

Chapter 5: Intravenous laser blood irradiation - Introduction of a new therapy

第5章：静脉内光血液照射-新疗法介绍

5.1 Introduction

5.1 简介

The method of intravenous laser blood irradiation was first introduced into therapy by the Soviet scientists E.N.Meschalkin and V.S.Sergiewski in 1981 [32]. Originally this method was developed for the treatment of cardiovascular diseases. Improvement of rheologic properties of the blood as well as improvement of microcirculation and reduction of the area of infarction had been proved.

静脉内光血液照射的疗法最初由苏联科学家E.N.Meschalkin和V.S.Sergiewski于1981年引入 [32]。刚开始这种疗法是为治疗心血管疾病而研发的。已经证实能改善血液的流变性质以及微循环和减少梗塞面积。

Further reductions of dysrhythmia and sudden cardiac death occurred [4,21]. At first only the heliumneon-laser (632.8 nm, red light) was used in this therapy. A power of 1-3 mW and a period of exposure of 20-60 minutes were applied. The treatments were carried out once or twice a day for up to ten appointments in total. In the years after, many (for the most part Russian) studies showed that heliumneon-lasers had various effects on many organs and on the hematologic and immunologic system. The studies were published mainly in Russian and were little known in the West because of decades of political separation and were regarded with disapproval. Besides clinical research and application for patients, the cell biological basis was developed by the Estonian cell biologist Tiina Karu at the same time. A summary can be found in her work "The Science of Low-Power Laser-Therapy" [19].

进一步减少节律障碍和心源性猝死的发生[4,21]。期初，该疗法中仅使用氦氖光（632.8nm，红光）。施加1-3兆瓦的功率和照射20-60分钟。每天一次或两次治疗，一疗程最多十次。此后的几年中，许多（大多数是俄国人）研究表明，氦氖光对许多器官以及血液和免疫系统都有不同的疗效。这些研究主要以俄语发表，由于几十年的政治隔阂使得在西方鲜为人知，且不被认同。除了临床研究和患者应用外，《细胞生物学基础》同时由爱沙尼亚细胞生物学家Tiina Karu研发。在她的作品“低功率光疗学”[19]中可以找到相关介绍。

5.2 Effects and mode of operation of intravenous low-level-laser-therapy of the blood

5.2 静脉内低强度光治疗血液的效果和治疗方式

1. During laser blood irradiation, anti-inflammatory effects and improvements of the immunologic activity of the blood were observed.

1.光血液照射期间，可见抗炎作用和提高血液免疫活性。

2. A fundamental finding was the positive influence on rheological properties of the blood. This is of great interest to surgery, angiology and cardiology in particular [50]. A diminishing tendency of aggregation of thrombocytes and an improved deformability of erythrocytes result in an improved oxygen supply and further to a decrease of partial carbon dioxide pressure, which is particularly relevant to wound healing [10, 27, 59]. Furthermore, the activation of phagocytic activity of macrophages was proved in conjunction with structural modifications [8, 22]. A positive effect on the proliferation of lymphocytes and B- and T-cell-subpopulations could be verified, too [13, 50, 38].

2.基础研究成果对血液流变性质的积极影响。对手术、血管科和心脏病科的治疗尤其重要[50]。血小板聚集趋势减小和红细胞的可变形性改善诱导供氧改善且进一步降低局部二氧化碳压力，这尤其与伤口愈合相关[10,27,59]。此外，与结构修改相结合证明了巨噬细胞的吞噬活性被激活[8,22]。还证明了对淋巴细胞、B细胞和T细胞亚群的增殖起积极的作用[13,50,38]。

3. The hypoxia of the tissue is improved, leading to a normalization of the tissue metabolism. In addition, the fibrinolysis will be activated [35]. Apart from the elimination of hypoxia and normalization of tissue metabolism, an increase of ATP-synthesis and normalization of cell membrane potential could be observed [44]. Additional vasodilatation leads to de-blocking of capillaries and collateral vessels in connection with improved rheological properties of the blood, improved tissue trophicity and normalization of neurosensory stimulation. The increased release of NO from monocytes is of significant importance as well [29]. Because of these mechanisms and effects, the intravascular blood irradiation is also used in Russian university clinics for surgery to avoid preoperative thromboembolic complications and to improve postoperative woundhealing [12,27]. In addition, there are laser specific analgetic, spasmolytic and sedative effects [14]. There are reports on patients with chronic glomerulonephritis where intravenous laser therapy lead to significant improvement of tolerability of medication (glucocorticoids, cytostatic drugs, diuretics) and of kidney function [30]. In the same way, an improvement of inflammation parameters in acute pyelonephritis could be shown [7]. In necrotising pancreatitis, an improvement of blood lab values and of the immunological parameters had been proved, too.

3.组织缺氧症状得到缓解，诱导组织代谢正常化。此外，激活纤维蛋白溶解 [35]。除了消除缺氧和组织代谢正常化外，可见三磷酸腺苷合成增加和细胞膜电位正常化[44]。与改善血液的流变性质、提高组织的营养机能和感觉神经刺激的正常化相关，血管舒张还诱导毛细血管和侧支血管的去阻塞。单核细胞中一氧化氮释放的增加也是非常重要的[29]。基于这些机制和疗效，血管内血液照射也被用于俄罗斯大学诊所的手术，以避免术前血栓栓塞并发症和改善术后伤口愈合[12,27]。此外，还有光特异性镇痛、解痉和镇静的疗效[14]。有报道称慢性肾小球肾炎患者采用静脉内光疗可显著改善药物（糖皮质激素、细胞抑制剂、利尿剂）和肾功能的耐受性[30]。同样，可见急性肾盂肾炎的炎症参数的好转[7]。在坏死性胰腺炎中，也证实了血液化验值和免疫学参数的好转。

4. Intravenous blood irradiation was widely used in obstetrics and gynaecology to stimulate utero-placental blood exchange and as prophylaxis and therapy of inflammation of the interior genitals [11].

4. 静脉内血液照射广泛用于妇产科，以刺激子宫胎盘血液交换，预防和治疗内部生殖器炎症 [11]。

5. It was observed that mitochondria changed to so-called “giant mitochondria” (fig. 1) after laser irradiation with activation of various metabolic pathways and increased production of ATP [31] (fig. 2). The electron microscopy of “giant mitochondria” revealed intracellular annular (“ring-shaped”) structures (fig. 1 and 3).

