Dr. Randoll Institut

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Matrix Rhythm Therapy and the Lymphatic System

Background for therapists and patients

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"Systemic Medicine by cell biological regulation
based on the Matrix Concept."

Contents

Dear Reader,

the decisive importance of the lymphatic system for every aspect of health and disease has long been underestimated. Alongside the cardiovascular system and the nervous system, the lymphatic system is an essential component of the body's basic infrastructure. Its functions include removal, processing and recycling of waste materials, drainage of excess fluids, housing and transporting immune cells and serving as a key channel of communication within the immune system. The well-being of every cell in the body depends on it, directly or indirectly. Not surprisingly, chronic diseases and conditions are most frequently – if not always – associated with malfunctions of the lymphatic system.

Restoring and maintaining a well-functioning lymphatic system must be a priority in any strategy for the treatment of chronic illnesses. Here the Matrix Rhythm Therapy provides one of the most powerful tools. Why? The effectiveness of the Matrix Rhythm Therapy depends on a number of factors which act at different levels of the organism, in a symbiotic fashion. To understand them it is first necessary to get a deeper, process-oriented grasp of the lymphatic system itself.

With best wishes

Dr. Ulrich G. Randoll

President and Chief Scientific Officer of the Institute

P. S. On the last inner page you can find a copy template for requesting more information.

Life is a flow: the organization of the lymphatic system

The lymphatic system is a wide-reaching network consisting of vessels and nodes, which absorbs or sucks fluid (lymph) from the tissues of the body, collects, filters and processes it, and channels the processed fluid back into the blood circulation (Fig. 1A). The amount of lymph transported daily through the lymphatic system is quite small compared with the blood flow through the circulatory system. Approximately 3 liters of lymph are drained from the body's tissues every day, corresponding to about 0.04% of the total volume of blood pumped through the heart (approx. 8000 liters daily). Nevertheless, the transport and processing of lymph is vitally important for the organism.

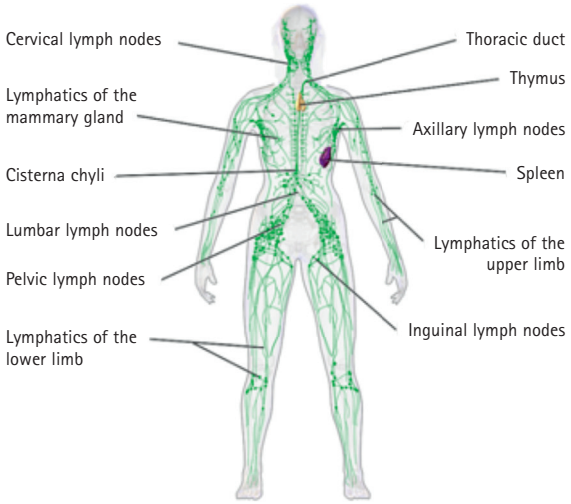

Fig. 1 A: adult lymphatic system

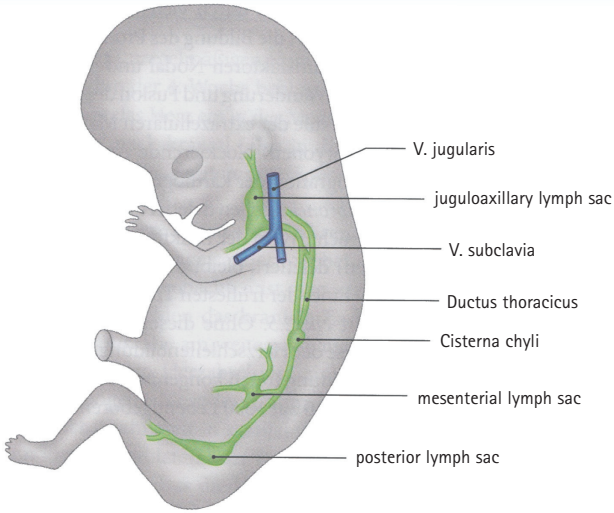

Fig. 1 B: early development of the lymphatic system in embryogenesis

The beginnings of the lymphatic network emerge early in the development of the embryo (Fig. 1B). Three or four weeks after the formation of the first blood vessels, the system of lymph vessels begin to develop, in the form of lymph sacks sprouting from neighboring veins. In turn, lymph vessels sprout out from the lymph sacks. As they grow and spread, the lymph vessels tend to follow the branching pattern of the arteries and veins. While the basic network is in place at birth, it continues to develop up into puberty, and the formation of new, microscopic lymphatic capillaries (lymphangiogenesis) can occur at any age.

The lymph nodes, formed at various intervals along the lymph vessels, are not distributed uniformly, but mainly concentrated in certain locations. The regional lymph nodes in these locations receive lymph fluid from an entire region of the body or from one or more organs.

The lymphatic system is constructed in a very sophisticated way, and it is worth examining its structure more closely. The main components of the system are the following:

- lymphatic capillaries
- lymph collecting vessels
- lymph nodes
- pre- and postnodal lymph vessels supplying lymph nodes and transporting "processed" lymph fluid further along the system
- lymphatic trunks (trunci lymphatici).

The so-called "glymphatic system" in the brain is a unique, highly-specialized component of the lymphatic system. Its structure, which is very different from the rest of the system, will be described later below.

First some details concerning the components listed above:

The **lymphatic capillaries** form a dense network in the connective tissue of the body (Fig. 2A-B), drawing fluid from the regions between the cells (commonly referred to as the interstitial space, interstitium or extracellular matrix). Fluid which has passed into the lymphatic system via the capillaries is called lymph fluid, and one speaks of **lymph formation**. Although the lymph fluid originates as interstitial fluid, its composition changes as it flows through the system and is processed in the lymph nodes (see below).

The lymphatic capillaries are tethered to the surrounding tissue by radial collagen fibers and elastic fibers. The capillaries begin in loose connective tissue as blind-ended, finger-shaped protrusions called lymphatic saccules (Fig. 2C). The walls of the lymphatic capillaries are formed by a layer of extremely thin endothelial cells. Fine collagen fibers, the so-called anchor filaments, extend from the edges of these cells, tying them to the surrounding connective tissue. The edges of adjacent cells overlap in such a way, that they are able to

bend or flap in an inward direction. This creates slit-shaped openings through which protein-rich fluid can flow into the lymphatic capillaries from the surrounding interstitial space. When the inside pressure increases, the endothelial cells are pressed onto each other, thereby closing the openings and preventing fluid from flowing back into the interstitium.

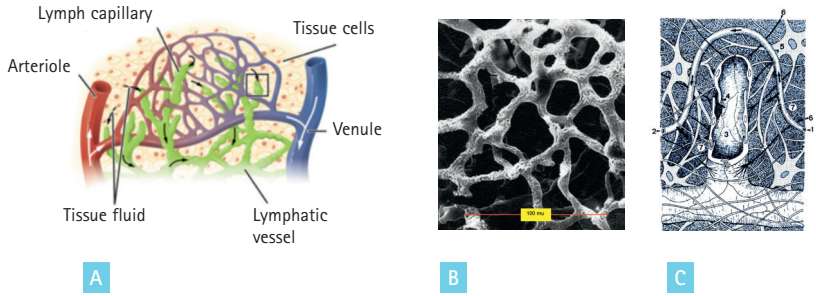

Fig. 2 A: scheme of lymphatic and blood circulation in the interstitium. B: micrograph of lymph capillary network. C: endings (saccules) of the lymphatic network (1. arterial arm of the capillary circulation; 2. venous arm of the capillary circulation; 3. lymphatic capillary; 4. lymphatic saccule with valve-like openings between overlapping cells; 5. fibrocytes; 6. anchoring filaments; 7. the interstitial space.)

This valve-like mechanism insures that successive compressions and expansions of the surrounding tissue exert a pumping effect: fluid is pumped from the intercellular space into the lymphatic capillaries.

The lymphatic capillaries feed into **collecting vessels**, which are the next larger vessels in the system. A given collecting vessel will generally gather lymph from a large number of capillaries. The walls of the collecting vessels are equipped with basal membranes and contractile elements (smooth muscle tissue). Their wall structure resembles that of small veins, but the walls are thinner and the interior space (lumen) is larger. In order to ensure a one-way flow of lymph, the lymph collectors are also equipped with valves,

located at intervals along their length. The unit formed by a pair of successive valves and the vessel segment between them is known as a **lymphangion** (Fig. 3). The lymphangions are the functional subunits of the lymphatic collectors.

