ideally, the vessels are free of deposits, flexible and elastic. In many persons, however, pathological or aging processes have resulted in deposition of so-called plaques on the interior walls of the vessels. This leads to a gradual hardening and narrowing of the vessels. The medical term for this arterial calcification is [arteriosclerosis](#).

The main risk factors for arteriosclerosis are poor diet and lack of exercise, overweight, smoking, high blood pressure and stress. Because lifestyle is



Participating in sporting activities can prevent arteriosclerosis. Regular exercise lowers blood pressure, improves fat metabolism, helps reduce overweight and the risk of diabetes.

a major contributor to its development, arteriosclerosis is known as a so-called diseases of civilization. Another factor is age. From about the age of 40, the blood vessels begin to show signs of deterioration. The tissue becomes hard and brittle. Arteriosclerosis is observed in almost all elderly persons.

VASCULAR DISORDERS: ANGIOPATHY

Angiopathy is the general medical term for vascular diseases. It usually refers to damage to the arteries and arterioles. If the smallest blood vessels, arterioles and capillaries, are affected, one speaks of a **microangiopathy**, whereas damage to the larger arteries constitute a **macroangiopathy**. Arteriosclerosis is the most frequent cause of angiopathy.

Many other diseases, e.g. metabolic disorders such as diabetes mellitus, fat metabolism disorders, cardiovascular and vascular disorders, may result in vascular damage and thus in circulatory disorders in the smallest vessels. In addition, such impairments can also occur as a side effect of treatments with medical drugs.

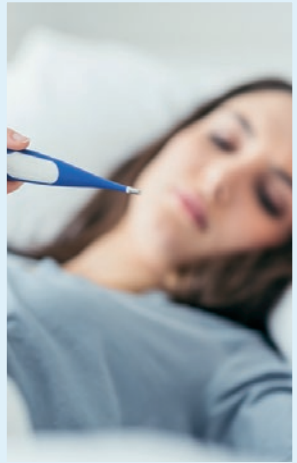
■ Health effects of impaired microcirculation

We are repeatedly warned of the effects of arteriosclerosis and circulatory disorders in the larger vessels: the threat of heart attacks and strokes. However, we are for the most part far less well informed regarding the effects of impaired blood flow in the smallest blood vessels. It therefore never occurs to many patients that their symptoms and physical impairments might be due to microcirculatory disorders.

The relevant changes are gradual and often remain unnoticed for a long period of time. The initial symptoms are

listlessness and lack of drive due to insufficient energy supply to the cells. The muscles do not regenerate as quickly following physical exertion and the immune system is weakened, increasing susceptibility to certain diseases and slowing down the healing process. Finally, impaired microcirculation can lead to acute and chronic diseases and loss of function of the affected tissues and organs.

The following chapter explains the relationships between impaired microcirculation and specific clinical pictures as well as the relevant therapeutic approaches.



Impairment of the microcirculation makes us particularly susceptible to diseases and infections and slows recovery.

CONSEQUENCES OF IMPAIRED MICROCIRCULATION

- Persistently low cellular energy levels lead to a weakening of general physical and mental performance.
- The immune system is weakened, increasing susceptibility to infections.
- Depending on which tissue is affected, organ dysfunction and chronic organ disorders with further complications may result.
- In the presence of existing diseases, the course of illness may be exacerbated.
- Regeneration and healing processes are slowed. Among other things, persistent wound healing disorders may develop.
- The limit threshold for all forms of stress is lowered. Negative effects of stress on physical and mental health can develop more rapidly.