5.可见光照射后线粒体变成所谓的“巨线粒体”（图1），激活各种代谢途径并增加三磷酸腺苷的生成[31]（图2）。电子显微镜可见“巨线粒体”细胞内的环状结构（图1和3）。

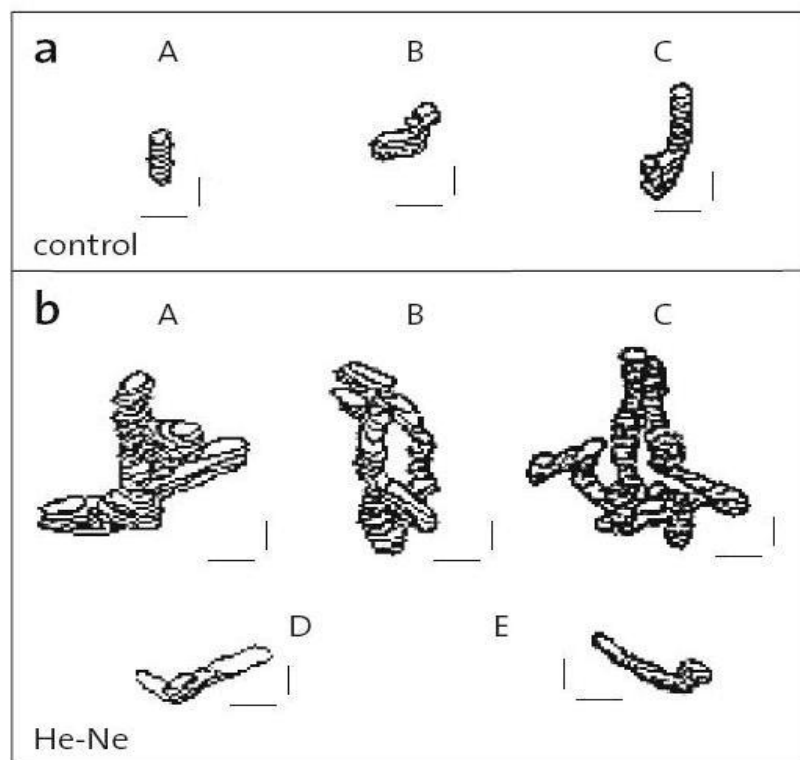


Fig. 1: Mitochondria of human lymphocytes before (a) and after (b) irradiation with helium-neon laser 632 nm, source: Manteifel et al. (31)

图1: 氦氖光632nm照射前 (a) 后 (b) 人淋巴细胞的线粒体。资料来源: Manteifel等人。(31)

These mitochondrial changes cannot be compared with pathological giant mitochondria as they appear in certain clinical syndromes. In these syndromes, we can observe pathological swelling of the organelles and deposit of pathological paracrystalline albumins leading to specific myopathies [47]. The structure of mitochondria may vary strongly according to the type of cell. They can form as sausage shaped organelles but may also appear as a highly branched intercommunicating tubular network. Observations of fluorescence marked mitochondria in living cells have shown that they are dynamic and may vary their shape strongly. Above all, it is important that mitochondria may merge with each other or divide themselves. It is supposed that the balance between fusion and division determines the shape and form of a mitochondrion [18].

这些线粒体变化与病理性巨线粒体不同, 因为后者出现在临床综合症中。在这些综合症中, 可见细胞器的病理性肿胀和病理性次晶白蛋白的沉积, 诱导特定的肌病[47]。线粒体的结构变化随细胞类型而大相径庭。可以形成香肠形状的细胞器, 或多分支的相互连通的管型网状物等等。观察活细胞中荧光标记的线粒体, 可见它们是动态的并且剧烈地改变形状。首当其冲的, 最重要的是, 线粒体可以相互融合或自我分裂。据推测, 融合和分裂之间的平衡决定了线粒体的形状和构成[18]。

Histological research on helium-neon laser irradiated lymphocytes show that giant mitochondria development leads to simultaneous diminishing of total number of mitochondria so that total volume was unchanged in the end. It was detected that development of “giant mitochondria” was the result of a fusion of smaller mitochondria [2, 31]. Manteifel and Karu proved big branched forms of mitochondria in germinating yeast cells. After laser irradiation, an expansion of the tubular network developed without damaging the organelles [32]. These mitochondria are marked by a relative enlargement of surface of the mitochondrial cristae due to activation of the respiratory chain and ATP-synthesis. It has to be mentioned that the description of the development of mitochondria to giant mitochondria is discussed controversially. Heine (reviewer of this article) points out that there is no evidence that such pathological forms of mitochondria will lead to an activation of varied metabolic pathways and the assumed increase of ATP-production. Heine described the way of reproduction of mitochondria in 1979: Whenever there is a need of additional ATP, they will divide, but not fuse with each other [17].

氦氖光照射淋巴细胞的组织学研究表明, 巨线粒体发育诱导线粒体总数同时减少, 因此总体积最终未变。据试验研究, “巨线粒体”的发育是较小线粒体融合的结果[2,31]。Manteifel和Karu证明了发芽酵母细胞中大支化形式的线粒体。在光照射后, 管状网络的扩张在不损坏细胞器的情况下发育[32]。由于呼吸链和三

磷酸腺苷合成的激活,这些线粒体表征为线粒体嵴面的相对增大。必须提到的是,线粒体向巨线粒体发育的描述尚存在争议。Heine (本文的审稿)指出,没有证据表明线粒体的这种病理性形式会诱导各种代谢途径的激活和假定三磷酸腺苷生成的增加。Heine在1979年描述了线粒体繁殖的方式:每当需要更多的三磷酸腺苷时,它们就会分裂,但不会相互融合[17]。

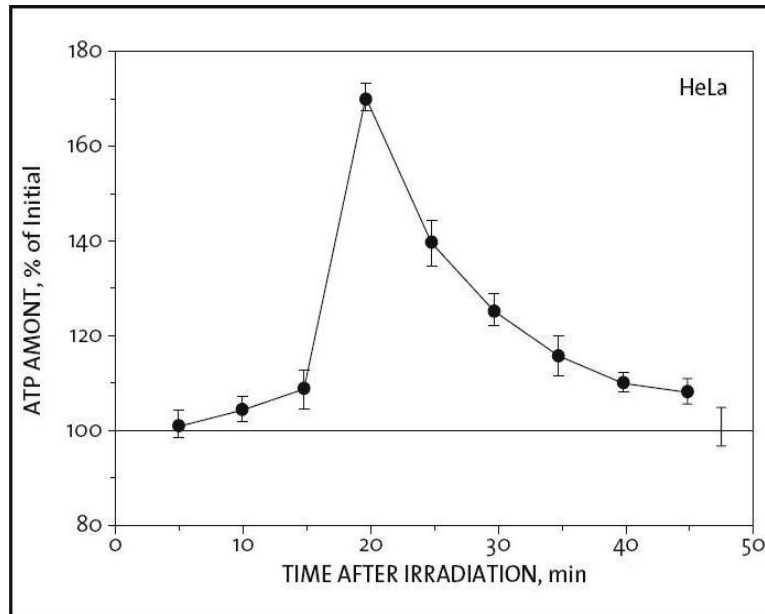


Fig. 2: Increase of ATP during laser-irradiation (632 nm) of HeLa-cell culture source: Karu [19]

图2: 光 (632 nm) 照射培养的海拉细胞期间的三磷酸腺苷增加: Karu [19]