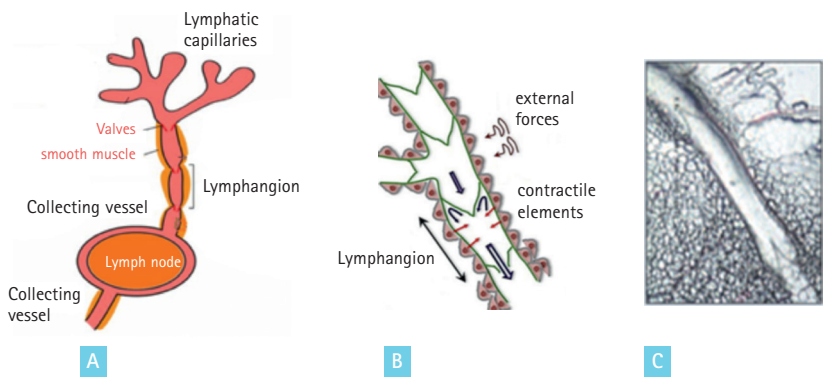

Fig. 3 A: components of lymphatic network. B: lymphangion, with valves and contractile elements. Lymph pumping results both from active contraction and from external forces. C: intervital micrograph of a lymphangion.

Each lymphagion pulsates, contracting and expanding in a rhythmic fashion, through a synchronization of the contractile elements in its walls. The pressure of each contraction causes the valve at the front end of the lymphangion to open and the valve at the back end to close, thereby propelling lymph in the forward direction. Normally the pulsations of the lymphagions along a given collecting vessel occur in a more or less coordinated manner, creating an effect somewhat similar to the peristaltic waves of the gastrointestinal tract. The result is to actively transport lymph through the collecting vessels and the interspersed lymph nodes, in the direction of the venous angles (see below). The pumping action of the lymphangions is crucial for an adequate drainage of lymph from each tissue region of the body.

The **lymph nodes**, located along the lymphatic network, are the processing organs of the system. They are distributed in a non-uniform manner, with high concentrations in certain specific regions. Basically no lymph fluid leaves any part of the body without having passed through at least one lymph node. The human body has roughly 500 lymph nodes, many of which form interconnected clusters. In the lymph nodes waste substances and particles (proteins, fat, dead blood cells), drained from tissue, are filtered out or broken down. Part of the lymph fluid is absorbed by a specially-organized network of blood capillaries in the nodes, with the rest moving further along the system. After passing through the network of regional lymph nodes, the remaining lymph fluid is carried through ever wider lymph vessels into the lymphatic trunks and from there into the general circulation.

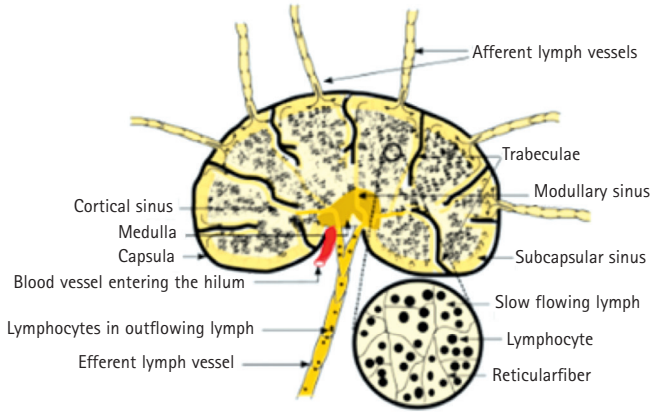

Fig. 4: structure of a lymph node

The **lymphatic trunks** (trunci lymphatici) are formed by the joining-together of large lymph vessels. They run parallel to the blood vessels and feed into one of the two lymph ducts, the thoracic duct (ductus thoracicus) or the right lymphatic duct (ductus lymphaticus

dexter) (Fig. 5A). These two main branches of the lymphatic network run along the left and the right venous angles (angulus venosus) to the vena cava superior, which begins at the juncture of the two veins carrying venous blood from the upper body, and carries that blood to the right atrium of the heart (Fig. 5B). At the vena cava superior the lymph fluid, having been processed in the network of lymph nodes, is channeled back into the circulatory system.

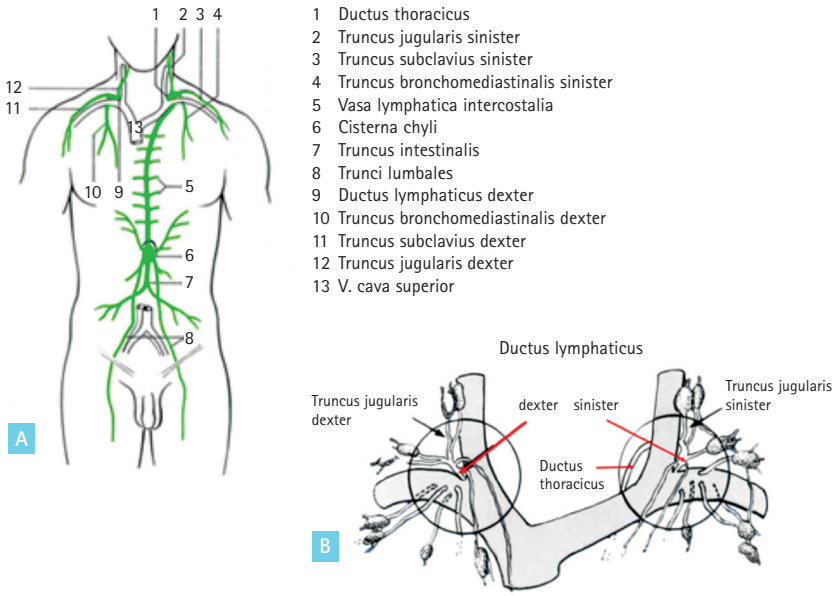

Fig. 5 A: lymphatic trucks and ducts B: left and right lymphatic ducts, where processed lymph enters the bloodstream.

One should not think of the lymphatic network as something completely fixed, especially on the microscopic level. Over time, new lymph capillaries and lymph vessels can form (lymphangiogenesis). This often occurs in connection with inflammation, injuries, surgeries and various diseases, including cancer.

The glymphatic system

For a long time it was thought that the brain had no lymphatic system, and that the removal of cellular waste products was somehow accomplished by processes of diffusion. In fact, the typical morphology of lymphatic capillaries, vessels and nodes seemed to be entirely lacking. But how could the brain, a sensitive organ with a high metabolic rate, be able to function without a well-developed lymphatic system? After a history of intensive investigations, in 2011-2013 a research group at the University of Rochester, USA, discovered what they called the **glymphatic system** (Fig. 6). This remarkable structure carries out the functions of a lymphatic system for the brain, and is connected with the lymphatic network of the rest of the body. The name "glymphatic system" was suggested by the special role played by glial cells, which constitute the second major cell group in the brain, in addition to neurons.

The glymphatic system is based on the channeling of fluid through the so-called paravascular spaces (sometimes referred to as Virchow-Robin spaces, although the terminology is sometimes inconsistent). These spaces exist due to the fact, that the blood vessels in the brain are densely surrounded by flat protrusions or "end feet" of glial cells. The specific glial cells involved are the astrocytes, which are present only in the central nervous system (CNS) and support the network of neurons in many ways. Indeed, a unique feature of the CNS vasculature is that all arterioles, capillaries, and venules within its functional tissue (the parenchyma) are enclosed by astrocytic end-feet. A tiny gap separates the outer wall of each blood vessel from the surrounding layer of these astrocyte end-feet, thereby creating a cylindrical channel which runs along the length of the vessel. The paravascular channels are largely free from obstructions and form an interconnected network extending throughout the CNS.

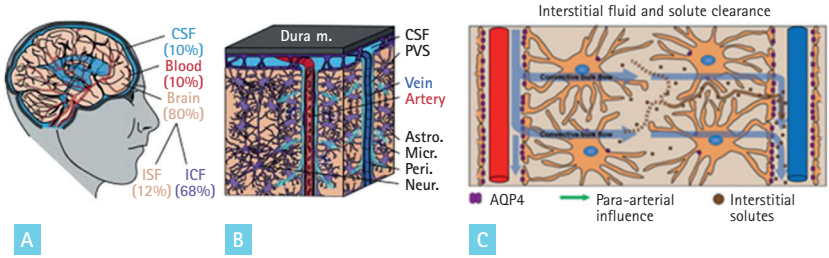

Fig. 6 The glymphatic system A: Fluid compartments of the brain. CSF = cerebrospinal fluid, ISF = interstitial fluid, ICF = intracellular fluid. B: Entry of CSF from the subarachnoid space via the para-arterial channels. C: flow of fluid through the intercellular space, from the para-arterial channel to the para-venous channel. The fluid passes through the AQP4 channels in the astrocyte feet which form the outer boundary of the paravascular spaces.

