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University

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“La Sapienza”

Masters in Aesthetic Medicine and Aesthetic Surgery
Medical specialisation

MICRO MULTI ALVEOLAR STIMULATION IN MECHANISED CONNECTIVE TISSUE MASSAGE ACCORDING TO THE THEORY OF THE MICROVACUOLE

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A brief history of massage

Massage is, without a doubt, man’s most ancient remedy to ease pain, relieve fatigue and reinvigorate body and mind. Just think about the instinctive, universal gesture of applying pressure to a painful part. This is why, in fact, we can certainly hypothesise that since man first appeared on earth, the only way he had at the time of alleviating pain, was to ‘caress’ the injured part.

Some authors believe that the term derives from the Arabic 'massa' meaning 'to touch', whilst others prefer the theory that it originates from the Greek 'massein' meaning ‘to mix’, or even the Hebrew 'machec' meaning ‘to handle’. In any case, and whatever its real origins, the term ‘massage’ indicates a blend of different manual techniques practised on a person’s skin. The physical and psychological benefits of this practise have been acknowledged since ancient times. And there is no doubt that the medical art began with massage. The ‘Kong Fou’, a Chinese text dating back to 2698 B.C. describes physical exercises and various types of massage that aimed to reach a perfect psycho-physical balance. In the XVIII century B.C., the Ayur-Veda, the sacred text dictated by Brahama to his disciples, recommends massage for hygiene purposes. And Egyptian, Persian and Japanese medical literature also makes frequent reference to the benefits obtained through massage. In his writings, Hippocrates (406 B.C.), Greek physician and father of modern medicine, confirms the virtues of massage, making important comments on the practise of massage-therapy, which were then confirmed many centuries after his death. He wrote “*The physician must be experienced in many things, but assuredly also in rubbing, hard rubbing binds, soft rubbing loosens, much rubbing causes parts to waste, moderate rubbing makes them grow".* The Hellenic world then refined massage technique, giving it two different purposes linked to the Greek games: to prepare the athletes’ muscles for the forthcoming physical efforts and, at the end of the sports competition, to relieve the tired muscles. We can therefore state that it is in this period that the two different massage techniques are perfected: for sports and for therapy linked to medicine. The Romans too, similar to the Greeks, cultivated massage at the thermal baths, where guests were invited to bathe and be massaged. For the entire duration of the Roman Empire and throughout Europe, the practise of massage was an important element in treating health, so much so as to put the 'massista' on an equal footing with the physician, with many references made to this technique in documents of the times. After the fall of the Roman Empire, and during the Middle Ages, this knowledge and consequent practise disappeared into oblivion, whilst in the east, the tradition of massage continued uninterrupted. Subsequently, it returned to popularity during the Renaissance, thanks to the work of Mercuriale (1530-1606), physician and gymnasiarch who rediscovered ancient Greek medicine, and with it, Hippocrates. Mercuriale wrote ‘De arte Gymnastica’, a scientific-practical work describing massage and gymnastics as fundamental elements of preventative medicine to keep the body in good health. During the XX century, the great progress made by conventional medicine left more traditional treatments that had been practised for centuries, somewhat in the background. The tragic heritage of the men martyred in body and soul after the two world wars, was the determining factor in the return to physical therapy. In fact, *rehabilitation physiotherapy* and the modern *orthopaedia*, developed tremendously given the incredible number of patients spread throughout Europe with the stigmata of war, simply consider the great skills of the artisans of the time in preparing wooden, leather and aluminium prosthesis to replace limbs.

Massage practised today

From this brief anecdote, we have seen how massage has been handed down from generation to generation over the centuries, evolving and adapting to meet the various different needs but, in any case, keeping the constant factor of using hands as multipurpose tools. Many different techniques are used, that differ in terms of execution and purpose.

The various different authors who have conducted scientific studies on the matter agree in classifying massage according to the following main strains: *classic, reflexogenic connective, myofascial trigger point* and *zonal*.

The classic massage. Mainly identified with lymph drainage, which associates the different manual techniques born of empiricism and codified through the study of man's physiological vessel structure.

The reflexogenic connective massage. This uses the reflexogenic relationship between skin, nervous system and internal organs.

The myofascial trigger point massage. Encourages recovery of muscle function, particularly appropriate for spasms, hernias and distortions of the muscle belt.

The zonal massage. We acknowledge almost all oriental techniques based on the search for the energy meridians of acupuncture with the aim of balancing the body's global energy, adding where it lacks, and removing where there is too much. Shiatsu and Plantar and Palm massage are just some examples of these.

The psycho-therapeutic massage. Massage therapy is understood as the search for body contact and, therefore, as a need to establish an emotional contact.

The post-surgical massage. Post-surgical aesthetic remodelling treatment to facilitate the reabsorbing of the oedema, thereby reducing recovery time.

The Connective Massage

This brief description begins to hint at the importance and evolution of massage. Our report will examine the specific development of reflexogenic connective massage in the light of the biomedical-humeral discoveries and technology starting from the 1950s.

The reflexogenic connective massage originates from the intuition of therapist Elisabeth Dicke, born in Lennep on 2/03/1884. At the age of 45, seriously ill, she began to massage herself in a specific way that she then baptised with her surname ‘Dicke’, successfully healing herself to the amazement of the Berlin professors of the time.

Since then, although the main structure of the method has remained valid, modern scientific research has allowed us to better understand and take a more in-depth look at the complex dynamics that take place on a cellular level, thereby allowing the technology to integrate significantly, yielding better therapeutic results in the various sectors of the medicine. Although we take this brief trip into the method of connective massage, our attention will mainly focus on the 'mechanisation' of this massage, performed by electro-medical appliances.

Before discussing mechanised connective massage, we must first clarify what is intended by connective tissue.

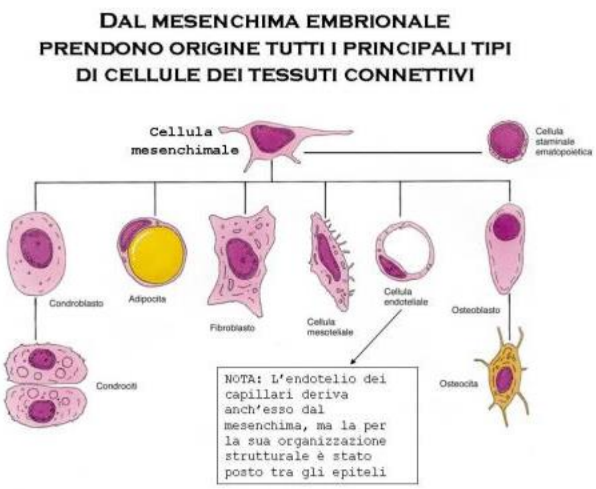


Photo 1

Connective tissue (photo 1) develops embryologically from the mesenchyma, marked by ramified cells positioned in a plentiful amorphous intra-cellular substance. The mesenchyma derives from the intermediate embryonic leaf, the mesoderm, very widespread in the foetus, where it surrounds the developing organs very deeply. Apart from giving rise to all the types of connective tissue, the mesenchyma also forms the origin of other tissues such as muscular tissue, blood vessels, the skin and some glands. Connective tissue is morphologically marked by various different cell types: *fibroblasts*, *macrophages*, *mastocytes*, *plasma cells*, *leukocytes*, *adipocytes*, *chondrocytes*, *osteocytes*, immersed in a plentiful intercellular material known as the *extracellular matrix* or ECM that is produced by the connective cells themselves. The ECM comprises insoluble protein fibres (collagen, elastics, and reticular) and ground substance, erroneously defined as amorphous, colloidal, formed by soluble carbohydrate complexes mainly linked to proteins, thereby forming the mucopolysaccaride acids, glycoprotein, proteoglycans, glucosaminoglycans or GAG, keratin sulphate, heparin sulphate, etc., and, to a lesser extent protein, including *fibronectin*, as the most represented.