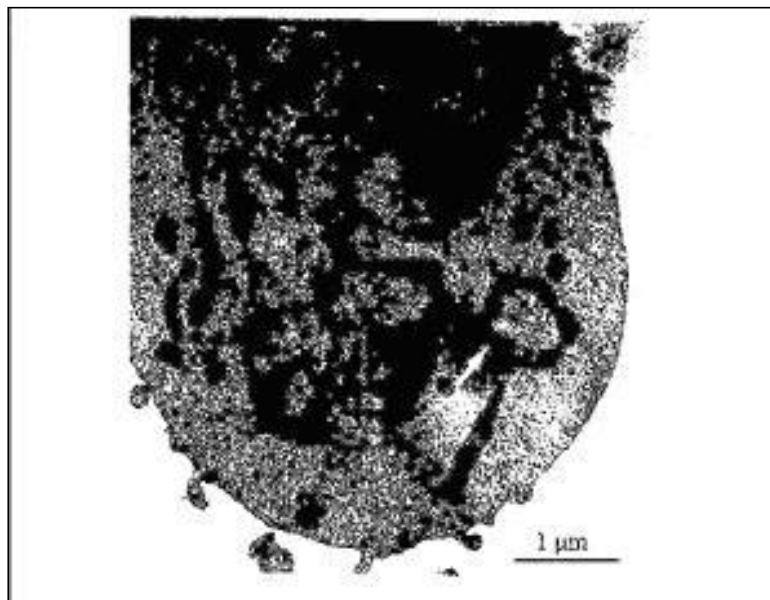


Fig. 3: Ringshaped "Giant mitochondria" of irradiated human leucocytes with helium-neon-laser 632 nm, source: Manteifel et al. [32]

图3: 氦氖光632nm照射人体白细胞的环状“巨线粒体”。资料来源: Manteifel等人。[32]

6. Gasparyan described the improvement of microcirculation in central nervous structures. This is mostly important in the hypothalamus due to its highly developed vascular micro system. He assumes that intravenous blood irradiation is stimulating the functional activity of the hypothalamus and limbic system, leading to an activation of hormonal, metabolic, immunological and vegetative processes with mobilization of adaptive reserves [11].

6. Gasparyan描述了中枢神经结构中微循环的改善。由于其高度发育的血管微系统使得其在下丘脑中尤为重要。他假设静脉内血液照射刺激下丘脑和边缘系统的机能活动，诱导激素、代谢、免疫和营养过程的激活，调动适应性储备[11]。

There seems to be generalized effects of the intravenous blood irradiation on almost every organ system. In conclusion, this therapy may be employed in the treatment of various diseases causally or additively.

似乎静脉内血液照射几乎对每个器官系统都有普遍的疗效。总之，该疗法可因此用于治疗各种疾病或成为各种疾病的附加疗法。

Normalization of the cell membrane potential 细胞膜电位正常化
Stimulation of immune response, specific and non-specific 刺激免疫反应、特异性和非特异性
Increase of the immunoglobulines IgG, IgM and IgA 增加免疫球蛋白G、M和A
Stimulation of interferons, interleukins and TNF-alpha 刺激干扰素、白细胞介素和肿瘤坏死因子-α
Stimulation of the proliferation of lymphocytes 刺激淋巴细胞的增殖
Increase of phagocytic activity of macrophages 增加巨噬细胞的吞噬活性
Lowering of CRP 降低反应蛋白
Improvement of the anti-oxidant enzymatic system with antitoxic effect 改善具有抗毒作用的抗氧化酶系统
Improvement of regeneration of erythrocytes and of microcirculation 促进红细胞和微循环再生
Reduction of aggregation of thrombocytes 减少血小板聚集
Activation of fibrinolysis 激活纤维蛋白溶解
Stimulation of the NO-production in monocytes with vasodilatation and improvement of endothelial dysfunction 刺激具有血管舒张和改善内皮功能障碍的单核细胞中的一氧化氮

的生成
Fusion of mitochondria to “giant mitochondria” with increase of ATP-production in the respiratory chain 随着呼吸链中三磷酸腺苷生成量的增加，线粒体向“巨线粒体”融合

Table 1: Biological effects of intravenous laser blood irradiation

表 1：静脉内光血液照射的生物效应

5.3 Comparison of intravenous laser with ultraviolet irradiation of the blood

5.3 静脉内光与紫外光照射血液的比较

In ultraviolet blood irradiation (UVB), a certain amount of blood is taken out of a patient's vein, anticoagulant substances are added and after UV light irradiation the blood is reinfused into the body.

在紫外光血液照射中，从患者的血管中抽取一定量的血液，添加抗凝血物质，并且在紫外光照射后，将血液重新注入体内。

In haematogenous oxidation-therapy (HOT), blood is frothed with oxygen additionally before irradiation by ultraviolet light [9]. As a result, there are various positive effects that are very similar to those effects of intravenous laser blood irradiation mentioned above. This is no surprise: In both types of therapy, high-energy photons are administered to the blood, influencing blood rheology and stimulating immunological and cellular biological processes.

在血源性氧化疗法中，紫外光照射之前，血液还会充满氧气[9]。结果，与上述静脉内光血液照射存在非常相似的各种积极效果。毫无意外：在两种类型的治疗中，高能光子被施用于血液，影响血液流变性并刺激免疫和细胞生物过程。

Comparing both methods, the difference is obvious: In intravenous laser blood irradiation, there is no need of taking blood out of the vein or giving additional anticoagulants. The blood will not be cooled down or modified due to direct irradiation of flowing blood by means of a disposal catheter. There is no risk of blood coagulation and no need of constant observation of the patient. Primarily, it can be assumed that direct intra-vascular blood irradiation will affect a much higher amount of blood cells compared to the amount taken out of the vein in UVB/HOT treatment.

这两种疗法相比，差异显著：在静脉内光血液照射中，不需要从血管中抽取血液或不需要使用额外的抗凝血剂。由于通过处置导管直接照射流动血液，血液不会被冷却或改变。不存在血液凝固的风险，也无需持续观察患者。根本上，与紫外

光血液照射/血源性氧化疗法中从血管抽取的量相比，可以假设直接血管内照射血液会影响更多数量的血细胞。

The use of monochromatic laser irradiation in contrast to non-monochromatic ultraviolet light irradiation is considered to be an additional advantage. Since we have essential understanding of absorption and action spectra of the various intracellular macromolecules and electron-carrier systems [19], different wavelengths can be used to target different catalytic centres of these structures, leading to various wavelength-specific biological effects. It is a known fact that i.e. the cytochrome-c-oxidase-complex (final part of the mitochondrial respiratory chain) is absorbing in the red- and infrared range while the NADH-complex (starter complex) is activated by blue light. In conclusion, there is only one wavelength used in UVB/HOT while we combine red, green, blue and yellow lasers in intravenous laser blood irradiation. Activation of cellular structures is of much higher complexity and significantly improved effects can be observed.

与非单色紫外光照射相比，认为用单色光照射增添了优势。因为我们对各种细胞内大分子和电子载体系统的光吸收和作用光谱有基础了解[19]，不同波长可用于靶向这些结构的不同催化中心，诱导各种波长特异性生物效应。已知的事实是，诸如，细胞色素-c-氧化酶-络合物（线粒体呼吸链的最后部分）在红光和红外光范围内吸收，而烟酰胺腺嘌呤二核苷酸-络合物（起始络合物）被蓝光激活等等。总之，在紫外光血液照射/血源性氧化疗法中只使用一种波长，而我们在静脉内光血液照射中却配合了红光、绿光、蓝光和黄光。细胞结构的活化具有更高的复杂度，可见疗效显著提高。

Another advantage of lasers (besides monochromasy) is light coherence (particular order functions, in-phase-conformity of the waves), with additional specific biological effects. However, the role of coherence regarding effects on cellular structures is still discussed controversially.