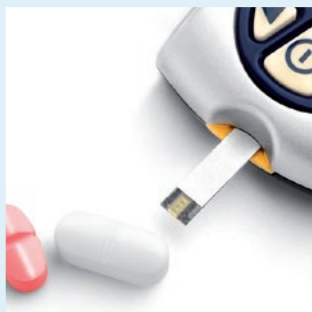
DISEASES AND PROBLEMS ASSOCIATED WITH IMPAIRED MICROCIRCULATION

■ Metabolic diseases such as diabetes mellitus

Diabetes mellitus is a disorder of sugar metabolism. The blood sugar level is regulated mainly by the hormone insulin. If the amount of insulin produced is insufficient (type 1 diabetes), or if the effect of insulin is reduced (type 2 diabetes), blood sugar levels are chronically elevated. After some time, this results in significant damage to blood vessels. The term used for this is therefore diabetic angiopathy. If larger blood vessels are affected, the risk of heart attack and stroke is increased. The microvascular changes caused by diabetes can also cause serious complications.

• Impaired microcirculation in patients with diabetes mellitus

Among the most feared long-term consequences of diabetic angiopathy are damage to the eyes (diabetic retinopathy), the kidneys (diabetic nephropathy) and the nerves (diabetic neuropathy).



About 10% of the world population suffer from diabetes mellitus. The main cause is an unhealthy lifestyle: improper diet, overweight and lack of exercise.

Diabetic retinopathy is the main cause of blindness in middle age in Germany and other industrialized countries. The retina is supplied with nutrients and oxygen through very fine microvessels. Over time, diabetes can damage the microvessels so that this supply is no longer sufficient. Affected persons at first see everything blurred, as though

through a veil. In advanced stages, pronounced vision disorders and even blindness may develop.

According to estimates by the German Diabetes Society, 20 to 40 percent of diabetics suffer kidney damage in the course of their disease. One of the tasks of the kidneys is to filter toxins and waste products out of the blood so they can be excreted in the urine. This work is done via tiny blood vessels in the renal corpuscles. Persistently high blood sugar levels damage these microvessels.

As a result, the filtering capacity of the kidney is reduced and the body is no longer sufficiently detoxified. If left untreated, this can lead to chronic renal failure so that renal functions must be replaced by dialysis or a kidney transplant.

Approximately 30 percent of diabetes patients suffer nerve damage. One cause of this is impaired nerve cell metabolism due to high blood sugar levels. Another factor is reduced oxygen supply to the nerve cells due to the damaged microvessels supplying them. The most evident consequences are abnormal sensations like tingling, burning pain or numbness, especially in the hands and feet. In addition, tactile and temperature sensations, as well as pain perception,

LONG-TERM DAMAGE RESULTING FROM IMPAIRED MICROCIRCULATION IN PATIENTS WITH DIABETES MELLITUS

- Damage to eyes (diabetic retinopathy) with vision impairments
- Damage to renal function (diabetic nephropathy), possibly mandatory dialysis
- Nerve damage (diabetic neuropathy) with abnormal sensations and impaired pain perception
- Impaired wound healing (diabetic foot syndrome)

may be reduced. This latter factor favours the development of diabetic foot syndrome since wounds are not noticed in early stages and - also due to impaired microcirculation – heal poorly.

■ Wound healing disorders

A healthy body can renew or replace injured tissues and close wounds. A wound that still shows no healing tendency after about four weeks is considered to be a chronic wound.

• Impaired microcirculation in wound healing disorders

For the natural healing process to proceed smoothly, the damaged tissue must be amply supplied with nutrients and oxygen. Circulatory disorders, especially in the small blood vessels, delay and hinder the healing process. Chronic wounds are often the result of a lack of blood supply in patients with diabetes mellitus, diseases of the blood vessels or pressure sores (decubitus) in bedridden patients.



Impaired wound healing often involves several factors. Blood vessel and nerve damage, e.g. caused by diabetes mellitus, are among the most common causes of wound healing disorder.

■ Peripheral arterial occlusive disease (PAOD)

Peripheral arterial occlusive disease affects the larger blood vessels that supply our extremities. In most cases the legs are affected, less frequently the arms. The cause is arteriosclerosis, which leads to narrowing of the vessels (vasoconstriction).