The glymphatic system appears to operate in the following way. Cerebrospinal fluid (CSF), produced in the ventricles of the brain, flows into the network of paravascular channels surrounding the brain's arteries (the **para-arterial channels**). The feet of the astrocytes forming the outer boundary of the paravascular spaces, are equipped with special structures – the so-called AQP4 water channels – which permit the fluid, as it flows through the para-arterial spaces, to gradually escape into the surrounding tissue, becoming part of the interstitial fluid. Simultaneously, fluid is constantly being drained away from brain tissue via a second, para-venous pathway. Passing through the astrocyte sheaths, it enters the network of para-venous channels which run along the veins carrying venous blood from the brain to the heart. At the point these veins arrive at the neck, the fluid drains into the vessels of the normal lymphatic system, is processed and finally returned to the bloodstream. According to present models, these fluid flows are driven by arterial pulsations which effectively pump CSF into the para-arterial channels, through the brain tissue and into the para-venous channels. Recent studies indicate that the cervical lymph nodes are a key intermediate destination and processing center for the "brain lymph".

Lymphatic organs

In addition to the lymphatic network just described, the bone marrow, thymus, spleen, appendix, and tonsils are commonly characterized as lymphatic or lymphoid organs and included within the term, “lymphatic system” in an extended sense. For their functions the reader is referred to the standard literature. Insofar as these organs are not directly involved in the transport and processing of lymph fluid – the main focus of this text – they will not be dealt with here, except to remark that the functions of the lymphatic network and the above-mentioned organs are highly interconnected. This applies above all to their roles in the immune system. As discussed below, the lymphatic network serves as a key transport system, reservoir and “information highway” for the immune system’s main players – the lymphocytes –, whose growth and maturation takes place mainly in the bone marrow and the thymus gland. It is also worth noting the complementary relationship between the spleen and the lymph nodes: the former filters blood, while the latter filter lymph fluid. They also have structural similarities.

After this brief overview of the structure of the lymphatic system, including its glymphatic branch, it is time to take a closer look at its essential functions in the body. Why does the lymphatic system play such a decisive role in medicine?

Maintaining the quality of the cellular environment

As Claude Bernard and Rudolf Virchow emphasized long ago, the health of cells and tissues depend on the quality of their surroundings in the body. Claude Bernard spoke of the "internal environment" and Rudolf Virchow spoke of the "cell territory", i.e. the region immediately surrounding the cell, which is occupied by the so-called extracellular matrix. Virchow made the important observation, that diseases often begin **first** with pathological changes in the cell territories, and only later manifest themselves in the cells.

In textbooks one often reads that the main function of the lymphatic system is to maintain a constant fluid balance (homeostasis) in tissue, by draining off excess fluid arising from the difference between the amount of fluid diffusing out from the arterial capillaries, and that which is reabsorbed through the venous capillaries. Thereby the lymphatic system acts as a "flood control" mechanism, counteracting the tendency for fluid to build up in tissue (oedema). **But the other functions of the lymphatic system are in some ways even more essential for the health of the organism!** Apart from its key role in the adaptive immune response (see below), the lymphatic system is the body's main instrument for removing, filtering and recycling cellular waste products which would otherwise accumulate in its tissues. Together with the circulatory system it provides essential "logistics" for maintaining healthy cells.

Strangely enough, the role of the lymphatic system as a "waste disposal system" has received relatively little attention in medical research and practice, compared to its other functions. Major disturbances of the fluid balance (lymphedema) in some part of the body, are relatively easy to diagnose; but a systemic weakening of the lymphatic system's waste disposal function – which often occurs

without manifest lymphedema – is much more insidious, and can have devastating effects on the organism. Inadequate waste disposal can lead to a great variety of symptoms, including symptoms that are not commonly attributed to a malfunction of the lymphatic system. Failure to recognize this fact is one reason why conventional treatments for chronic diseases so often fail to produce the desired results.

Prof. Nole McHale, one of the pioneers in the study of the lymphatic system, characterized the situation quite aptly as follows:

"A system which normally works efficiently in the performance of vital tasks for the well-being of the body is often considered to be of minor importance if the consequences of its failure are not dramatic or immediately apparent. ... The lymphatic system has certainly been viewed in such a light since its malfunction may go unnoticed except in such extreme cases as the grotesque swelling resulting from chronic lymphatic insufficiency in lymphoedema or when the lymphatics are chronically blocked ... Impaired lymphatic drainage may, however, contribute more to the malfunction of many organs than has previously been acknowledged. Thus a normally functioning lymphatic system is an essential part of the body's defence and healing mechanisms. An obvious example of this is the increased susceptibility to infection that one finds in lymphedema but there are also more subtle examples where impaired lymphatic function can delay recovery from insult or contribute to a downward spiral towards organ failure."
(Nervous control of the lymphatic system, Vascular Medicine Review 1993)

Waste disposal and recycling

It is important to understand the scope of the waste problem which confronts the human organism. Like an industrial city, the body must constantly deal with the danger of "environmental pollution" of the intercellular medium (Virchow's "cell territories").

All cells secrete a variety of metabolic products into their surroundings. Many of these can become harmful if they are allowed to accumulate beyond a certain level. One general effect is a shift in pH, mostly in the acidic direction. A well-known case is fatigue and pain caused by buildups of lactate, which is released by muscle cells as a byproduct of anaerobic respiration. Toxic materials are produced by bacteria, including both "resident" bacteria (e.g. in the digestive system) as well as invading bacteria. A great deal of more or less insoluble "trash" accumulates in tissue, which must be cleared away: fragments of dead cells, damaged macromolecules, fibrous material from the extracellular matrix etc. Most of the garbage material is too large to pass through the walls of the blood capillaries, leaving the lymphatic system as practically the only means to remove it from tissue.

In this context, one should bear in mind that depending on the type of tissue, there is more or less a constant turnover of cells, with cells dying out and being replaced. Cells are damaged and die in the course of normal "wear and tear", for example in layers of the skin or in muscle; while others undergo apoptosis, dismantling themselves in a programmed manner. Large amounts of trash are generated when invading bacteria are killed off by the immune system, through phagocytosis by macrophages in situ or through the effects of anti-bacterial antibodies.

A further aspect to be kept in mind is the process of **aging** of tissue, which is closely associated with growing accumulations of fibrous material – especially collagen – in the extracellular space. While not

fully understood, this process evidently involves some combination of an increased net production of fiber-forming material (e.g. by fibroblast cells), and an inability of the lymphatic system to remove this material at a sufficient rate. Not surprisingly, promoting lymph drainage is the focus of many “anti-aging” therapies.

Typically, the derailing of normal lymphatic function involves a vicious circle: lymph drainage becomes increasingly hampered by the fibrotic/sclerotic clogging-up of tissue, leading to even greater accumulation of fiber, proteins and other “trash” in the intercellular space, which degrades lymphatic function even more. Breaking this vicious circle is essential to any effective therapy.

“Flood control”

Excessive accumulation of fluid, commonly manifested as edema, constitute one of the “environmental catastrophes” which can threaten various regions in the body. Fluid constantly diffuses through the walls of the arterial capillaries into the intercellular space, and from the intercellular region back into the venous capillaries as well as the lymphatic capillaries. As noted above, under normal conditions the percentage of fluid entering the lymphatic capillaries is very small. However, in case the flow of fluid back into the venous capillaries is reduced or blocked for whatever reason, the lymphatic system can greatly increase its transport capacity, if necessary by up to 15-20 times (see below). Thereby, swelling can be prevented and the fluid balance in the intercellular space maintained within healthy limits. The precondition, however, is a proper functioning lymphatic system. Chronic edema is practically always a symptom of lymphatic malfunction, which is why it is commonly referred to as “lymphedema”.

Filtering, sorting and reprocessing of materials in the lymph nodes

Apart from their role in the immune system, described below, the lymph nodes function as "waste treatment plants". They have the task of filtering, breaking down and recycling the material which is pumped in from tissues in the form of lymph. Without some sort of processing in the lymph nodes, the waste and garbage collected by the lymphatic system would simply be dumped back into the bloodstream. On the other hand, this noxious material cannot be allowed to accumulate in the lymph nodes. It must somehow be transformed into a mixture of substances which can suitably be released into the circulatory system. Having entered the bloodstream, part of the processed material will be absorbed and utilized by tissues and organs, some undergoes further processing by the blood-filtering organs (e.g. the liver and spleen), and the rest is eliminated from the body via the kidneys.

In this context the lymph nodes must operate **selectively**: mixed together with the cellular waste and garbage, the lymph entering the lymph nodes also contains enzymes, antibodies and other molecules released by tissue cells, which have important functions in the body. Somehow these valuable materials must be allowed to pass into the general circulation without being broken down or damaged.

How exactly is this complex task accomplished? Present-day knowledge is far from complete, but for sure a great deal of the work is accomplished by specialized cells – phagocytes – through the process of **phagocytosis**: these cells can engulf nearby objects, ingest them and chemically break them down by suitable enzymes and oxidants (Fig. 7). After more or less complicated chemical transformations and extraction of useful materials, the end-products of phagocytosis are finally excreted by the cell. Many cell types fall under the

category of phagocytes, including above all macrophages, dendritic cells, neutrophils, monocytes, and mast cells. These are often called "professional phagocytes" because many other cells in the body are capable of phagocytic activity in varying degrees. One should also bear in mind that cells change their (pheno)type repeatedly in the course of their lifetimes.