光（除了全色盲之外）的另一大优势是光相干性（特定的序函数、波的同相一致性），具有更多的特异性生物效应。然而，关于对细胞结构效应的一致性作用仍然存在争议。

Finally, light of the visible and infrared spectrum is regarded less dangerous than ultraviolet light. Today there is a well known borderline of 320 nm. Beyond that, ultraviolet light may cause fractures of DNA-chains. This risk does not exist in the visible and near infrared spectrum.

最后，可见光和红外光谱的光被认为比紫外光的危险性小。今天320纳米的界线是耳熟能详的。除此之外，紫外光可诱导脱氧核糖核酸链断裂。这种风险在可见光和近红外光谱中不存在。

5.4 Intravenous laser blood irradiation from a Chinese medicine perspective: "Blood Acupuncture" by dissolving of blood stasis

5.4 中医认为静脉内光血液照射：溶解血瘀的“血针灸”

In Chinese Medicine, the term “Xue” is of great importance. It comprises the most important body juices including the blood. Due to continuous circulation, nutrients are transported to all organs and structures. Xue and Qi are closely linked to each other. In traditional Chinese medicine, Qi is commanding the blood: When Qi is moving, blood is moving, too. When Qi is stagnating, blood is stagnating as well.

在中医中，“血”这个术语十分重要。它包括血液中最重要体液。由于持续循环，营养素被传递给所有器官和结构。血与气是紧密相连的。传统中医中，气是血液的司令：气动，血液也动。气停滞，血液也停滞不前。

Therefore it can be concluded: Blood cannot flow without Qi while Qi cannot be held without blood.

因此可以推断：没有气，血就不会流动，而没有血，就不能保持气。

Stagnation of blood and Qi are called blood-stasis-syndrome. This problem is influenced by classical acupuncture by needling specific points. Looking at blood circulation hypothetically as a central interior meridian of its own, this method of stimulating the flow of blood and Qi by means of intravenous laser blood irradiation could be called “blood acupuncture”. Such an interpretation could not be made with ultraviolet therapy mentioned above by definition.

血与气的停滞被称为血瘀症。这个问题受针刺特定穴位的传统针灸影响。将血液循环假设为其自身的中央内部经络，这种通过静脉内光血液照射的方式刺激血和气流的方法被称为“血针灸”。根据定义，这种解释不适用上述紫外光疗法。

5.5 The relationship between intravenous laser blood irradiation and the system of basic regulation according to Pischinger and Heine

5.5 根据Pischinger和Heine的研究，静脉内光血液照射与基础调节系统之间的关系

Intravenous laser blood irradiation is a therapeutical method that seems to be suitable to intervene in the system of basic regulation. This system is defined as the functional connection between capillaries (the “end stream”), basic substance (extracellular matrix [ECM]), and cells. The extracellular matrix is located between capillaries and cells and represents a kind of molecular sieve where vegetative nerve fibres finally spread and establish a connection to the entral nervous system and the endocrinium (hypothalamus). This molecular sieve presents the transit route of the entire metabolism between capillaries and cells. It is mainly formed by proteoglycanes, glucosaminoglycanes, structure-proteins like collagen or elastin and the networking-glycoproteins

like fibronectin. There are various defensive cells in the ECM that control the synthesis and the decomposition of ECM-components by means of a cytokine-network. By aging and chronic oxidative stress with an increased production of radicals, acidosis and clogging-up of ECM will grow, leading to a restriction of this vital molecular sieve effect. Additionally, the antioxidant enzyme-system is negative influenced. The increased transferral of the transit route leads to micro- and macroangiopathies. The acidosis may furthermore encourage the forming and spreading of tumour cells through pro-inflammatory effects.

静脉内光血液照射在基础调节系统中似乎是一种适合干预的疗法。该系统被定义为毛细血管（“末端流”）、基础物质（细胞外基质）和细胞之间的功能连接。细胞外基质位于毛细血管和细胞之间，代表一种分子筛，其中营养神经纤维最终延伸，并与中枢神经系统和内分泌系统（下丘脑）建立连接。该分子筛呈现毛细血管和细胞之间整个代谢的转运途径。它主要由蛋白聚糖、葡糖胺聚糖、结构蛋白（如胶原蛋白或弹性蛋白）和网状糖蛋白（如纤连蛋白）组成。细胞外基质中存在各种防御细胞，通过细胞因子网络控制细胞外基质组分的合成和分解。随着自由基和酸中毒生成的增加，细胞外基质的堵塞通过衰老和慢性氧化应激而增加，诱导这种生死攸关的分子筛效应的约束。此外，抗氧化酶系统受到负面影响。转运路线的转移增加诱导微血管病变和大血管病变。此外，酸中毒还可以通过促炎作用刺激肿瘤细胞的形成和扩散。

Thus, the antioxidant, antiacidotic and anti-inflammatory effects of intravenous blood irradiation and its modulation of the immune system could have manifold effects on the system of basic regulation and the extracellular matrix. Additionally, there seems to be a certain protective effect on the development of tumour cells. Another assumption is that general aging processes (that go hand in hand with the above-mentioned clogging-up of ECM with pro-inflammatory effects and with increased formation of radicals) could be positively influenced. From this point of view, intravenous laser blood irradiation could also be considered as an antiaging therapy, in particular when combined with additional useful methods like dieting, orthomolecular therapy, acupuncture, neural therapy or others.

因此，静脉内照射血液的抗氧化剂、抗酸剂和抗炎作用及其对免疫系统的调节，它们可以对基础调节系统和细胞外基质产生多重效应。另外，似乎对肿瘤细胞的发育有一定的保护作用。另一个假设是，一般的衰老过程（与上述伴有促炎作用和增加自由基形成的细胞外基质的堵塞密切相关）会受到积极影响。从这个观点来看，静脉内光血液照射也可以被认为是抗衰老疗法，特别是配合其他有益方法如节食减肥、正分子疗法、针灸、神经疗法等等时，抗衰老疗效尤为突出。

Another important aspect is the physiological leucocytolysis. Approximately 1.2 million leucocytes (of totally 1-2 billion leucocytes in the organism) are in the process of disintegration every second. By this mechanism, a great number of mediators like cytokins, chemokins, prostaglandins, leucotriens and many others are released. These immunomodulators can influence regulation of blood plasma and extracellular matrix. According to Pischinger and Heine, the physiological lyses ability of leucocytes is the “pivot of all

naturopathic treatments” and measures of regulation medicine. You will find detailed presentation to these topics in “Lehrbuch der biologischen Medizin” by Heine [16].

另一个重要方面是生理性白细胞溶解。每秒大约有120万个白细胞（生物体总共10-20亿个白细胞）处于崩解过程中。通过这种机制，释放出大量的介质如细胞因子、趋化因子、前列腺素、白三烯等等。这些免疫调节剂会影响血浆和细胞外基质的调节。根据Pischinger和Heine的研究，白细胞的生理性溶解能力是“所有自然治疗的枢纽”和调节药物的措施。在Heine的《生物医学教科书》[16]中找到这些课题的详细介绍。

In conclusion, intravenous laser blood irradiation obviously can stimulate physiological leucocytolysis similar to other immunomodulating therapies. Respective research is pending.