Cells and intercellular matrix mark the various types of connective tissue proper (connective strip), elastic, reticular, epithelial, endothelial, cartilage, bone, blood and lymph tissue, namely all the constituents of the human body. The connective tissue therefore plays various different and important roles: structural, defensive, trophic and morphogenetic, organising and affecting the growth and differentiation of the surrounding tissues.

To better understand the great 'variety' of the connective tissue, the following lists the classification adopted throughout the world.

The most common connective tissue, and that to which reference is usually made with this term, is defined as **connective tissue proper** (often abbreviated to **CTP**). This, in turn, can be divided up into three varieties:

- **fibrous connective tissue**

- **elastic connective tissue**, with a prevalence of elastic fibres
- **reticular connective tissue**, with a prevalence of reticular fibres.

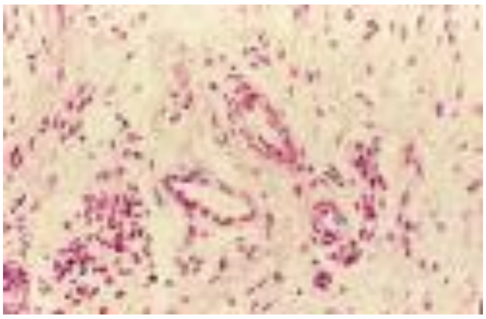
There are then the various different types of specialised connective tissues carrying out specific tasks, and which are therefore marked by a specific morphology or physiology:

- **fatty tissue**
- **cartilage tissue**
- **bone tissue**
- **blood**
- **lymph**.

Connective tissue proper

Connective tissue proper is the most common type of connective tissue and acts as support and protection, forming the basis on which the various epitheliums rest, and helping defend the body against external impacts and traumas. It exists in three sub-types: *loose connective tissue, compact connective tissue* and *reticular connective tissue*.

Loose connective tissue



Loose connective tissue (photo 2) is, in mammals, the most common type of connective tissue. It forms the support structure (tunica) of the epithelial tissue in various different internal ad external parts of the body, envelops the organs providing protection and support, also performing this function elsewhere, such as in muscular tissue and nerves. It comprises plentiful amorphous substance, superior, in terms of quantity, to fibres, and observed under phase contrast, at takes on a gelatinous appearance (hence the use of the adjective 'loose').

Dense connective tissue

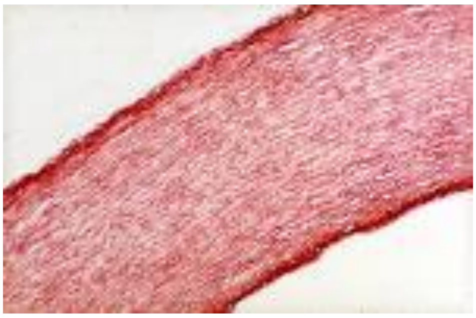


Photo 3

Compact connective tissue, also referred to as *dense* or elastic (photo 3) has much greater fibre density than loose connective tissue. These fibres, of collagen or elastic nature, are also gathered in bands, making the tissue significantly compact (hence the name) and elastic. Compact connective tissue, in fact, rather than support, serves to defend the body from mechanical traumas and tears. The differing organisation of fibres comprising it, classifies it according to one of two different varieties: dense *regular* and *irregular* connective tissue.

- in dense regular connective tissue, the fibres form an ordered layout. This high level of fibril organisation allows the tissue to resist even significant traction, and it is this type of tissue, in fact, that forms elements such as tendons and ligaments
- in dense irregular connective tissue, on the other hand, the fibres form an irregular organisation. This tissue is extremely elastic, also due to the great presence of many elastic fibres, many more than in regular tissue, and forms the subcutaneous skin and the support structure to many organs and glands.

Fibrous connective tissue

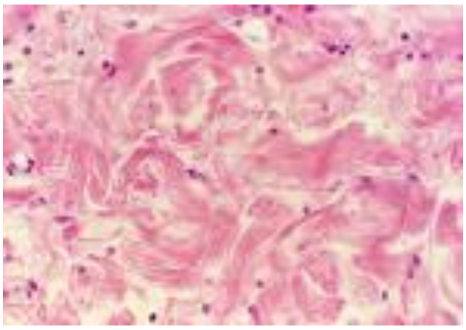


Photo 4

Reticular connective tissue (photo 4) is a particular type of connective tissue that can only be found in certain specific places, such as the support structures for smooth muscle of lymphatic and haemopoietic organs. As the name suggests, this mainly comprises reticular fibres. Depending on how these fibres run, a two-dimensional and three-dimensional connective tissue can be seen.

Fatty tissue

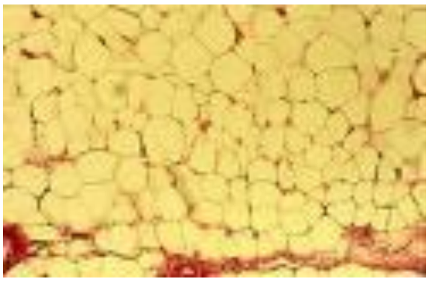


Photo 5

Fatty tissue (photo 5), which should more correctly be referred to as the adipose organ, is a specific type of connective tissue. It is yellow in colour and spongy in texture, and comprises cells, fat, the stated adipocytes, which can be individual or grouped together in loose fibrous connective tissue. If there are a great deal of fat cells, and they are therefore organised into lobules, then they comprise adipose tissue, which is a variety of loose connective tissue.

This tissue is present in many different parts of the body and, in particular, beneath the skin, forming the adipose panniculus (from the Latin *panniculus* a diminutive of *pannus*) meaning a particularly abundant strip or layer of subcutaneous fat.

50% is accumulated in the subcutaneous connective tissue, where it both acts as covering and with a mechanical insulating action. 45% can be found in the abdominal cavity where it forms the internal fatty tissue. 5% is found in the muscular tissue as *infiltration fat* that serves to help and facilitate the function of the muscle tissue.

Cartilage tissue

Photo 6

Cartilage tissue (photo 6) is a specific type of connective tissue. It comprises connective fibres immersed in a very consistent ground substance and cells contained in lenticular cavities. The cells are arranged in groups of four and called chondrocytes. This type of tissue is divided up into: hyaline, elastic and fibrous.

Bone tissue

Photo 7

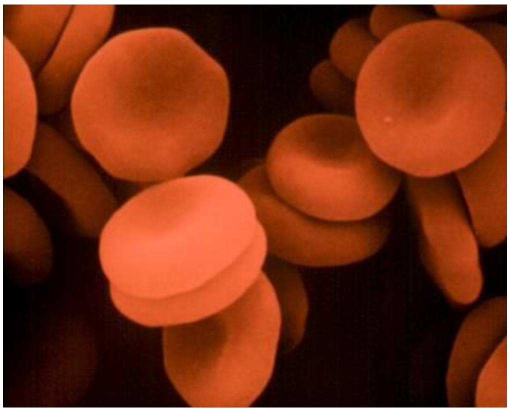
Bone tissue (photo 7) is a specific type of connective tissue that acts as a structural support for the whole body. Its main feature is that of possessing a calcified extracellular matrix that makes the tissue itself significantly compact and resistant.

The matrix also contains fibres, particularly elastic fibres, that make the tissue flexible. Clearly, it also contains the cells known as osteoblasts. Depending on how the matrix is organised, the bone tissue can be divided up into two sub-types: *lamellar bone tissue* and *non-lamellar bone tissue*.

- non-lamellar bone tissue is present in birds, whilst in mammals it represents the immature version of the bone tissue, and is only present during the body's development, before being replaced by lamellar tissue during growth. In this type of tissue, the calcified matrix is not organised into defined structures, but is disordered and irregular

- the lamellar bone tissue is, instead, present in the adult organism and is marked by a high level of organisation of matrix components that are laid out in layers, defined *lamellae*, and which are very ordered indeed. It can, in turn, be divided up into two types, depending on the type of organisation of the lamellae: spongy bone tissue and compact bone tissue.
  - in spongy bone tissue, the lamellae form ramified structures defined as *spicules*. This is why an optical examination will reveal a spongy mass filled with inter-communicating cavities
  - in compact bone tissue, on the other hand, the lamellae are organised into concentric rings defined as osteon, lying one against the other, leaving a single central space.