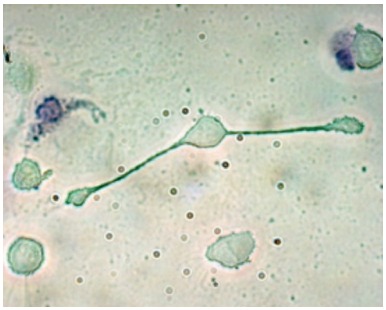

Fig. 7: Macrophage of a mouse, reaching out to engulf foreign particles

Importantly, phagocytes operate in a selective way, utilizing their chemical and physical sensing abilities. Today most attention is paid to the "lock-and-key" model according to which phagocytosis is triggered when proteins (antigens) belonging to an outside object bind to receptor molecules located on the phagocyte's cell membrane. But there is no doubt that cells also have other ways to "feel" objects in their environment, for example via changes in electric charge distributions.

The lymph nodes are sites of intensive phagocytic activity, apparently mostly carried out by macrophages and to a certain extent by dendritic cells. The capability to selectively phagocytize practically anything – from macromolecules, viruses and other inorganic foreign particles all the way to entire cells – permits macrophages to carry

out both immune functions and “waste disposal” functions at the same time. In fact, these functions are closely related. Exposure to lymph flows allows the macrophages and dendritic cells to identify and/or destroy organisms and antigens of foreign origin alongside the trash and waste from the body’s own tissue.

In addition to a large resident population of phagocytic cells, the lymph nodes are also stopping-points for macrophages and other immune system cells during their travel through the lymphatic network. Macrophages are present throughout the body, where they carry out immune and “waste disposal” functions in situ. They frequently migrate from tissue into the lymph nodes, carrying antigens which are presented to specialized immune cells as a necessary step in the formation of the so-called adaptive immune response (see below).

Naturally, all of these functions depend upon maintaining an adequate flow of lymph fluid through the system. When the pumping mechanisms fail, or the lymphatic flow is blocked at the level of tissue and capillaries, this weakens the immune response and can cause tissue damage through accumulations of waste and “trash” in the extracellular matrix.

Transport network and "information highway" for the immune system

The network of lymphatic capillaries, collecting vessels and lymph nodes, with their outlets to the circulatory system, provide a means for immune cells to travel over large distances in the body. Assisted by lymphatic flow, large numbers of immune cells constantly migrate from tissues and arterial capillaries, into the network of lymphatic capillaries and collecting vessels, to the lymph nodes, where they interact with each other and with "resident" cells.

Why does this happen?

The answer lies in the fact, that the functioning of the immune system – particularly the so-called specific or adaptive immune response – necessitates the transfer of large amounts of information between immune system cells. Much of the needed information transfer occurs through direct cell-to-cell contact within the lymph nodes.

A useful summary of this process can be found in an often-cited article by the biologist Cynthia Willard-Mack, entitled "Normal Structure, Function, and Histology of Lymph Nodes" (further details can be found in textbooks on the immune system):

"When foreign antigens invade the body, antigenic material, antigen presenting cells known as dendritic cells (DCs) and inflammatory mediators generated by local immunological activity at the site of infection are all picked up by the lymphatic vessels and swept along in the flow of lymph. The system of lymphatic vessels has been called an 'information superhighway' because lymph contains a wealth of information about local inflammatory conditions in upstream drainage fields ... Lymph nodes are essentially information

marketplaces where antigen presenting cells, the body's scouts, come to display information they have gathered about antigens they have encountered in the field and patrolling lymphocytes come to look for evidence that their specific antigen has entered the body. The lobule provides the infrastructure for the marketplace and its activities. The reticular meshwork and its channels and interstices provide spaces for antigen-presenting cells (APCs) and lymphocytes to meet and mingle and a three dimensional scaffold for them to move around on. T and B cells and their respective APCs meet in separate areas. The vascular and lymphatic systems, the body's transportation systems, are intimately integrated into the lobule and provide portals for lymphocytes to enter and exit the reticular meshwork. When a lymphocyte encounters its designated antigen, clonal expansion occurs in specific areas of the lobule. This unique arrangement allows a relatively small population of lymphocytes to efficiently and effectively monitor antigens throughout the entire body..."
(Toxicologic Pathology, 34:409–424, 2006)

Lymphatic pumps and role of rhythms

For the lymphatic system to function, it requires a **pumping system** to move fluid material from the intercellular space (the extracellular matrix) into the initial lymphatic capillaries, to propel the lymph through the network of lymph vessels to and from the lymph nodes, where it is "processed", and to transport the processed lymph through the thoracic duct into the venous blood stream.

According to present knowledge the lymphatic pumping system operates via two basic mechanisms:

(A) Rhythmic contractions of smooth muscle lining the lymphatic collecting vessels and ducts (the so-called **intrinsic pump**). Lymph fluid is propelled through these vessels by rhythmic contractions of the valved lymphangions forming the vessels. These contractions generally take the form of synchronized contraction waves propagating along the chain of lymphagions which make up the lymphatic vessels, in a similar manner to the peristaltic contractions of the digestive tract. Each lymphangion has a tiny pacemaker which controls the sequence of contractions and expansions (systoles and diastoles) of the contractile tissue in its walls. The pulsation frequency is regulated by physiological factors and generally lies in the range of 6-12 pulses per minute for the body at rest.

(B) The pumping effect of compressions and expansions of the surrounding tissue, acting upon the lymphatic capillaries and vessels from the outside (**extrinsic pump**). The extrinsic pumping action is exerted mainly by (i) constant microvibrations of the skeletal musculature (see below); (ii) arterial pulsations, generated by the heart; (iii) displacement of the diaphram (breathing); (iv) body movements

during walking or other daily activity. Naturally, the relative impact of these factors differs according to tissue location and type, and depends also on the physiological state of the body.

As far as the newly-discovered glymphatic system in the brain is concerned, the main pumping mechanism appears to be the heart-driven arterial pulsations, which effectively pump cerebrospinal fluid from the para-arterial channels into the brain tissue, and push the waste-carrying fluid into the para-venous channels. Other pumping mechanisms may exist, however, that have not yet been discovered.

It is important to emphasize the fundamentally **rhythmical** character of lymphatic pumping. The only exception is the pumping effect of more or less irregular, voluntary body movements. The latter can induce much larger lymphatic flows, but for limited periods, By contrast, the "baseline" lymph fluid transport, e.g. when the body is at rest, depends entirely on rhythmical processes. The mechanisms providing continuous, rhythmic pumping of lymph flow operate in different frequency ranges. For an average adult at rest the normal ranges are:

- Lymphagion pulsation: 6–12 pulses per minute = 0.1–0.2 Hz
- Breathing: 12–16 cycles per minute = 0.2–0.26 Hz
- Arterial pulsation: 60–100 pulses per minute = 1–1.7 Hz
- Microvibrations of the skeletal musculature: 8–12 Hz

The multitude of pumping mechanisms provides various ways for the body to regulate, and if necessary increase, the volume of lymphatic flow, both on a local level and for the system as a whole.

The pumping function of the lymphangions is physiologically regulated. On the local level, an increase in the amount of lymph entering a given lymphangion exerts an expansive pressure on its walls, generating a feedback signal. On a systemic level the pumping process appears to be regulated in large part via the sympathetic

nervous system and various signalling substances. Under conditions of sympathetic or hormonal activation, the amplitude and frequency of lymphangion pulsation are increased, causing an increase in the volume of lymph pumped through the lymph vessels per unit time. When an increased pumping action of the lymphangions is combined with that of external compression forces, which are generated by body movements and act especially on the larger lymph vessels, the body can increase its total lymph flow by a factor of 15 or even 20 times compared to the rate at rest.

One should bear in mind, that the microscopic lymphatic capillaries, including the initial capillaries where lymph fluid enters the system from the tissue, lack contractile elements. Capillary lymph flows depend nearly entirely on extrinsic pumping actions. This has major implications for the functional tissues of the skeletal musculature and the other organs of the body (parenchym tissue). Generally speaking, the lymphatic network in the parenchyma tissue consists only of capillaries, while the collecting vessels, with their contracting lymphangions, are located outside.

The extrinsic pumping mechanism – made possible by the existence of one-way primary and secondary valves in the lymphatic vasculature – can be utilized for therapeutic purposes, by applying periodically varying pressure to the body from the outside. It is a well-established experimental fact that massage, even very gentle massage, accelerates the formation and drainage of lymph in the skin and superficial muscles. This method has limitations, however. For one thing, the pumping action of classical massage techniques continues only as long as the massage itself. Secondly, it does not propagate to deeper-lying tissues in the body. In both regards Matrix Rhythm Therapy proves to be much more effective (see below).