总之，显而易见，静脉内光血液照射可以刺激生理性白细胞溶解，类似于其他免疫调节疗法。各项研究正在进行中。

5.6 Methodology: Practical application of Intravenous Laser Blood Irradiation

5.6 方法：静脉内光血液照射的实际应用

Intravenous laser blood irradiation is performed with low power lasers in the range of 1-5 mW and an exposure time of 20-60 minutes. Normally, a treatment course involves 10 treatments that are conducted either every day or three times a week with a weekend break.

用低功率（1-5兆瓦）光照射静脉内血液，照射20-60分钟。通常，一个疗程涉及10次治疗，每天或每周三次，周末休息。

For practical applications a canula is inserted into a suitable vein of the elbow or forearm. The vein should have a wide lumen to catch a great volume of blood during laser irradiation. In the Russian procedure, a simple steel canula was used. Afterwards, a disposal plastic-catheter was inserted into the canula and connected to the light source [fig. 4].

实际应用时，将套管插入肘部或前臂的适当血管中。血管应具有宽腔，以在光照射期间捕获大量血液。俄罗斯人的治疗使用了简单的钢套管。然后，将一条处置塑料导管插入套管并连接到光源[图4]。

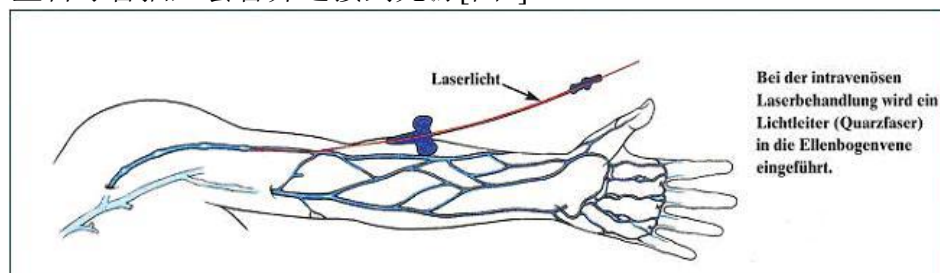


Fig. 4: Practical application of intravenous laser blood irradiation in the elbow vein

图4：静脉内光血液照射在肘部血管中的实际应用

This procedure was modified by the author, by using a blue plastic canula for children (Braun Medical, Melsungen) in combination with a newly developed disposable laser-catheter made of biological compatible plastic material (fig. 5).

通过儿童专用蓝色塑料套管（梅尔松根Braun 医疗），连接新研发的、由生物相容性塑料材料制成的一次性光导管的方式（图5），作者修改了该操作。

If veins are difficult to puncture or there is lack of practice, using a canula may cause problems. Thus, a suitable little butterfly was recently developed to simplify the application.

如果血管很难穿刺或缺乏实践时，使用套管可能会产生问题。因此，最近研发的一种合适的小蝶型管简化了该项应用。

A huge advantage of this therapy and its simple application is the possibility for the practitioner to delegate most of the work to an assistant or nurse.

该疗法的巨大优势及简捷的应用使得执业医师将大部分工作委托给助理或护士成为可能。

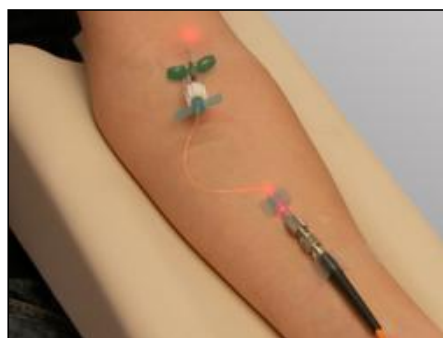


Fig. 5: Intravenous laser therapy with a newly developed butterfly and laser catheter using red light (632 nm)

图 5：用红光（632 nm）配合新研发的蝶型管和光导管进行静脉内光疗

5.7 Innovations

5.7 创新

5.7.1 Green laser light in intravenous laser therapy

5.7.1 静脉内光疗中的绿光

Up to now it was believed that irradiation in the red range was particularly effective due to the absorption spectrum of cytochrome-c-oxidase in the

respiratory chain and its proven stimulation of ATP-synthesis. All of the Russian studies were carried out only with red light helium-neon-laser of the wavelength 632,8 nm because there was no other laser with a shorter wavelength (green or blue) available at this time. When red laser light is introduced into the bloodstream, it can't be absorbed by erythrocytes and strong emitting of red light from the vein is observed (fig. 5).

到目前为止，由于呼吸链中细胞色素-c-氧化酶的吸收光谱及其证明的刺激三磷酸腺苷合成，红光范围内的照射认为特别有效。所有的俄罗斯研究都只用波长为632.8 nm的红色氦氖光进行，因为此时没有其他更短波长的光（绿光或蓝光）。当红光引入血流时，不能被红细胞吸收，观察到来自血管的强烈红光照射（图5）。Thus, it is assumed that the use of complementary green laser light for laser blood irradiation can be of additional benefit (fig. 6). When green laser light is conducted into a vein, practically no green shining from the vein is observed due the strong absorption by the “red” erythrocytes [41].

因此，假设使用互补的绿光进行光血液照射会带来更多的疗效（图6）。当绿光进入血管时，由于“红色的”红细胞的强烈吸收，实际上未见血管中有绿光闪烁[41]。

The intravenous application of green lasers was introduced into clinical practice by the author for the first time in 2008: Patients that were treated with red laser light before were treated with green laser now and the results were compared with the first clinical results. The findings seemed to confirm that green laser light causes corresponding stimulation of erythrocytes (while red laser stimulates leucocytes) and obviously reacts differently on various parameters compared to red laser alone.

作者在2008年首次将绿光引入静脉应用的临床实践：之前用红光治疗的患者现在用绿光治疗，并将疗效与第一次临床疗效相比较。研究成果似乎证实，与单独的红光相比，绿光会引起相应的红细胞刺激（红光刺激白细胞），并且对各种参数的反应明显不同。

In a third cycle, same patients were treated with a combination of red and green laser. Consequently, the combination of both lasers turned out to achieve the best possible clinical effect.

在第三个疗程中，相同的患者用红光和绿光的组合进行治疗。因此，两种光的组合证明可以获得最佳的临床疗效。

Reviewing current literature on laser research, the green laser was recently also tested in blood irradiation by other scientists. An article published by MI et al. of Shanghai University in March 2004 [34] described the comparison of blood cells irradiation (in vitro) with the wavelengths 632,8 nm (red laser) and 532 nm (green laser). The results indicated green lasers' advantage on rheologic properties of the blood by an improved deformability of erythrocytes. The corresponding absorption spectrum of haemoglobin is assumed to induce these specific effects of green laser light.