Blood



Blood (photo 8) is a fluid tissue contained in the blood vessels of vertebrates. IT has a complex make-up and can be considered as a variety of connective tissue.

Foto 8

It is formed by a liquid part and a corpuscular part comprising cells or fragments of cells.

Lymph

Photo 9

Lymph (photo 9) is another fluid tissue that circulates in the lymphatic system. It differs from blood both in terms of the molecular make-up of the plasma and in cell content: there are absolutely no red blood cells in the lymph, and a dominance of lymphocytes.

After this important classification, which allows us to have a very clear anatomical-physiological picture, we absolutely must take a more detailed look at the make-up of the insoluble protein fibres in the loose connective tissue proper and the extracellular matrix.

Collagen fibres

These are the most abundant, giving the tissues in which they are most present, such as tendons, aponeurosis, capsules, etc., a whitish colour. They form the structure of many organs and are the most resistant components of their stroma. Collagen fibres are long, parallel molecules structured into micro fibrils comprising tropocollagen that, in turn, comprises α chains forming long, tortuous fibrils held together by a cementing substance containing carbohydrates. Tropocollagen fibrils are 280 nm long and 1.5 nm thick, and each molecule comprises 3 α chains of 1000 amino acids. These such constituted fibres are very flexible but cannot be extended, thereby yielding a resistance to traction that is significantly greater to that of steel. There are different types of α chain that generate approximately 20 different types of collagen. The table below lists those that are most represented in our body.

Type I collagen:	connective tissue proper, bone, dentin and cement (fibroblasts, osteoblasts, odontoblasts, cementoblasts)
Type II collagen:	thin fibres, almost exclusive to hyaline and elastic cartilage (chondroblasts)
Type III collagen:	reticular fibre, highly glycosilated, fibril form of 0.5-2.0 µm that can be coloured with reactants for sugars (PAS reaction), (fibroblasts, muscle cells, hepatocytes)
Type IV collagen:	non fibrillar form and does not have 67 nm bands. Forms protocollagen nets that combine to form the network of the basal membrane (epithelial cells, muscle, Schwann cells)
Type V collagen:	forms thin fibrils that combine with the type I collagen fibrils (fibroblasts, mesenchymal cells)
Type VII collagen:	forms small aggregates known as anchorage fibrils that anchor the basal membrane to the type I and III collagen fibres below (epidermal cells)

This resistant structure is made up of a repeated sequence of three amino acids. One amino acid every three is glycine, a small amino acid that enters the helix perfectly. Many of the other positions remaining in the chain are occupied by two unexpected amino acids: proline and its altered version hydroxyproline. The image to the side shows just a small segment of the internal molecule of the α chain.

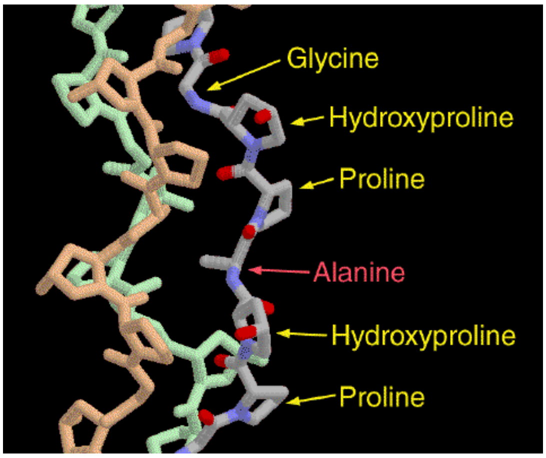


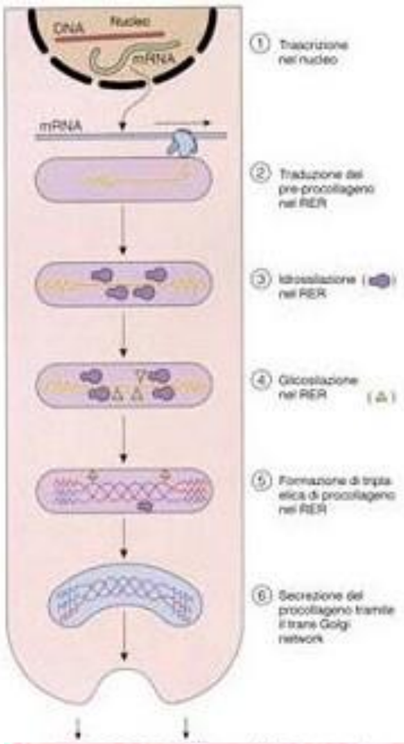
Photo 10

This discovery was important for two reasons. The first is that we have now understood the reason with which elasticity is guaranteed to the molecule, the second is partly how its denaturation takes place. In fact, if we replace hydroxyproline with another amino acid, such as alanine, we created a steric encumbrance with the nearby chains, and consequent alteration of its structural function. (Photo 10) Discovering that proline was this common, was of significant importance, as it forms a fold in the polypeptide chain that is difficult to house in normal globular proteins, and this accounts for the extremely high traction capacity. Hydroxyproline, which is critical to collagen stability, is synthesised by modifying the amino acid proline after the collagen chain has been constructed. The reaction requires vitamin C to allow for oxygen addition. Unfortunately, our body is not able to synthesise vitamin C independently, and it must therefore be assumed through diet, otherwise the consequences can be disastrous. The lack of vitamin C, in fact, slows production of hydroxyproline and stops the construction of new collagen, in the most serious cases causing serious illnesses such as scurvy. The symptoms of scurvy, namely the loss of teeth and easy shedding of skin, are caused by the lack of collagen to repair the small tears caused by daily activity. An altered diet filled with refined sugars and saturated fats can also damage the collagen structure, as excess sugars can bind with the amino acids forming the structure, altering and deforming it, and causing it to lose much of its function.

The space between its fibres increases, appears inhomogeneous and can no longer have the compact appearance, typical of youth. Furthermore, its stoechiometric structure represents the perfect target for radical acids.

Collagen represents approximately 30% of the total proteins and can change, on the basis of the environmental and functional demands, taking on variable degrees of rigidity. Collagen is produced by fibroblasts with the protein synthesis that takes place until the stage where the pro-peptides of the tropocollagen are formed. (Photo 11) Subsequently, this is exocytosed and through the exopeptidases in the matrix, the pro-peptides are eliminated and the tropocollagen molecules assembled by the 'collagenine' according to the type of collagen for which synthesis is required.

Photo 11



Elastic fibres.

Photo 12

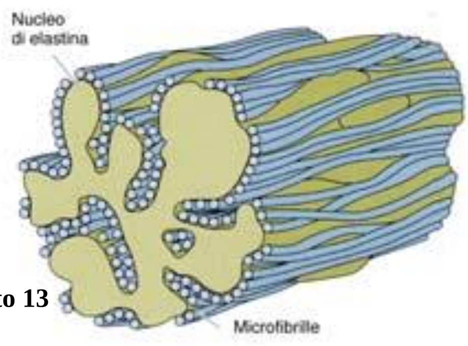


Photo 13

Elastic fibres (photos 12-13) are produced by the connective fibroblasts and by the smooth muscle cells of the blood vessels, and are thin fibres that can be stretched to one and a half times their length. These comprise elastin and fibrillin micro fibrils organised into a very ordered layout. The central axis of the fibres comprises elastin, protein made up predominantly by amino acids such as glycine, lysine, alanine, valine and proline, and is surrounded by a micro fibril sheath of fibrillin, with a diameter of 10 nm. The elastin chains are aligned together in such a way that the 4 molecules of elastin of 4 different chains form covalent links (links crossed by desmosin). Fibrillin is a glycoprotein that is widespread particularly in the arterial and venous vessels. As already mentioned, the main characteristic of these fibres is their great elasticity: they can, in fact, bear even significant torsion and tension, stretching and then returning to their original dimensions. We should specify that this is passive deformation: these fibres, in fact, only alter their extension by means of external pressure factors, or following contraction of muscular fibres. Elastic fibres can also blend amongst themselves, leading to *lamina* or *elastic membranes* where greater deformability is required, such as in the tunica media of the blood vessels. They are coloured to their typically brown shade, by the orcein.