The role of microvibrations

Although hardly recognized today, there can be no doubt that the microvibrations of the skeletal musculature contribute in an essential way to the healthy functioning of the lymphatic system. These constant microscopic vibrations, caused by alternating contractions of small numbers of muscle fibers, take place on a continuous basis in the approximate frequency range of 8-12 Hz. Often referred to as the "physiological tremor", they can be thought of as a kind of trembling, like that occurring when the body is overcooled, but with a far smaller amplitude. The microvibrations are too small to be visible or felt directly, but can easily be detected everywhere on the body surface using suitable mechanical sensors (Fig. 8). Originating from the skeletal musculature, they propagate throughout the body, inducing periodic micro-extensions and compressions of body tissues. Thereby, the microvibrations exert a constant pumping action on the lymphatic capillaries. The acute pumping effect of macroscopic muscle contractions may be larger; but unlike these, the microvibrational pumping continues day and night without interruption.

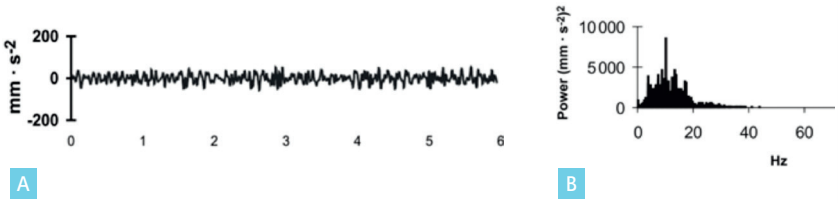

Fig. 8 A: microvibrations of the skeletal musculature, recorded from the biceps of a human subject at rest using an accelerometer. B: frequency distribution of microvibrations (McCay et al. 1998)

Apart from their direct impact on the lymphatic system, the microvibrations also play an essential role in promoting the blood microcirculation, i.e. the material exchanges between tissue cells, the capillaries and the venules of the circulatory system. The Russian physiologist N.A. Arinchin referred to the microvibrations as a "peripheral heart". They can be considered as a microscopic analog of the well-known skeletal muscle pump. The microvibrations doubtless also contribute to maintaining the elasticity, permeability and other physical properties of the extracellular matrix which is are essential to healthy cellular function. Given the piezoelectric properties of matrix proteins such as collagen, the microvibrations automatically generate alternating electric fields in tissue. Unfortunately, the impact of this bioelectrical effect has so far not been sufficiently investigated.

Matrix Rhythm Therapy is the first successful attempt to fully exploit the microvibration phenomenon for therapeutic purposes. Although the discovery of the microvibrations inspired a number of modern approaches to vibratory stimulation of tissue, these practically all utilize frequencies above the natural physiological range of 8-12 Hz.

Hardening and stiffening of tissue: enemies of the lymphatic system

Hardening of tissue is a typical symptom as well as a causal factor in many chronic illnesses. Although tissue tends to gradually lose its elasticity with increasing age, a pathophysiological stiffening of tissue can occur at any age, with serious consequences for the whole organism.

Tissue hardening and stiffening inevitably interfere with lymphatic function. The efficiency of extrinsic lymphatic pumping depends on the elasticity of the tissue surrounding the lymphatic capillaries and vessels, including especially the extracellular matrix. As tissue loses its elasticity, the strength of compression-expansion movements decreases; beyond a certain point the extrinsic pumping effect may practically cease. Often these processes manifest themselves as a swelling of tissue due to inadequate fluid drainage from the interstitial space (lymphedema) and the further classical signs of inflammation (dolor rubor, calor, function laesa, tumor), as a reaction.

Loss of tissue elasticity is frequently the result of silent inflammation, ending in fibrosis – an accumulation of fibrous material in the extracellular matrix. Such accumulations impede the flow of fluid into the initial lymphatic capillaries. Macromolecular “garbage” becomes trapped in the matrix and can no longer be removed.

Needless to say, the processes of tissue hardening and malfunctioning of the lymphatic system tend to aggravate each other.

Hardening due to contraction residues

In the case of the skeletal musculature, hardening can also come about through a buildup of **contraction residues** – muscle fibers which fail to return to a relaxed state following a contraction cycle, and remain in a chronically contracted state. This condition, which is extremely widespread in the population today, can have serious effects on the lymphatic system. In the same way as fibrosis, hardening by contraction residues impedes the flow of lymph in the muscle and surrounding tissue and reduces the efficiency of extrinsic lymphatic pumping. Among other things the buildup of contraction residues affects the microvibrational activity of the muscle's motor units, undermining its coherence and weakening its pumping effect. In addition, the muscle hardening, cramping and pain, associated with contraction residues, tends to reduce body movements in general, hampering these intermittent sources of lymphatic pumping.

Where do contraction residues come from? One of the most important, but also most frequently overlooked facts about muscle physiology is that **muscle relaxation is an energy-consuming process**. ATP is required in order for a muscle fiber to convert from the contracted to the relaxed state. This fact runs contrary the intuitive idea, that it is the contraction phase which consumes energy from the muscle cells. In reality, contraction releases energy which was stored up in the relaxed state, in the form of bonded ATP. ATP can be called the "muscle softener".

This fact is reflected, among other things, in the phenomenon of rigor mortis: the hardening of the musculature following death, which occurs when the cut-off of oxygen supply to muscle cells causes the production of ATP to cease, and existing stocks of ATP are broken down and exhausted.

The same type of phenomenon occurs in everyday life, albeit in a much milder form, when muscle fibers receive too little oxygen (hypoxia) and/or nutrients. This can occur for various reasons, including extreme, sustained exertion, or poor microcirculation, leading to a slowdown in the transport of oxygen and nutrients from the blood capillaries to the cells. Lack of oxygen causes the muscle cells to switch to an anaerobic pathway of ATP production, which is much less efficient than the aerobic (respiratory) pathway. In addition, the products of anaerobic metabolism (especially lactate) tend to accumulate, leading to acidosis. Inadequate supply of nutrients causes a further drop in ATP production. Without ATP, muscle fibers remain in a contracted state, and muscle tissue hardens. Here one should bear in mind that normal muscle function involves an alternating process, in which at any given time some groups of muscle fibers (motor units) are contracting, while others are relaxing. Insufficient ATP hinders the relaxation phase of the cycle, resulting in an increasing number of fibers which are stuck in the contracted state.

Muscle hardening through contraction residues sets off a physiological vicious circle: hardening weakens the microvibrations; decreased microvibrational pumping adversely affects the delivery of oxygen and nutrients and removal of metabolic waste by the lymphatic system; the resulting hypoxia and acidosis of muscle tissue leads to further hardening etc.

It is crucial to understand that as a rule, contraction residues cannot be resolved in a voluntary fashion. Once established, they persist even when the affected person tries to relax completely. Eliminating them requires an active intervention from outside. Muscle hardening is unfortunately widespread even among people who regularly practice meditation, deep breathing, yoga etc.

The circulo vicioso of lymphatic dysfunction

As we have pointed out several times above, disturbances of the lymphatic system nearly always involve a vicious circle. Defective lymphatic system function inevitably causes a decline in the quality of the cellular environment – the extracellular matrix – which leads directly and indirectly to a further decline in lymphatic function, and so forth. Many factors enter into this vicious circle, including physical blockage of lymph flow, decline of tissue elasticity and pumping efficiency, degenerative processes in tissues and in the lymphatic vasculature itself etc.

Evidently the highest priority of therapy must be to interrupt this vicious circle, removing the blocks to self-healing processes and opening the way to restoring normal functioning of the lymphatic system. This is a central goal of Matrix Rhythm Therapy.

The influence of the sympathovagal balance on the lymphatic system

Despite their enormous clinical importance, the mechanisms of regulation of the lymphatic system are only partially understood today. Among other things, however, research has demonstrated a strong connection between lymphatic function and the autonomic nervous system.

The lymph vessels are innervated by nerves of the autonomic nervous system, especially the sympathetic branch. As is well-known, the sympathetic branch of the autonomic nervous system orchestrates the physiological response of the organism to stress and danger (the so-called "fight or flight" mode); while the vagal or parasympathetic nervous system is dominant when the organism is in the relaxed and resting state (the "rest and digest" mode). The relative degree of activity of these two branches is generally referred to as the **sympathovagal balance**. Experiments indicate that when the sympathetic nervous system is strongly activated, as in situations of acute stress, it acts upon the musculature of the lymphangions to cause a more or less dramatic increase in the amplitude and frequency of their contractions. This reaction evidently serves the purposes, when the organism has been injured or perceives an immediate threat of injury: (1) To immediately transport antibodies, produced by cells in tissue and lymph nodes as part of the so-called innate (non-specific) immune response, into the general circulation. It should be recalled that the innate immune response is the most rapid one, constituting the first line of defense against invading pathogens. (2) To quickly transport antigens and antigen-presenting cells and other immune cells from damaged or infected tissues into the lymph nodes, as an essential step in the so-called adaptive or specific immune response.