• Impaired microcirculation in PAOD

Due to the vasoconstriction, blood supply to the muscles is reduced. The microcirculation in the muscle tissue is no longer able to supply the cells optimally. When the muscles are stressed, e.g. when walking, the oxygen supply is eventually insufficient. The undersupplied leg becomes weak and hurts. In later stages, the pain occurs even on very short walks as well as at rest.



In the early stages of the disease, treatment consists of special supportive training and targeted exercises. Joining a vascular sports group with training under expert supervision is the best option.

■ Delayed regeneration, weakened immune system

After any physical effort, including disease and injuries as well as after physical activity and mental work, our body requires a recovery phase. Both metabolism and reaction processes change under such stress. The supply requirements of the stressed body cells increase – more nutrients and oxygen are needed. At the same time, more metabolic products are produced that need to be removed. The subsequent regeneration period is used to replenish the store of nutrients and recover metabolic balance.



In order to stay strong and healthy, energy reserves must be replenished following physical or mental exertion.

• Importance of microcirculation for regeneration

The most important part of supplying the cells and removing waste products takes place via the microvessels. Consequently, microcirculation disorders affect the process of regeneration.

This means that supply to the affected tissue cells is delayed or cannot meet requirements. In the long term, this means a downturn in overall performance capability. The body needs more time to recover after exertions, we recover more slowly, feel exhausted more quickly and are more susceptible to illnesses.

■ Measures to improve vascular health

Stimulating impaired microcirculation is one thing. It is equally important to counteract the factors that caused the disorder in the first place.

In addition to consistent treatment of the underlying disease (e.g. diabetes mellitus, high blood pressure, high cholesterol levels), patients should reconsider lifestyles and dietary habits and exclude harmful influences as far as possible. This includes giving up smoking as well as weight reduction in many cases.

Those who then eat a balanced diet, exercise regularly and make an attempt to reduce stress contribute a great deal to protection of vascular health and overall therapeutic success.

■ Improvement of microcirculation

The impact of microcirculation on the diseases described above and a number of others supports this therapeutic approach: Targeted stimulation of microcirculation in order to increase blood circulation in the smallest vessels and thus improve substance exchange between blood and cells.

Blood flow in the larger vessels can be regulated to some extent with the help of medications that control the widening and narrowing of blood vessels by way of nerve impulses and chemical



Every single cigarette damages the vascular walls and encourages arteriosclerosis.

HOW TO PROMOTE VASCULAR HEALTH

- Smokers should definitely quit smoking! If necessary, speak to your doctor about possible ways to get rid of the smoking habit.
- Overweight patients should lose weight with a diet under medical supervision.
- Drink only small amounts of alcohol.
- Your everyday life should include exercise: Take the stairs instead of the elevator, walk or ride a bike to get somewhere as often as possible.
- Participate in sports. Light endurance sports such as walking, swimming or cycling, are ideal.
- Reduce stress and learn to relax. Make sure you get enough sleep.



Targeted stimulation of microcirculation is possible. This treatment is gaining importance as a supplement to orthodox medical treatments of many illnesses and as a way to increase physical and mental performance capability.

signals. Microvessels lack the receptors for these signals, so that medically induced regulation of the periodic vessel wall movements of small-calibre arteriole segments is not possible.

However, local mechanical stimulation of small vessels is possible with the help of **physical vascular therapy**.

• **Physical vascular therapy**

Physical vascular therapy is a biorhythmic stimulation of the blood vessels. A special, certified medical device is required that sends impulses in a precisely defined temporal sequence and generates a magnetic field. With the help of this electromagnetic field, the muscle cells in the vascular walls of the microvessels are stimulated to contract, increasing the volume of blood pumped into the capillary region.

Physical vascular therapy has been used for decades, resulting in extensive experiential data.

Many patients report an improvement in their general state of health and increased wellbeing and performance. Observational studies also confirm that physical vascular therapy provided as a supportive treatment can contribute to the success of orthodox medical treatments. This applies for instance to treatment of diabetes, wound healing disorders and peripheral arterial occlusive disease.