Reticular fibres.

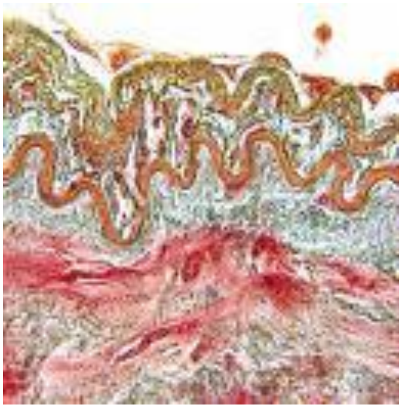


Photo 14

The reticular fibres too (photo 14) comprise collagen chains, but these are organised to form a ramified weave rather than strips, laying out over two planes or in a three-dimensional sense. As compared with collagen, reticular fibres are thinner and have a greater glucide component, reacting positively and weakly to the PAS colouring technique. As the fibres are thin, they can be shown up by means of argentic impregnation. It is for this reason that they are also called *argyrophilic fibres*. They form nets within full organs such as the liver.

After having discussed the anatomical and physiological constitution of the mechanical components of connective tissue, we must now take a thorough, detailed look at the make-up and function of the extracellular matrix. Most recent discoveries have, in fact, shed new light on its function and relational capacity with the other systems.

The extracellular matrix

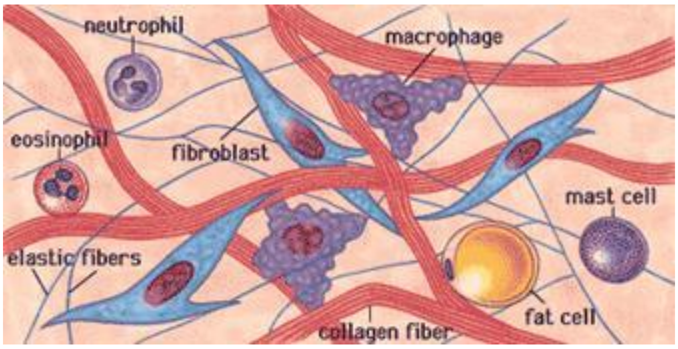


Photo 15

The matrix (photo 15) comprising the intercellular substance of the loose connective tissue, is formed by a very viscous amorphous ground substance in which there is plenty of water originating from the diffusion of the blood capillaries in the tissue. There are plenty of organic molecules in the matrix, mucopolysaccarides, complex polymers of some sugars, glucosaminoglycans and adhesive glycoproteins. These compounds link

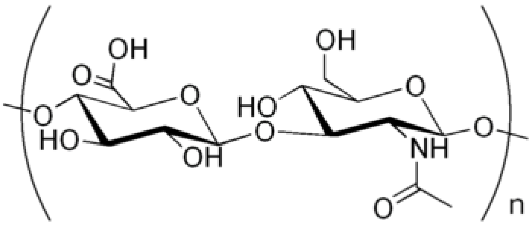


Photo 16

to other organic molecules, the proteins, and constitute ramified compounds known as mucoproteins or proteoglycans. The mucopolysaccarides include hyaluronic acid, (photo 16), chondroitin sulphates, keratan sulphate and heparin. As the extracellular matrix therefore comprises ground substance and fibres, its main function is to resist pressure by a correct hydration of its ‘gel’, whilst the main function of the fibres comprising it, is to resist traction. Furthermore, the presence of water permits and facilitates the spread of nutritional substances and gasses and constitutes, therefore, an important layer of communication between the blood vessels and the tissues below. The glucosaminoglycans or GAG are long chains of disaccharide units repeated and negatively charged as they are filled with hydrogen sulphide groups, very hydrophilic and link, therefore, Na+ cations that hydrate the matrix by recalling water (e.g. N-acetyl glucosamine).

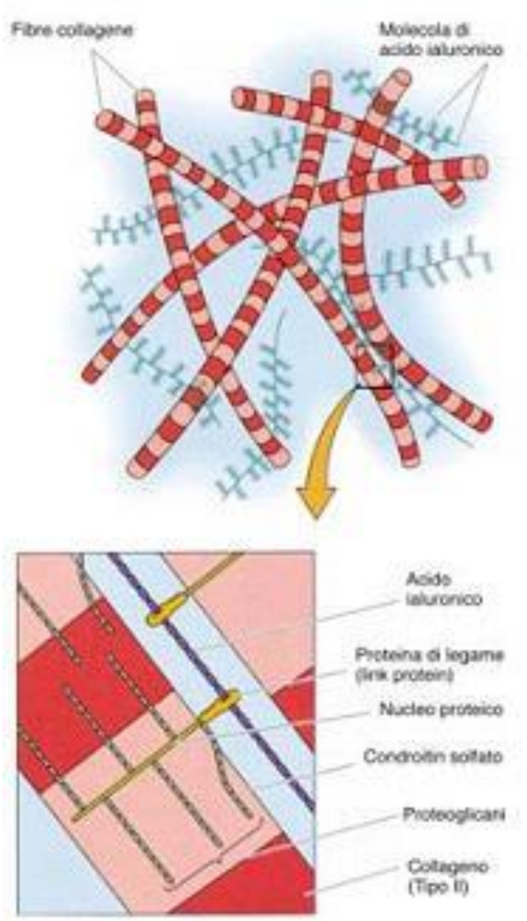


Photo 17

Proteoglycans (photo 17) are proteins on which glucosaminoglycans link in a covalent manner, and, like these, are sulphurs. They are often associated with hyaluronic acid by means of certain proteins that act as bridges between them and which are responsible for the jellification of the extracellular matrix (liquid diffusion barrier or formation of the 'blister' after injection) and also act as receivers for some hormones. Adhesive glycoproteins are glycosylate proteins with various link sites both for the various different components of the extracellular matrix and for the membrane surface proteins (integrins). The main glycoproteins are fibronectin, laminin and entactin.

By analysing this component in greater depth, we have seen, and it is now a universally accepted fact, that the conditions of the fibrous part and of the ground substance of the connective system, are partially determined by genetics and partially by environmental factors and nutrition and physical exercise above all. Protein fibres are, in actual fact, able to modify themselves to meet environmental and functional needs. The ground substance varies its status continually to more or less viscous (from fluid to sticky and even solid), depending on specific organic needs. Although present in all tissues, it is to be found in large quantities in synovial joint fluid and in the ocular vitreous humour. Its components that are able to withhold water, link ions and form weak or covalent links, mean that connective tissue varies its structural characteristics through the *piezo-electric effect*, or rather: any mechanical force that creates structural deformation stretches the molecular ligaments producing a slight electrical flow (piezo-electrical load). This load can be the ‘primum movens’ of multiple cell cations, leading to biochemical alterations. From a mechanical viewpoint, MEC allows for the amortisation and distribution of tension forces due to movement and gravity, simultaneously keeping the form of the various different body components through a wide range of possibilities that go from the rigidity of a continuous compression structure to the elasticity of a tensegrity structure, namely structures containing both elastic and rigid structures as can be found in the skeletal tissue.

Photo 18

In the aponeurotic-muscular-skeletal system (photo 18), the parts subjected to compression, the bones, push outwards against the parts in traction (myofascia) that push inwards. This type of structure has a more elastic stability than that of continuous compression, and become more and more stable as they are loaded. All the elements interconnected by a tensegrity structure rearrange in response to a local tension. The same skeleton is, in actual fact, only apparently a continuous compression structure, as the bones rest on slipper surfaces (joint cartilage) and without the myofascial support, are not able to support themselves. As such, varying the tension of the soft tissues means varying the bone layout and the minimum change to an organic 'angle' is mechanically and piezo-electrically transmitted by means of the tensegrity network, on all the remaining parts of the body.