(3) To speed up the removal of noxious materials produced in infected tissues (e.g. following injury) in the course of the battle between invading bacteria and the immune system, including fragments of dead cells and damaged matrix components, products of phagocytosis, bacterial toxins etc.

While a short-term "emergency" sympathetic stimulation of lymphatic pumping may be evolutionarily advantageous, it is no doubt harmful when maintained over a long period of time. More generally: for the body to remain healthy, any acute activation of the sympathetic nervous system must be followed by a vagal **recovery phase**, in which physiological processes can return to their optimum, balanced state. Without doubt this applies to the lymphatic and immune systems in particular.

There is clear evidence that chronic stress is harmful to the lymphatic system. Among other things, chronic sympathetic stimulation tends to disrupt the natural rhythm of the lymphangion contraction. Furthermore the sympathetic nervous system response, when triggered, restricts the blood supply to many tissues (vasoconstriction); as a result, less fluid enters the extracellular matrix via the arterial capillaries and less will be available for the formation and transport of lymph. Fluid is needed, however, to wash away the trash and waste accumulating in the intercellular space. Lack of sufficient fluid harms the ability for the lymphatic system to fulfill its waste disposal function.

Indirect evidence for the negative effect of sympathetic overactivation on the lymphatic system, comes from the well-established association between stress, immune system dysregulation and chronic disease. This is hardly surprising given the close dependency of immune system function on the lymphatic system, discussed above. In particular, inadequate lymph flow automatically interferes with the body's immune response.

From these and many other indications we can conclude that chronic activation of the sympathetic nervous system – typified by patients with stressful lifestyles – is one of the chief factors which interfere the endogenous healing processes of the body. The totality of experience and scientific evidence dictates, that: **in cases of diagnosed or suspected lymphatic dysfunction – as in practically every chronic illness – a key target for therapy must be to reduce sympathetic activation and bring the patient into the "vagal" mode**.

It is interesting to note, that measoures to interrupt the local transmission of sympathetic nerve impulses, by anaesthesia or surgical intervention ("sympathetic blockade") have already proven successful in the treatment of lymphedema. The causal mechanism is still not fully clarified, but preliminary studies point both to vasodilation and more efficient lymphatic pumping as results of sympathetic blockade. Naturally this type of intervention is appropriate only in extreme cases.

It should be noted that sympathetic nervous system activity tends to increase with age.

The glymphatic system and sleep: the secret of a healthy brain?

As described above, the brain possesses its own special lymphatic system, the "glymphatic system". Like the lymphatic system for the rest of the body, the glymphatic system serves as a waste disposal system for the brain, removing metabolic waste products and other unwanted materials from the environment of the brain cells. When this system fails to work properly, waste and garbage accumulates in the intercellular spaces, interfering with the normal functions of brain tissue and eventually even causing irreversible brain damage. Not surprisingly, research suggests strongly that numerous neurological diseases are causally related to malfunctions of the glymphatic system.

The discovery of the glymphatic system has enormous medical implications. Among other things it may provide the key to understanding and treating Alzheimer dementia, which is associated with a pathological accumulation of the protein beta-amyloid (A) in the spaces between neurons. The so-called amyloid plaques are a hallmark of Alzheimer's disease, and it is natural to attribute their presence to a failure of the glymphatic system to clear away beta-amyloid from brain tissue. This hypothesis is supported, among other things by the observation, that glymphatic function declines with increasing age.

While investigating the glymphatic system, researchers made a second revolutionary discovery: **the glymphatic system is mainly active during sleep!** When asleep, the brain "cleans itself". This discovery sheds a totally unexpected light on the relationship between sleep and health. One of the long-standing mysteries of biology and medicine is why human beings (and animals) need sleep. It is well established that lack of sleep reduces learning abilities, impairs performance in cognitive tests, prolongs reaction time, and is a

common cause of seizures. Complete sleep deprivation kills rodents and flies within a period of days to weeks. In humans, fatal familial or sporadic insomnia is a progressively worsening state of sleeplessness that leads to dementia and death. Lack of adequate sleep is also linked to a variety of chronic illnesses. The discovery of the glymphatic system now provides a highly plausible explanation: lack of adequate sleep prevents the glymphatic system from clearing away harmful substances from brain tissue. It also coheres with the subjective perception of sleep as refreshing, as a kind of physical and emotional "reset", and with the well-known curative effects of sleep for a wide variety of conditions.

Evidently the discovery of the glymphatic system and its relationship to the "restorative function of sleep" has the potential to revolutionize the treatment and prevention of Alzheimer dementia and other brain diseases. Several indications point to this conclusion. Among other things, sleep disturbances are routinely encountered in Alzheimer's disease. Also, recent experiments with healthy subjects have documented an increase in beta-amyloid in brain tissue after even a short period of sleep deprivation. This is currently an area of intensive research.

But the relationship between glymphatic function and sleep has much broader significance. Sleep is one of Nature's most powerful healing agents. Can we learn to understand and use it better? Might it be possible to enhance the effectiveness of the glymphatic system and thereby to reduce mental fatigue and strengthen the ability to think? The metaphorical expression, "to clear the mind", takes on a new meaning. Does emotional stress have an effect on the glymphatic system? What about meditative practices, techniques such as autogenic training etc.? How does dreaming fit in to the picture? What can the connection between sleep and the glymphatic system teach us about the mind-body relationship?

In any case, the new developments confirm the close connection between health and the sympatho-vagal balance. During sleep, when the glymphatic system does most of its work, the body is in the vagal mode and the sympathetic nervous system is inactive. Conversely, when the sympathetic nervous system is hyperactive – due to chronic stress or other causes – it is often difficult to sleep, or the quality of sleep is low.

Matrix Rhythm Therapy: a powerful means for restoring healthy lymphatic function

A great variety of therapeutic methods have been developed to deal with malfunctions of the lymphatic system, with greatest attention being given to the treatment of lymphedema and promotion of lymph drainage in general.

Matrix Rhythm Therapy (MaRhyThe) can justly be regarded as a major breakthrough in this area. MaRhyThe occupies a **unique position** among treatments for conditions linked to lymphatic malfunction, among other things because it is the only approach which takes account of the physiological pumping functions of the 8-12 Hz microvibrations, described above. This is only part of the story, however. While focusing on improving the environment of the cells – the extracellular matrix – Matrix Rhythm Therapy operates on several different levels of organization of the body at the same time (see below). In contrast to this multilevel, multidimensional approach, other therapy methods often fail because they ignore one or the other essential dimension of the disease process. As a result, the positive effect on one level is often blocked at another level.

Details on the strategy and modalities of Matrix Rhythm Therapy can be found in a number of publications (see Bibliography below). Here only the most essential points will be summarized, using excerpts from the book "The Matrix Concept" by the original discoverer of the Matrix Rhythm Therapy, Dr. Ulrich Randoll. To introduce these it will be useful first to briefly describe how the treatment is carried out.

Using a specially-designed hand-held device – the Matrixmobil® – the therapist applies gentle vibrational action to the body in the frequency range 8-12 Hz, which coincides with that of the micro-

vibrations of healthy skeletal musculature (Fig. 9). Applied locally, the Matrixmobil® generates mechano-magnetical waves propagating deep into the body. The immediate effect is to mimic, at a higher amplitude, the pumping effect of the musculoskeletal microvibrations on the arterial-venous and lymphatic microcirculation, while at the same time strengthening the spatial-temporal coherence of the microvibrations through the mechanism of entrainment. As noted above, sclerotic processes and the buildup of contraction residues greatly hamper the natural microvibrational activity of the skeletal musculature, in a self-aggravating manner. Treatment with the Matrixmobil® has proven uniquely effective in breaking this vicious circle, as demonstrated by more or less rapid and lasting improvements in the elasticity, perfusion and drainage of tissue (see Dr. Randoll's remarks below).

Fig. 9 Application of the Matrixmobil® in Matrix Rhythm Therapy

In addition to mechanical vibration, permanent magnets are mounted in the Matrixmobil® applicator, generating a synchronously oscillating magnetic field which appears to support the therapeutic effects of the mechanical action on the tissue, cellular and perhaps even subcellular levels. (Without going into this complex and poorly-understood subject here, it is relevant to point out, that, due to their high content of collagen fibers, the extracellular matrix and connective tissues in the body all have **piezoelectric** properties. Mechanical vibrations, applied to these tissues, generate oscillating

electrical fields and thereby also oscillating currents of ions and electrons, which interact with applied magnetic fields and have physiological effects. In the human body all vibrations automatically have a mechano-electromagnetic character – a fact which has so far only begun to be exploited in a serious way for therapeutic purposes.

In the cited book Dr. Randoll explains:

Treatment with the Matrixmobil® is the central module of the therapeutic strategy. Thereby, as the first step, a healthy rhythm of cell matrix pulsations (matrix rhythms) is restored together with the cell logistical processes connected with it. If this does not succeed, then no other therapeutica, regardless of whether they are pharmacological or physical in nature, will be able to fully attain their intended effects. Every therapy benefits from restoring the permeability of the extracellular matrix.