Also reported are success in pain therapy, improved sleeping values in patients with sleep disorders and positive support of rehabilitation and regeneration processes.

No health-threatening side effects of physical vascular therapy have come to light in all the years of its use. Nevertheless, each therapeutic application should be discussed and assessed with the treating physician since, among other things, physical vascular therapy may impact the effect of some medications.

COMPLEMENTARY MEDICINE

Complementary medicine sees itself as a complement to classic, scientifically oriented „orthodox medical practice“. The origin and the history of the vast majority of diseases is influenced by a variety of factors.

They includes, for example, genetic predisposition, diet, lifestyle, stress and environmental influences. In many cases, orthodox medical practice cannot take these sometimes highly individual factors into account. In such cases, complementary medical methods can play a supplemental and supportive role.

Examples of complementary medicine include, for example, relaxation techniques, massage, acupuncture, bioenergetic methods and homeopathy. In many cases, the effects of these procedures as experienced by patients cannot be explained with the scientific approach. This aspect is a frequent target of criticism.

However, observational and comparative studies do confirm the effectiveness of many complementary therapeutic approaches quite clearly. Such critical efficacy studies are important when it comes to uncovering any side effects or contraindications of the treatments.

As in orthodox medical practice, a risk-benefit assessment should be done before each therapy. Thus applied, complementary medicine is increasingly accepted and used in support of orthodox medical practice.



Physical vascular therapy can be used in a relaxed atmosphere in the comfort of your home.

Also, some more serious conditions require a number of medical monitoring sessions before and during the period of application.

Depending on the clinical picture, physical vascular therapy is used as a whole-body therapy for general improvement of microcirculation or locally for additional stimulation of the microvessels in the affected body regions. There are various application modules (wholebody module, seat cushion, chair, spot, pad) for these purposes.

Many physicians and therapists also provide physical vascular therapy in their practices.

In home application with one's own device, the basic therapy is initially recommended for a period of at least 6 weeks, daily mornings and evenings for 8 minutes respectively. This basic treatment can be supplemented by intensive additional treatment.

The recommended total duration of treatment depends on the severity and course of the disease, general health status and the age of the patient.

GLOSSARY

Arteriosclerosis: Pathological changes in the inner walls of the arteries.

Angiopathy (macroangiopathy/microangiopathy): Generic term for diseases of the vessels, the most common cause being arteriosclerosis. Macroangiopathy affects the larger blood vessels, microangiopathy the smaller and smallest vessels.

Blood flow: Movement of the blood in the blood vessels.

Capillaries/capillary region:

The tiniest blood vessels which, in contrast to the larger vessels, have a thin vascular wall that is permeable to certain substances. The exchange of oxygen, nutrients and metabolic waste products between tissues and the bloodstream takes place in the capillaries. The extremely thin capillaries form a finely branched network, the capillary region, which constitutes the transition between arterioles and venules.

Complementary medicine: Generic term for various therapeutic methods used in supplementation of classic, scientifically oriented orthodox medical practice.

Microcirculation: Segment of the blood circulation system located in the microvascular region.

Microvessels: Blood vessels with a diameter ≤ 0.1 mm, including arterioles, capillaries and venules.

Physical vascular therapy: A complementary medical therapy approach that aims to stimulate microcirculation by applying a specific configuration of signals adjusted to the needs of the organism.

FOR MORE INFORMATION

■ Information on physical vascular therapy



- Information from the BGV:
www.bgv-mikrozirkulation.de



- International Microvascular Net:
www.imin-org.eu



- Institute for microcirculation, Berlin/Buch:
www.institute-microcirculation.com



- ESM European Society for Microcirculation:
www2.szote.u-szeged.hu/esm/

Edition 1/2018

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Referat Presse- und Öffentlichkeitsarbeit,
Heilsbachstraße 32, 53123 Bonn

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