The extracellular matrix also supplies the chemical-physical environment for the cells it encompasses, forming a structure to which these adhere and within which they can move freely, keeping an appropriate ionic, hydrated and permeable environment through which the metabolites can be spread. The density of the fibrous matrix and the viscosity of the ground substance (due to the GAGs, mucopolysaccarides, Proteoglycans and all the compounds described previously, determine the free flow of the chemical substances amidst the cells, at the same time preventing bacteria and inert particles from penetrating. By combining a small variety of fibres within a matrix that varies from fluid to sticky to solid, the connective cells respond to the demands of flexibility and stability, diffusion and barrier. Local ‘obstructions’, such as fascia adherences, that can derive from excessive strains or lack or exercise, traumas, etc., force the cells to have an altered metabolism that is returned to normality once the causes have been eliminated. Furthermore, the study of the piezo-electrical cellular effect has allowed us to create excellent physiotherapeutic tools that act on the redistribution of the membrane’s electrical loads, determining a return to normality, and particularly in the above described pathological conditions.

Integrins

The high technology of the electronic microscope has made it possible to reveal many secrets on the constitution of the cell membrane, both with regards to its structure and its function. Considering the constitution of the cell membrane and its cytoplasm, the fact that these two units are intimately connected, cannot fail to hold our attention. (Photo

19) In fact, the cell we have seen today comprises filaments, microtubules, fibres and trabecules forming a structure defined as the *cytoplasmatic matrix* or *cytoskeleton*.

In this condition, there is very little space available to allow for the random diffusion of molecules. There is also very little water present in a free state, as it is almost entirely

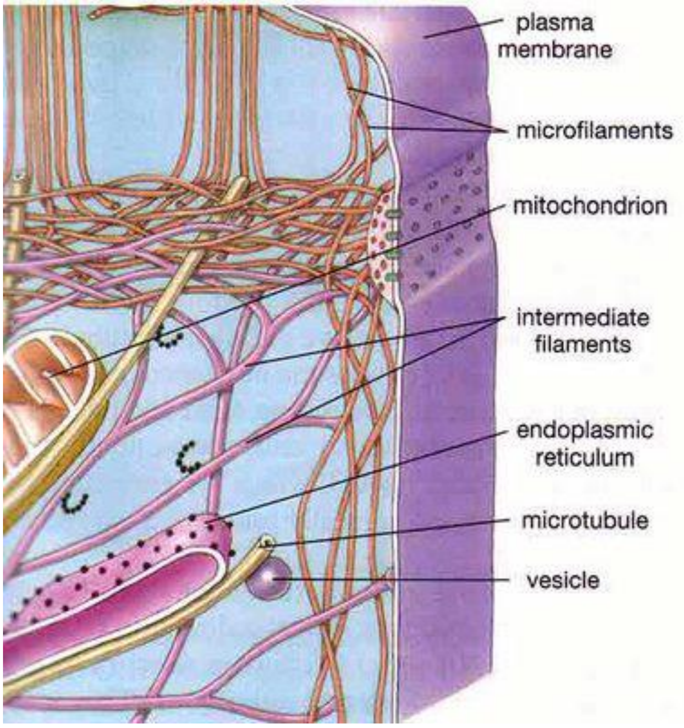


Photo 19

in a state of solvation, as occurs for the connective tissue proper. The cytoskeleton mainly comprises microfilaments of actin, a globular protein, and microtubules of tubulin, a tubular protein. Microtubules and microfilaments form and separate spontaneously as specific environmental conditions occur, such as, for example, in the presence of Ca^{++} and Mg^{++} ions. During the first half of the 1980s, we understood the role played by the cytoskeleton in supporting the cell in order to allow for the movements of the cell itself and of the vesicles within and outside the cytoplasm, and of its implication in the processes of cell division. These particular links that are created, are those responsible for that interaction that develops between the extracellular matrix and the cytoskeleton system in order to keep all the structures of our body together. Today, we have discovered that these links affect physiological processes such as embryo development, blood coagulation, wound healing, etc.. After these discoveries, there is no need to point out that the mechanically changing connections between the cell and the ECM have entirely cancelled out the idea that cells are united to themselves as they float in an amorphous substance. In fact, the double casing of the phospholipid cell membrane is not only highly concentrated, both inside and out, with chemoreceptor (globular proteins with a specific structure for given chemical agents able to modify cell activity), but also has some two-chain structure membrane glycoproteins, defined as **integrins**, that act as *mechanoceptors*.

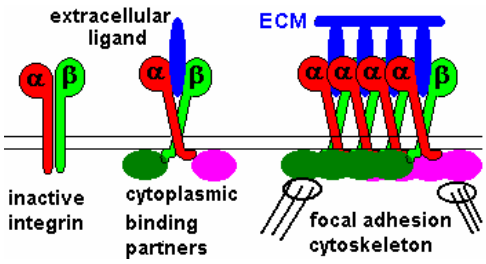


Photo 20

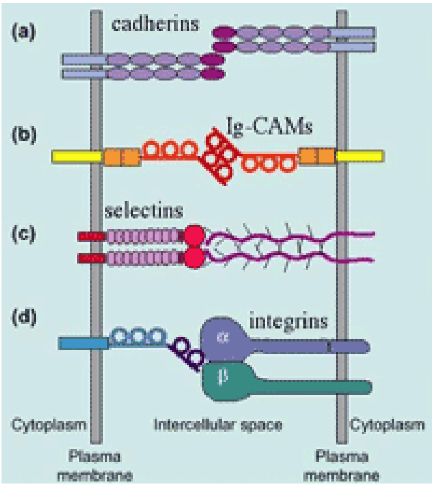


Photo 21

The integrins (photos 20-21-22) interact with the extracellular matrix proteins, and particularly with the glycoproteins, factors of the completion, interleukins and other, transmitting tractions and mechanical thrusts from the extracellular connective fibrous matrix to the inside of the cell and vice versa. The integrins appear virtually on every cell of the animal kingdom and, as of today, would appear to be the main receptors through which the cells adhere to the extracellular matrix, and are able to mediate important cell-cell adhesion events. Furthermore, their capacity to translate signals inside and outside the cell, in a selective and modular manner and in a wide range of cell types, has also been proven, even in synergy with other receptor systems.

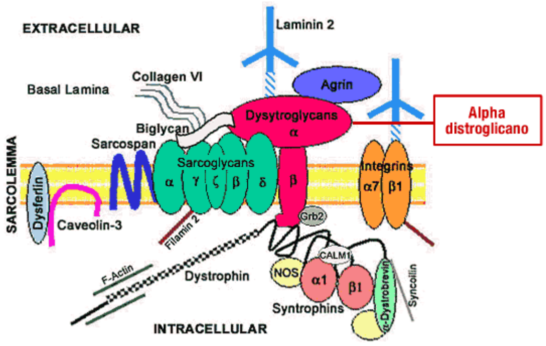
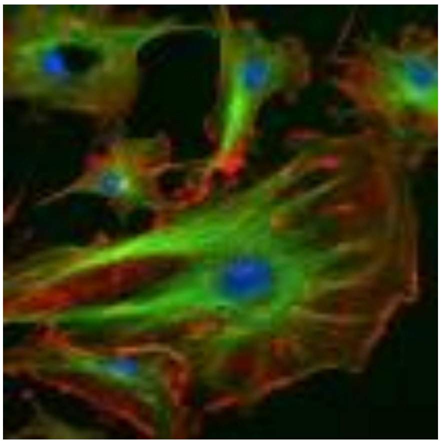


Photo 22

Integrins are therefore versatile molecules that play a key role in the various cell processes, both during development and in the adult organism: cell migration and adhesion, cell division and growth, survival, apoptosis and cell differentiation, support to the immune system and much, much more. The mechanics of the connections between the extracellular and intracellular matrices is reached by means of a numerous series of weak (not covalent) and indirect links through specific ‘armouring’ proteins (talin, paxillin, alpha-actinin to mention just a few of the most important) that connect or disconnect very quickly (‘velcro’ effect). The cells are therefore linked by means of a matrix that communicates with them through active weak

Photo 23



links according to a geometry of tensegrity that varies constantly on the basis of the cell activity, organism and condition of the matrix itself. The connection of the cell to the extracellular matrix is a basic requirement for the formation of a multicellular organism. It allows the cell to resist pulling forces without being thrown out of the ECM. The integrins also represent the structures that allow the cell to migrate into the extracellular substrate.