回顾目前关于光研究的文献，最近绿光也在其他科学家的血液照射中进行了测试。上海大学MI等人于2004年3月发表的一篇文章[34]，描述了用波长632.8nm（红光）和532nm（绿光）的血细胞照射（体外）的比较。结果表明绿光具有通过改

善红细胞变形性影响血液流变性的优势。假设血红蛋白相应的吸收光谱诱导绿光的这些特异性效应。

In a recent work by Kassak and colleagues of Bratislava University (Slovakia) in cooperation with the department of General Biophysics of Lodz University (Poland) [20], the effect of green laser light on Na-K-ATPase was investigated. A significant stimulation effect of green laser light on the Na-K-ATPase activity was shown (picture 7). These latest findings are of exceptional significance. Previous explanatory models of the photo- biochemical energy transfer were all about mitochondrial structures and electron carrier systems in the respiratory chain. This mechanism does not exist in erythrocytes. According to previous beliefs, absorption of green laser photons by erythrocytes would only be transferred into local warming. Now, the evidence of an increased Na-K-ATPase is leading to the assumption that structural molecular changes are activated with triggering of specific biochemical activity. Thus, membranous lipid layers can also change [20]. In another work from Vinck and colleagues of the department of anatomy, embryology and histology of the University Ghent/ Belgium (2005), shows that green light irradiation increases fibroblast proliferation with an improved effect on glucose metabolism [52].

最近，布拉迪斯拉瓦大学（斯洛伐克）的Kassak及其同事与罗兹大学（波兰）生物物理学系合作的一项工作中[20]，研究了绿光对钠-钾-三磷酸腺苷酶的效应。可见绿光对钠-钾-三磷酸腺苷酶活性具有显著的刺激作用（图7）。这些最新的研究成果具有非凡的意义。以前的光生物化学能量转移的解释模型都是关于呼吸链中的线粒体结构和电子载体系统的。这种机制在红细胞中不存在。根据先前的观点，红细胞对绿光光子的吸收只会转化为局部变暖。现在，增加钠-钾-三磷酸腺苷酶的证据导致假设触发特异性的生化活性而激活结构分子的变化。因此，膜脂质层也会改变[20]。来自比利时根特大学（2005年）的解剖学、胚胎学和组织学系的Vinck及其同事的另一项研究表明，绿光照射可增加成纤维细胞增殖，具有改善葡萄糖代谢的效果[52]。

However, it must be emphasized that all mentioned research on green laser so far was exclusively done by in-vitro-experiments. The first clinical investigations with green light laser blood irradiation were done by the author himself and have been described above.

然而，必须强调的是，到目前为止所有提及的绿光研究都是通过体外实验完成的。绿光血液照射的第一次临床研究由作者本人完成，如上所述。

Most of the following research (see chapter 5.8) was conducted with both red and green laser blood irradiation (combination) and today both lasers are combined regularly in clinical practice.

下面的大部分研究（参见第5.8节）都是用红光和绿光（组合）照射血液，现在这两种光在临床实践中是常规组合。



Fig. 6: Green laser light (532 nm)

图 6: 绿光 (532 nm)

5.7.2 Blue laser light in intravenous laser therapy

5.7.2 静脉内光疗中的蓝光

Due to the wavelength of 400-470 nm, the blue laser is strongly absorbed by porphyrins and haemoglobin [54, 41]. So far there is only little scientific data on clinical applications because of the technical difficulty to build a solid blue semiconductor laser from galliumnitride (fig. 7).

由于波长为400-470 nm，蓝光被卟啉和血红蛋白强烈吸收[54,41]。迄今为止，关于临床应用的科学数据甚少，因为制造氮化镓的固体蓝光半导体存在技术难度（图7）。

However, it is well-known that caries, periodontosis or acne can be treated with blue LED light (light-emitting diode) with good success (as LED's are also emitting monochromatic light, but without deep-acting coherence) [55]. According to latest research, *Helicobacter pylori* can be eradicated successfully by application of blue light over the gastroscope [15]. The mechanism behind these findings is the bactericide effect of the blue monochromatic light that is binding to bacterial porphyrins and destroying them by release of reactive oxygen radicals.

然而，众所周知，发光二极管灯（发光二极管）蓝光可以治疗龋齿、牙周病或痤疮，且取得了成功（因为发光二极管也发单色光，但无深层相干性）[55]。根据最新研究，通过胃镜应用蓝光可以成功根除幽门螺杆菌[15]。这些发现背后的机制是单色蓝光的杀菌疗效，与细菌卟啉结合并通过释放活性氧自由基来破坏它们。

Tiina Karu showed in several of her publications that red and infrared laser light stimulates the last complex of the mitochondrial respiratory (cytochrome-c-oxidase), while the first complex (NADH- dehydrogenase) has its absorption maximum in the blue range [19]. Thus, it is possible to stimulate this “starter complex” by irradiation with blue laser. This effect is of considerable importance for intravenous laser blood irradiation. First clinical data is already available from work of the Armenian laser scientist Levon Gasparyan [11].

Tiina Karu的一些出版物表明，红光和红外光刺激线粒体呼吸的最后一个络合物（细胞色素-c-氧化酶），而第一个络合物（烟酰胺腺嘌呤二核苷酸-脱氢酶）在蓝光范围内吸收性能最强[19]。因此，可以通过蓝光照射来刺激这种“起始络合物”。这种效果对静脉内光血液照射是相当重要的。第一个临床数据已经从亚美尼亚光科学家Levon Gasparyan的研究[11]中获得。

He was able to show that rheology of the blood improves significantly during irradiation of the blood with blue laser light of low power (0,3 mW). As a result, microcirculation improves significantly.

他能够证明，在用低功率（0.3兆瓦）的蓝光血液照射期间，血液的流变性显著改善。微循环也随之显著改善。

According to Gasparyan's latest data, severe cases of tinnitus resistant to other therapies can be treated more successfully than before. Furthermore, it was reported that metabolism effects lead to a significant decrease of cholesterol, triglycerides, blood-glucose and bilirubin. Additionally, the immunologic activity of the blood is increasing significantly according to Gasparyan [11]. Due to its proximity to the ultraviolet spectrum, it is assumed that blue laser blood irradiation also induces the well-known immunostimulating effects that are known from UVB therapy [9, 11].

根据Gasparyan的最新研究数据，耐其他疗法的重度耳鸣可以获得比以前更成功地治疗。此外，据报道，代谢作用诱导胆固醇、甘油三酯、血糖和胆红素的显著降低。还有，根据Gasparyan的研究 [11]，血液的免疫活性显著增加。由于其接近紫外光谱，假设蓝光血液照射还诱导了众所周知的紫外光照射血液治疗的免疫刺激作用[9,11]。

In a work from October 2006, the blue laser was also used diagnostically to trace tumour cells. Due to strong absorption impulses of the blue laser, circulating melanoma-cells in the blood start to swing and emit signals that can be recorded with highly sensitive microphones. This is called photoacoustic detection [54].

在2006年10月的一项研究中，蓝光也被用于追踪肿瘤细胞的推断。由于蓝光的强吸收脉冲，血液中的循环黑素瘤细胞开始摆动并发出可用高灵敏度传声器记录的信号。这称为光声检测[54]。



Fig. 7: The blue laser (405 nm)

图 7：蓝光（405 nm）

Today, the blue laser is also well established in clinical application of intravenous laser therapy, mainly due to its strong anti-inflammatory and anti-bacterial effects. Therefore, intravenous blue laser therapy is especially successful in the treatment of inflammatory diseases or infections.