For this reason I decided, back in 1996, on Matrix Therapy as an essential therapeutic strategy for medicine. Thereby a bridge was built between different viewpoints, as an integrative approach.
I believe that all healing begins on the level of cell biological regulation via the extracellular matrix, with secondary effects on the parenchyma cells of the given organs, thereby constituting, in this sense, a kind of Matrix Therapy

The Matrixmobil® operates as the extended arm of the therapist, who must diagnostically assess the elasticity of the tissue and then intervene using this device and his highly-developed haptic capabilities for sensing the condition of the patient's body and tissue to treat process breakdowns in the patient.

The therapy begins in a diagnostic mode. The vibration head of the device is placed on the body at a suitable location, and the tissue's response to the vibrational input is assessed. The musculature is stimulated along its length, in its various layers, and using vibrations in the physiological frequency region between 8 and 12 Hz. The patient experiences this as pleasant. Only where the propaga-

tion of the waves is blocked by hardenings, adhesions, scars etc., perturbations occur which the therapist observes and reacts to by appropriate changes in the mode of application of the device to the body. Without such changes the treatment would trigger unpleasant sensations in the patient.

Therapeutic application of the Matrixmobil® generates a rhythmic microstretching (microextension) of tissues, which is adjusted to the natural microvibrations of the muscle cells (shivering) and thereby acts at the level of the individual cells. By changing the pressure applied to the vibration head and rotating the apparatus, the therapist modulates the intensity and the focus of the signal propagated into the tissue. The special shape of the vibrational head makes it possible, by a small rotation of the apparatus, to modulate the amount of the microextension generated in the tissue. This is especially important in terms of effects on the acceleration-sensitive muscle-spindle and Golgi tendon organs. At the same time, modulation in the direction perpendicular to the muscle fiber generates variations in the pressure acting on the vessels and thereby modulates the "milking mechanism" in veins and lymph vessels.

All processes in and around the cells are thereby brought back into "well-tuned cooperation". An excessive - tonus (nerve-triggered muscle tension) – connected with accumulated overall psychical and bodily stress – normalizes itself, causing the pleasant feeling at the outset of the therapy to spread out. This is often accompanied by a sensation of warmth. The improved oxygen availability leads to relaxation and a decrease in the blood pressure, initiating the regenerative, self-healing processes of the tissue, and strengthening them. The rhythmic microstretching process, which reaches deep into the tissue, can even loosen conglomerations of fascias (fibrous tissue) and cells in deeper layers...

While therapy with the Matrixmobil® has enormous scope for variation and adaptation to the specific situation of the individual patient – guided by the insight and experience of the therapist – knowledge

of the organization of the human body, together with years of experience with Matrix Rhythm Therapy, point to two main areas for most effective overall therapeutic action: (1) the skeletal musculature and (2) the sympathetic trunk (sympathetic chord, gangliated cord).

The skeletal muscles constitute the single largest organ in the body, making up about 45% of total body weight and thereby constituting the largest collection of cells of a single type. The skeletal musculature has developed in the course of evolution into the biggest "propulsion organ" of the human body. Its function is based on a synergetic combination of microscopic cell processes leading to coordinated macroscopic motions. As the strongest clock-pulse generator ("orchestra conductor") besides the heart, it plays the decisive role in fluid transport in the body, especially for the microcirculation in and around the individual cells, i.e. in the circulation of the extracellular medium. The skeletal musculature is the most effective target domain for Matrix Rhythm Therapy not only because of its large share of the total body weight, but above all due to its decisive function as a "milking organ" for the microcirculation of the muscle tissue itself. And it is via the connective tissue that the waste products of the other organs are removed through the venal and lymphatic circulation, in order thereby to be supplied again from the arterial circulation.

Many well-known and less well-known physiotherapeutic procedures also focus on the skeletal musculature. They typically act from the outside on the skin, muscles, connective tissue, lymph and reflex zones by kneading and stroking. Thereby they stimulate specific nerves and pressure points – so-called trigger points – in order to improve the body condition by inducing a better perfusion of the blood, a loosening, stretching and uncramping of the muscles, as well as a better transport of metabolic products in the body. With these methods a certain activating effect can be achieved, but which only extends to a certain depth in the body. Thus, these therapies – even manual vibromassage methods, which also operate in the range

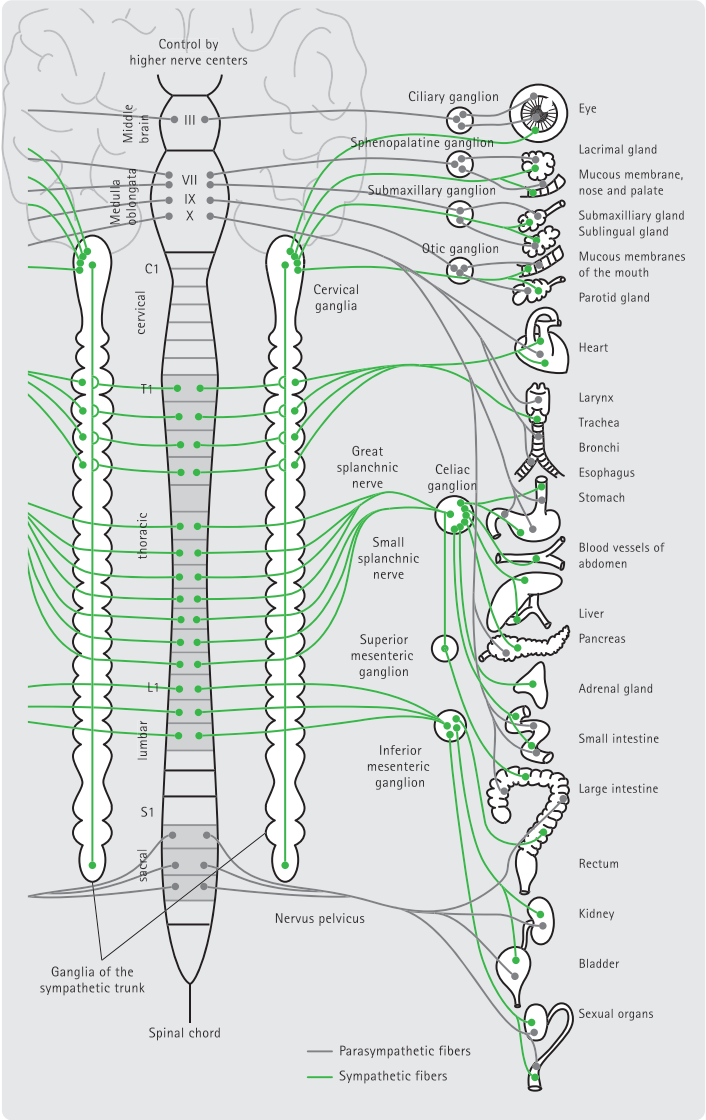

Fig. 10: Sympathetic trunk and its sympathetic nerve connections to body organs

of the body's natural rhythm – mostly provide only short-term relief. To obtain a sustained or permanent effect, reaching into the depth of tissues, it is clearly decisive to exploit the natural vibrations of the body tissue itself.

This systemic therapy of the sympathetic trunk (Fig. 10) produces marked sympatholytic effects such as improved respiration, normalization of the blood pressure, reduction of spastic states, improved quality of sleep as well as the disappearance of problems in the stomach and intestinal tract. Often a therapy along the cervical-thoracic and brachial nerves is found to eliminate noise in the ears (tinnitus), excessive intraocular pressure, and the grinding and clenching of teeth (bruxism).

Building on the stress research of Selye, sympathetic trunk therapy can achieve a generalized improvement in the function of organs along the vagus nerve, restoring the sympathovagal balance overall. Body functions thereby recover their natural equilibrium. In many cases we have been able to observe the effects on the central nervous system via EEG measurements.

In the course of years of therapeutic experience it been proven useful to apply the treatment not only locally, but "from head to foot" i.e. systemically. Thereby, Matrix Rhythm Therapy has developed more and more into an effective systemic therapy for chronic illnesses. The decisive feature of Matrix Rhythm Therapy is that it stimulates the self-healing powers of the organism via its temporal pattern. It is important, in addition, that this should occur with absolutely no side effects, on all of the hierarchical levels which are scientifically accessible today. As I observed with the majority of patients I have treated, many problems disappear by themselves as soon as the connective tissue and musculature are remobilized.

The multidimensional healing effects of Matrix Rhythm Therapy on the lymphatic system

Reviewing the various aspects of the lymphatic system, presented above, in light of Dr. Randoll's remarks, helps understand why Matrix Rhythm Therapy has proven so effective in treating conditions connected with lymphatic malfunction. The "secret" lies in a symbiosis of therapeutic effects achieved on several different levels simultaneously:

1) The direct pumping effect of the Matrixmobil, promoting lymph fluid formation and lymphatic flow in the lymphatic capillaries.