These connections act by allowing the cell shape to change (photo 23) and therefore also its physiological properties. The studies carried out by Ingber and published in the journal 'Scientific American' in 1998, have, in fact, shown that by simply modifying the cell shape, various different genetic processes are induced. By forcing the cells to take different shapes, by placing them onto ‘adhesive islands' comprising extracellular matrix, meant that the flat, stretched cells were more likely to divide, interpreting this state as a need for more cells to fill the surrounding space (as occurs, for example, in wounds). The rounded cells, on the other hand, which were prevented from extending, by being compressed, activated an apoptosis programme to avoid overcrowding, as generally takes place in tumours. When, on the other hand, the stimulus was modulated, the cells performed specific physiological activities on the basis of their origin and differentiation (capillary cells formed vessels, hepatic cells secreted hepatic substances, etc.). Most of these studies looked above all at the intrinsic mechanisms carried out in tumours in a broad sense. One study carried out in 2005, in fact, focussed on 'integrins and tumours' and published in 'cancer cell', highlighted a link between tissue rigidity and the formation of tumours, showing how the mechanical forces can adjust cell behaviour affecting the molecular signals that govern the spread of neoplastic cells. The researchers examined tumour cells during development within a three-dimensional gelatinous system, in which rigidity could be carefully controlled. They discovered that even a slight increase in the hardness of the surrounding extracellular matrix perturbs the tissue architecture and encourages growth, promoting focal adhesion and the activation of growth factors. Clearly all these complex processes are still being studied in greater depth. To summarise the concepts explained so far, it is now clear, and universally accepted by all scientific communities, that connective tissue is, in actual fact, a system that connects all the various systems of our organism. It forms a ubiquitarian network, a tensegrity structure that envelops, supports and connects all the body's functional units, thereby making an important contribution to its metabolism. The physiological importance of this tissue, is, in actual fact, far greater than imagined. It is part of the adjustment of the acid-alkaline balance, of the hydro saline metabolism, of the electrical and osmotic balance, of the blood circulation and the nervous system. It is the home of a great deal of sensorial receptors, including nervous exteroceptors and proprioceptors. It anatomically and functionally determines the muscles, structuring them into myofascial chains, thereby playing a fundamental role within the system of balance and posture. It is, in fact, precisely in the connective system, that the posture and pattern of movement is recorded through the connective mechanics, which affect most of the reflex mechanisms of the neuromuscular fuses and tendon organs of the Golgi (proprioceptive sense organs through which the nervous system discovers what is happening at the myofascial network). The connective system also performs a barrier action to the spread of bacteria and foreign substances, within cells of the immune system within, namely plasma cells, macrophages and other. It also has great reparative post trauma, lesion and loss of substance capacity. Differently from the complex interaction mechanism that takes place in the nervous system or endocrine and immune system, that of the connective system has a more archaic, yet no less important, method of interaction, which is mechanical communication. It 'simply' pulls and pushes, thereby communicating from fibre to fibre, from cell to cell and from internal and external environment to the cell and vice versa, through the fibrous weave, the ground substance and the sophisticated mechanical signal translation systems. In the last decade, we have begun to study this type of communication, paying particular attention in view of the development of instrumental and biochemical immunoenzymatic technology. We also need to consider the fact that the connective system is the fundamental integrated substrate on which the other systems (nervous, endocrine and immune) can interact. At the same time, these latter systems are able to cause major changes to the connective system, such as, for example, in the scar and inflammatory processes or, more simply, by considering the fascia changes determined by the muscles through the nervous system during contraction (we can consider the entire muscle system as a single gelatine that rapidly changes state in response to a nerve stimulus contained within 650 connective pockets). Last, but by no means least, *diet* is another key factor significantly affecting the connective system.

The erroneous assumption of macro and micro elements leads to very important alterations affecting, even seriously, the entire body. For example, scurvy due to lack of vitamin C, where the fibroblasts no longer synthesise collagen, or the lack of solvation and jellification capacity due to a lack of GAGs and other matrix proteins. To summarise this brief *excursus*, we have seen that the human body works, therefore, as an integrated net that joins the various organs and systems. The codes are the same and the substrate is common to the whole network. Whether cerebral circuits activated by emotions or thoughts, or neurovegetative circuits activated by demands or feedback from organs or systems, or endocrine or immune organs, or even mechanical connective tensions, through movement and muscular activation issuing messages, the latter, for the most part, are recognised by all network components. There is a single language. The connection is integrated and runs both ways. From here we deduce that any stimulus induced can exploit these multiple possibilities of entrance to the 'large connection'. On this basis, in fact, many interventions are possible: food education, pharmacotherapy, physical therapies, instrumental therapies, body and ergonomic techniques. The aim of the therapeutic intervention is to encourage the restoration of a balanced physiological communication between the systems. The importance of further research in this field is all too clear. We cannot ignore the study of the connective system if we wish to fully understand the global and local physiological behaviour. The study of the biochemistry can no longer be simplified into linear sequences of chemical-physical reactions, but we need to consider the active and dynamic habitat in which the 'chemistry of life' takes place, or rather that material that biochemists discard in purifying 'soluble' enzymes, and through which surgeons make way in their operations. *The connective system.*

The development and evolution of the mechanised connective massage

Starting from these anatomical-physiological remarks, it is now much clearer how Mrs. Dicke managed to obtain incredible results, thereby meaning that her method was so widely spread throughout the world. Clearly the results were directly proportional to the worker's anatomical and physiological knowledge and, above all, to their manual skills. At the end of the 1970s and start of the 1980s, an electro-medical device was developed in France to carry out mechanised physiotherapy with the aim of reducing the differences in results reported by different workers and the same worker if results of the first patient treated are compared with the last, thereby guaranteeing a result that can always be repeated. Thanks to this significant intuition and the capacity of the machine to perform a 'total body connective massage', this appliance has enjoyed undisputed success for around 20 years, and particularly in the field of cosmetic medicine (Endermologie method). Proceeding with the use of a mechanised treatment, however, some results do not satisfy expectations.

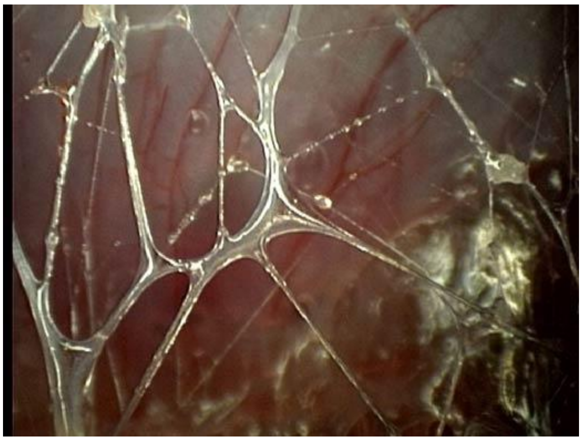


Photo 24

The admirable intuitions of a French reconstructive plastic surgeon, Jean Claude Guimberteau, led to a new anatomical-structural view of the connective tissue, that well blends with the latest discoveries as explained previously. Curious by the multiple movements of the hand and the skin’s capacity to adapt perfectly to sudden changes in force and traction, with the help of a micro-video camera of his own invention, Guimberteu was able to show that the connective system *in vivo* looks much like a three-

Photo 25

dimensional spider's web, comprising structural collagen fibres and others that slide amongst themselves, placed to outline the spaces that he named ‘micro vacuoles’. (Photo 24). The presence of collagen fibres had already been well demonstrated in dissection interventions, where a series of filaments were reported that, starting from the fibrous fascia, enclosed the entire structure, without, however, attributing them any function beyond that of keeping the sub-skin attached to the muscular fascia deep down. (Photo 25)