如今，蓝光在静脉内光疗中得到了很好的临床应用，主要得益于其强大的抗炎和抗菌作用。因此，静脉内蓝光治疗炎性疾病或感染特别成功。

Red, green and blue laser application in intravenous laser blood irradiation is combined regularly for most indications today because of the different (but synergistic) effects of the different light wavelengths.

由于不同光波长的不同（除协同之外）效应，今天对于大多数适应症，红光、绿光和蓝光被常规组合应用在静脉内光血液照射中。

Note: For updated information of the effects of green and blue lasers and their clinical applications in intravenous laser therapy, see chapter 5.8.8.

注释：有关绿光和蓝光疗效及其在静脉内光治疗中的临床应用的最新信息，请参阅第 5.8.8 节。

5.7.3 Yellow laser in intravenous laser therapy

5.7.3 静脉内光疗中的黄光



years of research and development efforts, in 2013 the yellow laser worldwide for intravenous and interstitial therapy was finally introduced. 经过几年的研发和努力，2013年
了全球首个用于静脉和间质光疗的黄光。



After
several

first
use in
laser

终于推出

What is the yellow laser good for?

黄光疗效是什么？

After the development of red, infrared, green and blue lasers, yellow was the last missing prismatic colour. Yellow light additionally stimulates the mitochondrial respiratory chain at complex III (cytochromes).

既红光、红外光、绿光和蓝光的研发之后，黄光是最后漏掉的棱镜颜色。黄光还会刺激在络合物III（细胞色素）阶段的线粒体呼吸链。

In clinical applications, the yellow laser has a strong detoxifying and anti-depressive effect.

在临床应用中，黄光具有强烈的解毒和抗抑郁作用。

Yellow laser stimulates the strongest natural photosensitizer – Hypericin out of St. Johns wart – and is therefore the most efficient laser in photodynamic cancer therapy.

黄光具有刺激最强的天然光敏剂-圣约翰草的提取物中的金丝桃素的作用，因此是光动力癌症治疗中最有效的光。

Combined with Hypericin, yellow lasers are also applicable for the treatment of viral and chronic bacterial infections.

配合金丝桃素，黄光也适用于治疗病毒性和慢性细菌感染。

A broad range of studies shows that anti-depressive effects of Hypericin can be strengthened significantly once the impact of Hypericin is enhanced by yellow laser. Immediate improvements in patient's sense of wellbeing have been observed.

大量研究表明，一旦黄光增强金丝桃素的影响，金丝桃素的抗抑郁作用就会显著增强。可见患者的健康感的立即提高。

The broad theoretical knowledge about the photodynamic application opportunities of Hypericin can now be implemented in practice.

关于金丝桃素的光动力应用机会的广泛理论知识现在已付诸实践。

The new yellow laser – first clinical results:

新型黄光 - 首次临床疗效：

- Strong positive (anti-depressive) effects on general mood: “many of the patients begin to laugh and speak freely [...], all have less pain and more freedom of movement.”
- 对一般情绪产生强烈而积极的（抗抑郁）疗效：“许多患者开怀大笑并畅所欲言等等，所有患者的疼痛缓解，运动更自由”。
- Positive results in chronic infections (e.g. lyme disease) and fatigue syndromes
- 对慢性感染（例如莱姆病）和疲劳综合症的积极疗效
- Very positive experiences in advanced lyme disease; significant improvement after few treatments (45 min. intravenous)
- 晚期莱姆病的非常积极的体验；几个疗程后显著改善（静脉内45分钟）
- Good effects on several viral infections (zoster, EBV, Herpes)
- 对几种病毒感染（带状疱疹、人类疱疹病毒第四型巴尔病毒、疱疹）具有良好疗效
- Strong anti-bacterial effect
- 抗菌效果强

- Very good results in patients with panic attacks, depression and anxiety disorders (yellow laser IV and hypericin oral; combination with Tryptophan in patients with lack of serotonin)
- 对惊恐发作、抑郁和焦虑症患者有非常好的疗效（黄光IV配合金丝桃素口服；配合色氨酸治疗缺乏血清素的患者）
- Promising developments in patients with lack of ATP; yellow laser stimulates complex III of the oxidative phosphorylation and supports therapy with other laser wavelengths, NADH, coenzyme Q10 and carnitin
- 有望治疗缺乏三磷酸腺苷的患者；黄光刺激氧化磷酸化的络合物III，并支持其他光波长的治疗、烟酰胺腺嘌呤二核苷酸、辅酶Q10和肉碱
- Positive effect on Multiple Sclerosis
- 对多发性硬化症的积极疗效
- Application in photodynamic tumour therapy (in combination with Hypericin): Significant reduction of tumour markers
- 应用于光动力肿瘤治疗（配合金丝桃素）：显著减少肿瘤各项指标

Case studies:

病例研究：

- One patient with advanced MS went bowling with her friend after a session and had the best score
- 一名晚期多发性硬化症患者，在一个疗程后与她的朋友打保龄球并获得最高分
- Autistic boy: “He has now had IV yellow laser therapy twice and has marked increase in facial expression, eye contact, vocabulary, focus, attention span and having ability to let people hug him”
- 自闭症男孩：“他现在经过了两个IV黄光疗程，面部表情、眼神接触、词汇、集中注意力、注意力持续时间以及能让人拥抱他的能力显著增加”
- “27 year old receives 20 mins of yellow laser twice a week and is no longer depressed in just three weeks”
- “27岁的人每周接受两次20分钟的黄光照射，在短短三周内不再抑郁”
- Architect, 51 years, chronic lyme disease with massive joint pain and fatigue; 14 treatments with yellow laser (and amino acids); completely fit, no more pain or trouble
- 51岁建筑师，患有大面积关节疼痛和疲劳症的慢性莱姆病；用黄光（配合氨基酸）照射14个疗程；完全奏效，甩掉病痛和烦恼
- Patient with squamous-cell carcinoma (and metastases); oral hypericin and local yellow laser irradiation of the bad healing area; very positive clinical results (strongly improved healing)
- 鳞状细胞癌（和转移瘤）的患者；口服金丝桃素，配合不良愈合部位的局部黄光照射；非常积极的临床疗效（快速愈合）
- MS-Patient: Significant positive influence on sensomotoric abilities and fatigue syndrome

- 多发性硬化症患者：对感觉肌肉运动能力和疲劳综合症有显著而积极的疗效

5.8 *Clinical results*

5.8 临床研究成果

5.8.1 The results from eastern studies

5.8.1 东部研究的成果

An extensive study of the Academy of Medicine Volgograd on 175 patients with chronic liver diseases including forms of chronic hepatitis and cirrhotic liver was published in German translation in 2002 [47]. After a series of 10 treatments with 630 nm 1mW red light laser for 40 minutes, a significant improvement of the antioxidant enzyme system and a long-lasting significant reduction of pathological increased liver parameters were achieved. In 2002, several very interesting articles on the influence of laser therapy on long term complications and fat metabolism disorders connected with diabetes mellitus were published by the Russian doctor Tatjana Kovalyova (Department, 2. Municipal Clinic Izhevsk, Russia) and translated by Prof. Marti, Institute for LLLT & naturopathic medicine, Thun/Switzerland [24, 25]. The patients were treated in three series with 10 sessions every day over a span of six months. The therapy was performed as so-called combined laser therapy, meaning that intravenous laser application and additional local (external) irradiation of liver, pancreas and spleen were combined. An almost statin-equivalent reduction of lipid parameters as well as a significant reduction of various typical diabetic complications such as retinopathies and angiopathies was described [24]. Siposan et al. (2004) of Bucharest University, Romania, could prove a significant improvement of the aggregation tendency of erythrocytes and a stabilization of the erythrocyte membranes in a study on 40 patients [44].