2) Restoring and strengthening the natural pumping action of the microvibrations of the skeletal musculature, through the mechanism of entrainment, operating in the same physiological frequency range 8-12 Hz. This has lasting effects.

3) Eliminating **mechanical blockages** to the flow of lymph and to the proper functioning of the intrinsic and extrinsic lymphatic pumps. This includes overcoming tissue adhesions which reduce the permeability and elasticity of the extracellular matrix.

4) Releasing contraction residues and reversing the hardened, rigid state of muscle tissue which weakens microvibrational activity and interferes with lymphatic function.

5) Stimulation of cellular metabolism, both through direct mechanical-vibratory action and through the action of the oscillating electrical fields generated in tissue by the piezoelectric effect.

6) Reducing sympathetic tone and increasing parasympathetic (vagal) tone in the autonomous nervous system (c.f. Dr. Randoll's emphasis on the sympathetic trunk). This effect is crucial for reversing the

negative impact of chronic stress on the lymphatic system and thereby on the health of the body as a whole.

7) Improvement of the psychological well-being of the patient, through the pleasant, relaxing sensations generated by the Matrixmobil, (therapeutic vibrations), the reduction of stress and heightening of vagal tone, reduction of pain and stiffness, and the supportive, empathetic attitude of the therapist.

The symbiosis of all these aspects is essential to breaking the vicious circle of illness, removing the blockages which stand in the way of the body's natural healing processes, and thereby achieving lasting therapeutic results.

Two final remarks should serve to underline the decisive importance of the multilevel approach designed by Dr. Randoll.

In a patient suffering from stress-induced hyperactivity of the sympathetic nervous system, efforts to improve lymphatic flow at the tissue level will often fail to achieve lasting results. One reason lies in the sympathetic innervation of the lymphangions. Another is the vasoconstrictive effect of heightened sympathetic tone. Chronic sympathetic stimulation tends to disrupt the normal rhythmic pumping activity of the lymphanglions – in some respects analogous to cardiac arrhythmia – and can even cause the wave of contraction (peristaltics) to become chaotic, slowing or interrupting lymph flow completely. In cases of chronic stress, lasting results can only be obtained by shifting the sympathovagal balance of the patient's autonomic nervous system, decreasing sympathetic tone and heightening vagal tone. Ultimately it will be necessary to address the source of stress, convincing the patient to adopt a more healthy life-style.

On the other hand, holistic therapies of alternative medicine, which focus on stress reduction for example, often fail because of pathophysiological changes in tissue which cannot be reversed without intervention on the cellular level. The paradigm of this sort of problem is the **Randoll bifurcation**: Emotional stress often causes muscular tension. If the stress is acute and short-lived, a healthy musculature will be able to relax afterwards. But if the stress is maintained over a sufficient length of time, muscles lose their ability to return to a fully relaxed state. Contraction residues build up, muscle tissue becomes hardened. The vicious cycle, described above, sets in. Hardening of muscle tissue degrades its permeability and its elastic-vibrational characteristics, weakening the effect of the extrinsic muscular pumps (including the microvibrations). Muscle cells suffer from a "logistical crisis" characterized by inadequate supply of oxygen and nutrients, and insufficient lymphatic drainage. The resulting accumulation of acidic metabolic products leads to chronic pain. The patient is no longer able to relax, and even the best techniques of meditation, yoga etc. cannot break the vicious circle. There is no alternative to an active, physiological therapy. In most cases Matrix Rhythm Therapy provides the best option.

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Fig. 2 B: from Földi M und Kubik S, Lehrbuch der Lymphologie, Gustav Fischer Verlag (1991)

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Fig. 8A, 8B: from Mckay W, Gregson P, Mckay B, Blanchet T (1998) Resting muscle sounds in anesthetized patients, *Can J Physiol Pharmacol.* 76(4):401-6.

Dr. Randoll Institut: research and education for optimizing cell logistics

Already by the end of the 1990s Dr. Ulrich G. Randoll was convinced that the key to health is to be found on the level of cellular processes. It is possible to intervene into these processes via the medium surrounding the cells: the extra-cellular matrix. Dr. Randoll developed Matrix Rhythm Therapy and has trained over 3000 people in the utilization of this method. Since then he has presented the Matrix Concept in many national and international congresses and workshops. His book, “The Matrix Concept” has appeared in two languages.

The Dr. Randoll Institute has the task of promoting prevention, rehabilitation, therapy and diagnostics. The goal is to transfer the new knowledge of biological systems theory and fundamental cell-biological research into the domain of medical practice. The noninvasive, nature-conformal therapeutic methods which have been developed on the basis of earlier research projects are now being applied for the benefit of patients in a wide variety of branches of medicine, and further optimized. Be a part of it!

The Dr. Randoll Institute organizes seminars, professional training courses and workshops with Dr. Randoll and his group of lecturers.

◆ Seminars and congresses

Current dates and themes can be found on our website, including for example:

(see the right side)

The Matrix Concept and
Matrix Rhythm Therapy

1. In **neurology**– spasticity, apoplexy, MS, pain therapy etc.
2. In **internal medicine** – rheumatoid arthritis, diabetes II, metabolic syndrome, prevention and rehabilitation etc.
3. In **dentistry** – pain inside and outside the masticatory system, CMD, lymph blockages, parodontosis, per-implantitis etc.
4. In **sports medicine** – improvement of performance, regeneration, prevention of injuries.
5. In **trauma surgery, orthopedics and traumatology** – diagnosis of pain in joints and soft tissue, perioperative care.
6. In **TCM, Ayurveda, Yoga** – Pancha Karma, Acupuncture
7. A week-long **Matrix Congress** in the Poseidon Garden of Ischia, Italy

If you are interested in a topic for which the date has not yet been announced, please contact us. We will reserve a place for you in advance.

You can also invite our experienced speakers to your own congress for lectures and workshops.

Choose your topic and request documentation, dates and prices using the request form on the last page.

◆ Where can you find a therapist?

Interested persons and patients can easily find a trained therapist for Matrix Rhythm Therapy near their place of residence. Consult the website: www.matrix-health-partner.com

◆ You can become a sponsor:

We are a nonprofit institute and appreciate your interest in research and education. You can become an active supporter through donations, research contracts, and by sponsoring congresses, symposia and publications. Please contact us!

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Request Form

Please send me the programs and dates
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❑ Applications of Matrix Rhythm Therapy to neurorehabilitation – spasticity, apoplexy, MS and pain therapy.

❑ Other topics (see the list of topics on page 31):

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Please send me information about the following topics
(mark the topics of interest):

❑ Introduction to the applications of Matrix Rhythm Therapy (MaRhyThe®)

❑ I would like to have a lecture presentation at my event. Please contact me.

❑ I would like to become a sponsor. Please contact me.

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The authors

Dr. Ulrich G. Randoll

Dr. Ulrich Randoll is a medical doctor, researcher, author, lecturer and Director of Dr. Randoll Institut in Munich, Germany.

He was convinced that the key to health is to be found on cellular processes. In the context of coherence and self-organization he studied from 1989 – 1997 cellular differentiation and dedifferentiation with high resolution video microscopes in Depts. of Maxillo Facial Surgery and Traumatology at the Univ. of Erlangen. Observing rhythmic cellular organization and pulsation even in the extracellular matrix of the dish he developed the Matrix Rhythm Therapy (MaRhyThe®), a treatment where physiological waves (8-12 Hz) are applied, to synchronize body intrinsic derailed processes. By optimizing cellular logistics and circulation, the Matrixmobil® is used preventively, pre- and postoperatively. Symptoms like headache, chronic pain in spine, knee, hip, open wounds and ulcers, diabetes II etc. can easily be treated. Already over 6000 medical doctors and therapists are meanwhile trained, also in India. His book, “The Matrix Concept” is available in its second edition both in German and English.

Prof. Dr. Rainer Breul

Univ. Prof. Dr. rer. nat. med. habil. Rainer Breul (D.O. h.c.) is one of the leading anatomists in Germany, author and lecturer.

His career: Studied at the German Sport University in Cologne (diploma 1971), biology studies and doctorate at the University of Cologne (1975), scientific assistant at the Anatomical Institute Cologne (1975-1984), habilitation in anatomy (1984), professor of anatomy Cologne (since 1984), Professor of Anatomy LMU Munich (since 1987, 2010 emeritus). From 1976 until the present, he has been active as a lecturer in the anatomy training and in further educational events of (dental) doctors, physiotherapists and osteopaths. He organizes interdisciplinary dissection courses for these professions. He has been active as a lecturer for the training of osteopaths in anatomy, physiology for almost 30 years. He is also the author of many anatomical book and journal articles and was a long-time co-editor of journals (DO, Osteopathic Medicine) and scientific advisory board of the Federal Association of Osteopathy e.V. -BVO.