The new concept: the microvacuole

These structures, instead, ‘enclosed’ by ground substance containing all the components of the extracellular matrix, according to Guimberteau’s theory, allow for the amortisation and displacement of the lines of force due to gravity and the dynamic of movement during its execution (photo 26). Specifically, this structure retains blood flow, keeping it constant even during extreme conditions, e.g. weight lifting exercise. This feasibility is easily explained with the theory of tensegrity, which allows the entire tissue to keep structural stability both in static, and even more so in dynamic. We can see how all structures involved act in synergy, not alone, during movement, by means of the cyto

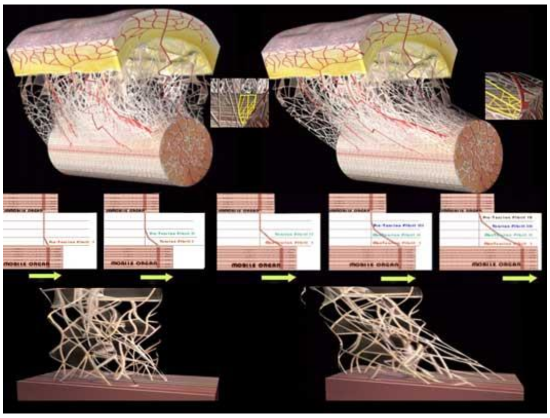


Photo 26

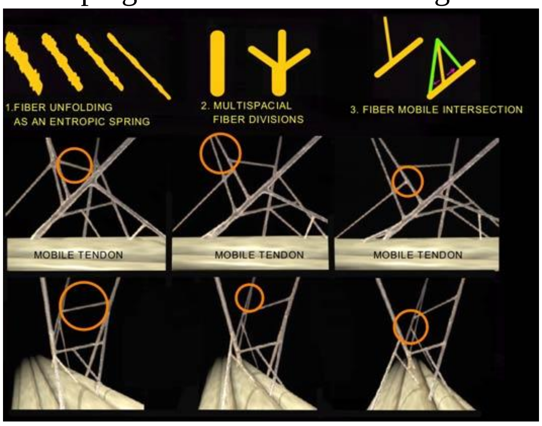


Photo 27

architecture of the micro alveolar unit. The collagen fibres run one over the other, according to the plans and lines of force during movement, (photo 27), allowing the whole structure to participate, separating out and directing the incidence of the force onto the structure itself, or onto several structures. It is a multi micro vacuole collagen system of dynamic absorption.

The connective vacuole is a mobile, global, shared tissue. IT occupies all planes and covers the adipose lobules. It filters through the muscular fibres. It is an optimal sliding system, without impacts and without demands on the peripheral tissues. It ensures continuity of the living tissue web and adjust intra-bodily physical forces. The intra micro vacuole pressure constitutes the basic unit. Its collagen structure is a system comprising fibres, fibrils and sub-fibrils that divide up, stretch, contract, resist and slide over each other. The tensions and pressures are shared out in all senses. The fibril structure inclines in 3D. This tissue comprises billions of micro vacuoles with dimensions varying from a few microns to a few tens of microns, organised randomly, with a chaotic layout, fragmentary appearance, apparently similar but all unique. The vacuole volume comprising the criss-crossing of the fibres can only be seen in the 3 dimensions of space. The vacuole is a volume with walls, a shape, sides and a content. It is a polyhedral fibrillar environment containing a gel of ground substance.

The fibres making up the structure of each vacuole are in continuity with each other, and essentially comprise type I collagen (70%) types 3 and 4, but also elastin (approximately 20%). There is also a high percentage of lipids (4%).

They head in all directions, with no pre-established diagram or any relation with logic. They are interconnected and vibrate against each other. Furthermore, the constitution of micro vacuoles would also explain how there can be damage to the load-bearing structures in the event of excess liquids, traumas, hydra depletion, and how a local problem can have general effects and vice versa. The condition of ‘inflammation’ of which we are well aware, initially on a local level, and then more generally, freeing up lytic enzymes, lymphokines, completion factors, activating macrophages and lymphocytes and a whole series of immuno-enzymatic activities, affects the variation of the cyto-sol condition both of the extracellular matrix and the cell cytoplasm of the structures involved, determining as a first result, an alteration of the cell metabolism that affects the capacity to keep the functions of the micro circulation whole, with consequent interstitial oedema. From this point, should the organism be unable to provide a solution, a series of events take place that become more and more important, until reaching very serious conditions such as structural subversion, as in the case of degenerative muscular skeletal diseases. This is why it is always extremely important to attempt to prevent or limit the 'damages caused' in an initial phase and/or restore the initial homeostasis conditions, abolishing and eliminating all risk factors such as smoke, alcohol abuse, overeating, particularly of saturated fats, and a sedentary lifestyle. In short, a correct lifestyle should be led. All these factors contribute to the body's 'ageing' as a whole, enormously limiting our capacity for recovery.

Roboderm® and Icoone

Starting from this new anatomical-structural viewpoint, comforted by the latest scientific discoveries and blended with the experience of previous technology, an attempt has been made to create an appliance that is able to respect the cytoarchitecture as far as possible, and the function of the structure as described above. The aim is to selectively stimulate the connective tissue and, if possible, to guide it to reaching preset results. The method was first used in the medical field, and subsequently, given the good results, in

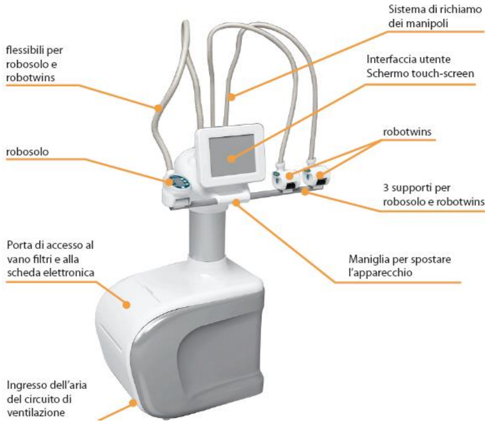


Photo 28

cosmetics, and particularly in P.E.F.S.. This appliance, known as Icoone, uses an advanced technology known as 'Roboderm'.

Photo 29

The machine comprises a central body to which three handpieces are connected. The largest is the Robosol, and the two identical, secondary handpieces are called Robotwins. (Photo 28) Each handpiece comprises a central suction chamber limited by two parallel rollers, with 156 holes in the Robosolo and 132 in the Robotwins. Suction is not only applied by the central chamber, but also by the holes in the rollers (photo 29) or only by the rollers, excluding the central chamber, depending on the therapeutic indications best suited to the tissue. With these technical characteristics, the skin surface treated by the two rollers, is never pulled and raised in folds, but rather stimulated in a punctiform manner without trauma, and 1180 times per square decimetre. This characteristic has been determined in order to eliminate most of the side effects of vascular trauma induced, as has been shown by many other appliances in their relevant reports. (Photo 30) This form of stimulation is able to transmit deep down, like the propagation of sound waves, according to the concept of alveolar or fractal micro stimulation. This mechanical stimulus, in accordance with the nature of the piezo-electrical effect generated by the moving of ionic loads, both in the matrix an din the cell membranes, and by the mechanical response deriving from the stimulus of the integrins, encourages the functional restoration and renovation of the entire collagen structure supporting the connective tissue being treated. (Photo 31) Should, in fact, the quantity of bio-available vitamin C fall within normal

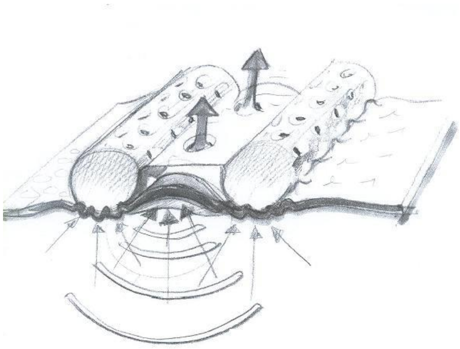


Photo 30

limits, the mechanical stimulus is able to increase cell turnover in a restructuring manner. This effect had already been demonstrated in an experiment carried out on genetically modified piglets from Yucatan, where, after a mechanised connective massage, an increase in quantity both of newly formed collagen and capillaries, was observed.

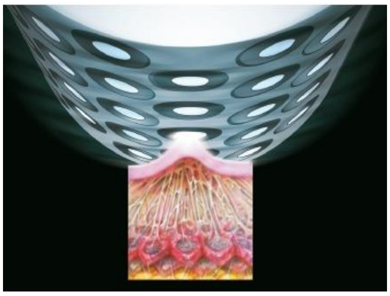


Photo 31

The Roboderm® technique has been designed and built in order to provide a performance in accordance with the micro vacuole theory, and is able to give an appropriate, repeated stimulus with no traction of underlying structures, as was the case in all previous methods, thereby yielding the result of improving the trabeculae of the micro vacuole itself. Roboderm®'s method of acting leads to extremely important alterations in the extracellular matrix too, stimulating it in such a way as to maintain correct hydration. In fact, if we remember that collagen is structured outside the cell, and that the hydra environment is maintained by the GAGs and proteoglycans, we can understand just how cell activation leads to an increase in the protein synthesis aimed at maintaining optimal matrix condition with, of course, the continued and increased production of these substances. We have seen how it is a fundamental condition that allows for the 'integrated communication' of the various systems. The treatment action performed on the whole body, in fact, leads to a series of responses. The stimulus of skin receptors, through the neuro-sensorial fibres, transmits the signal that reaches the rear horn of the spinal marrow. From the rear horns, the signal runs along the extra-pyramidal system that, connecting up with the neuro-vegetative system, is translated at the cortical level, in turn determining both local responses, such as the relaxing of an internal organ (the stomach or colon) and general responses, like the increase of subcutaneous capillary perfusion due to induced vessel dilation. The multiple nature of these actions, which take place in synergy, allows for a trophic stimulation of all structures involved by the massage, maintaining a young, elastic, compact appearance of the tissues.

Connective massage method with Icoone

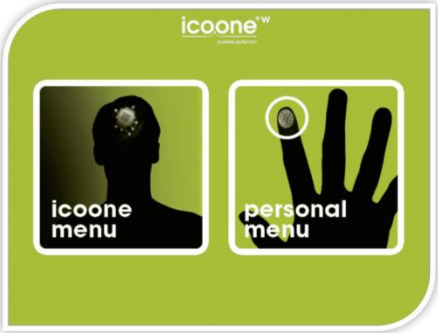


Photo 32

The appliance has a touch screen (photo 32) showing the treatment programmes. Its software is able to manage a combination of different programmes in order to optimise treatment of the different body areas. The possibility of varying the suction combinations, both of the central chamber and rollers, allows the user to change intensity and quality of treatment during a single session, mechanically respecting the structural differences of the various body zones. Before beginning a cycle with Icoone, the patient is subjected to an impedenziometric examination, in order to evacuate his body make-up (thin mass, fatty mass, extracellular liquids, total water, body mass index, basal metabolism). This data provides a specific indication as to any corrections the patient will need to make to his lifestyle and on the choice of programme to be used. Subsequently, photographs are taken with the patient wearing the pants supplied with the suit. The photos are taken by using a checked panel supplied with the appliance as a background. Light intensity and distance must be maintained in order to allow for the exact reproduction at the end of the treatment.

Foto 33

The massage is carried out with the patient wearing a thin, adherent suit (photo 33), both to protect their privacy and modesty, and to uniform and facilitate the contact of the roller surfaces with tissues, a fundamental aspect for an optimal result. Once a correct diagnosis has been made, the patient lies on the bed and the treatment programmes most appropriate to the problems highlighted, are chosen. The machine software develops the programme selected (Robosolo or Robotwins) and, showing a series of parameters such as suction power, frequency and rhythm, roller speed etc., allows the operator to vary all parameters and manipulations, as he deems most appropriate. For some areas of the body, such as the buttocks for example, with a wide, concave surface, the machine suggests using the Robosolo. Where, however, the tissue conditions do not allow for too energetic an action, as is that performed by the Robosolo, the massage can be carried out with the Robotwins until such time as the structure is able to use the main handpiece. It is important to stress that the treatment must be carried out with absolutely no pain. It must be perceived as a pleasant sensation to stimulate the neuro-sensorial system. And to increase this stimulus, most of the treatment programmes have been designed to use the Robotwins to give, as in a manual massage, the sensation of hands working together. In this way, as has been the case for thousands of years of manual massage, we begin by opening the main lymph nodes, terminus, aortic, armpit, inguinal and popliteus. Icoone follows these indications and manoeuvres lymph drainage, in order to eliminate the excess extracellular liquids through the venous-lymphatic system. As treatment continues, the bio-humeral and structural conditions of the tissue naturally change, hence different programmes are used together. In this way, each area of the body is stimulated in the most appropriate manner. Each session lasts approximately 30-40 minutes and, despite the fact that it is delicate enough to be carried out every day, two sessions a week are advised. However, in particularly important lymphatic extravasation, treatment can be carried out three times a week until such time as the lymphangitic picture is resolved, when twice-weekly sessions can be continued. At the end of the treatment, the series of photographs and impedenziometric examination are repeated, in order to provide clear documentation of the results obtained thus far. When the initial conditions are particularly serious, and a fairly high number of sessions is prescribed, the impedenziometric examination and series of photographs should be made several times during the treatment cycle, in order to document results obtained, comfort the patient by showing their improvement, and also allows for a more accurate alteration of the treatment protocol parameters. Treatment with Icoone is an excellent, if not extraordinary, way to remodel the entire body connective tissue. It does not cause weight loss but does help to restore tissue function during slimming. It does not replace surgical intervention where required, but does improve results, reducing healing time and stimulating tissues. A correct diagnosis associated with a correct lifestyle, namely correct diet and physical activity, is essential to obtaining the set results with Icoone. If the patient is not actively involved, the excellent results, from both an aesthetic and function point of view, that the machine is able to guarantee, cannot be obtained.

Conclusions

From this discussion, we can say that the electro-medical appliance Icoone, has been built in consideration of the most recent scientific discoveries and in accordance with the most sophisticated modern technology. Apart from this, it has accumulated thousands of years of practise that have allowed the technique of massage to be handed down to today, and no one can deny its therapeutic value in both the functional and cosmetic medical field. This fractioned mechanisation offered by massage, has the effect of regularising the microcirculation, causing neo-synthesis of collagen and elastin, as a relay on the level of extracellular matrix, neuro-sensorial and neuro-muscular activation and, certainly, much more that use in the years to come will allow us to discover and appreciate. Also in consideration of the fact that the whole body renews all its cols thousands of times during our lives, the multi micro fractal stimulation is able to maintain long-living cells that affects the entire body, granting a youthful appearance despite the effective age. As of today, Icoone is the only electro-medical appliance the world over that is able to obtain these results, whilst maintaining the ‘intimacy’ and ‘contact’ that mark a hand-applied massage.

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Contents

LEGEND

Photo 1:

All the main types of connective tissue cell originate from the embryonic mesenchyme
Mesenchymal cell – haematopoietic staminal cell
Chondroblast – adipocyte – fibroblast – mesothelial cell – endothelial cell – osteoblast
Chondrocytes – osteocyte

N.B.: The endothelium of the capillaries also derives from the mesenchyma, but due to its structural organisation, it has been placed between the epitheliums.

Photo 13

Elastin nucleus
Micro fibrils

Photo 17

Collagen fibres – molecule of hyaluronic acid
Hyaluronic acid
Link protein
Protein nucleus
Protein nucleus
Proteoglycans
(Type II)

(immagine p. 30)

Hoses for Robosolo and Robotwins
Handpiece recall system
User interface
Touch-screen
Robosolo
Robotwins
3 supports for Robosolo and Robotwins
Access door to filter container and electronic card
Handle to move the appliance
Air intake for the ventilation circuit