沃尔格莱德医学院对175例慢性肝病患者（包括慢性肝炎和肝硬化）的广泛研究，于2002年以德语文发表[47]。在每个疗程用（630nm,1mW）红光照射40分钟，共进行10个疗程后，显著改善抗氧化酶系统和显著减少肝脏参数的病理性增加且持久。2002年，俄罗斯医生Tatjana Kovalyova（俄罗斯Izhevsk市政门诊2科）发表了几篇关于光疗对与糖尿病有关的长期并发症和脂肪代谢紊乱疗效非常有建树的文章，并由瑞士图恩的低强度光疗和自然疗法医学研究所的Marti教授翻译[24,25]。患者在六个月的治疗期间内分三个阶段10个疗程每天进行治疗。该治疗以所谓的组合光疗进行，这意味着静脉内光应用和肝脏、胰腺和脾脏的另一种局部（体外）照射相结合。概述了对降低脂质参数的他汀类药物当量以及各种典型

的糖尿病并发症如视网膜病和血管病等的显著减少[24]。罗马尼亚布加勒斯特大学Siposan等人（2004年）在40名患者的研究中证实了红细胞聚集倾向和红细胞膜的稳定性的显著改善[44]。

Even an improvement of the life-threatening situation of hemorrhagic shock could be shown in a study by Kozura et al. (1993) [26]. Spasow et al. (2000) described a significantly improved tolerability of medication in patients with chronic hepatitis [48]. Khotiainsev et al. (1996) published a study on the effects of electrophysiological efficiency of laser blood irradiation in acute coronary syndromes on 200 patients, illustrating that this therapy results in significant positive changes of electrophysiological characteristics of the cardiovascular system with corresponding antiarrhythmic effects [21].

Kozura 等人的一项研究表明,甚至可以改善出血性休克的危及生命的病症。(1993年) [26]。 Spasow 等人 (2000 年) 描述了慢性肝炎患者药物耐受性的显著改善 [48]。 Khotiainsev 等人 (1996 年) 发表了一项关于光血液照射对急性冠状动脉综合症的电生理功能的疗效的研究,通过对 200 名患者的治疗,表明该疗法诱导心血管系统的电生理病症发生积极显著的变化,具有相应的抗心律不齐的疗效 [21]。

5.8.2 Results of studies 2004

5.8.2 研究成果（2004 年）

As the method of intravenous laser blood irradiation seems to have a huge scientific potential (according to eastern research), the author decided to conduct a pilot study in his own clinic, trying to reproduce the most remarkable results of the studies mentioned in chapter 5.8.1. Thus, the study of Skvorcov et al. on treatment of chronic liver diseases [46] and the large-scale studies of Kovalyova on treatment of diabetics with fat metabolism disorders [24, 25] were taken as a basis.

由于静脉内光血液照射的疗法似乎具有巨大的科学潜力（根据东部研究），作者决定在自己的诊所进行一项先导性研究，试图重现第5.8.1节提到的研究中最显著的疗效。因此，Skvorcov等人进行了治疗慢性肝病的研究[46]，并以Kovalyova治疗伴有脂肪代谢紊乱的糖尿病患者的大规模研究[24,25]作为基础。

20 patients with diabetes mellitus and 15 patients with chronic liver diseases were included in a first pilot study in 2004 and were treated according to the Russian research design with intravascular red light laser therapy (632 nm, 1,5 mW, 30 min) and transcutaneous infrared laser irradiation (810 nm, 100 mW) of liver, pancreas and spleen (at the points Lv 13, Lv 14 right side and CV 12) for 20 minutes. The intravascular treatments were performed with a newly certified laser blood irradiation system “weberneedle blood/ Endolaser” developed by weber medical GmbH, Lauenförde/ Germany (fig. 8) [53]. For additional external laser irradiation, the “weberneedle basic” system with infrared laserneedles was used.

2004年初步研究纳入20例糖尿病患者和15例慢性肝病患者。根据俄罗斯研究设计进行血管内红光治疗（632 nm，1.5 mW，30分钟）和经皮红外光照射（810nm，100mW）肝脏、胰腺和脾脏（在Lv 13、Lv 14穴位右侧和中腕穴位）20分钟。用德国韦伯医疗有限公司的Lauenförde研发的新认证的光血液照射系统“韦伯针血液/眼内光”进行血管内治疗（图8）[53]。使用配备红外光针的“韦伯针基础”系统进行了更多的体外光照射。

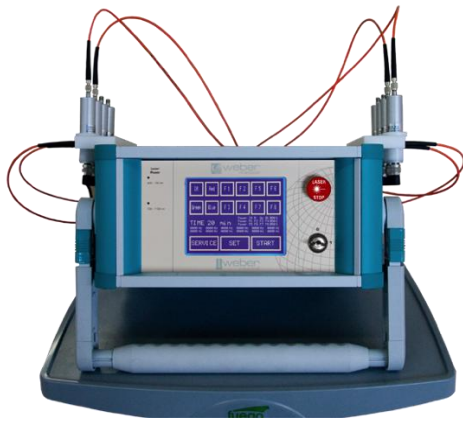


Fig. 8: Newly approved laser blood irradiation system (Weberneedle® Endolaser)

图8：新认可的光血液照射系统（韦伯针®眼内光）

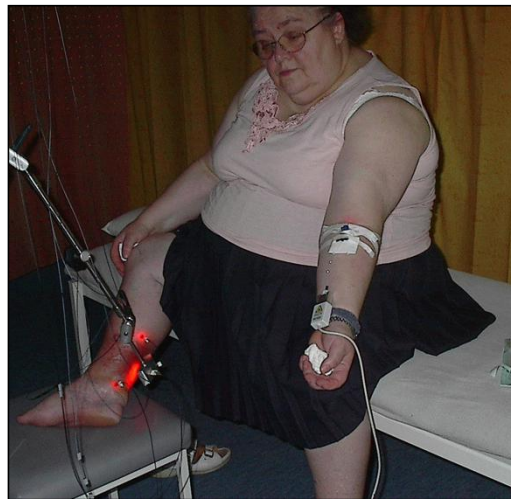


Fig. 9 - 10: Treatment examples

图9-10：治疗病例

Fig. 9 shows the treatment of a patient suffering from severe allergy with intravascular laser blood irradiation combined with laserneedle acupuncture.

图9显示用血管内光血液照射配合光针灸治疗重度过敏症患者。

Fig. 10 demonstrates the treatment of a diabetic patient with intravenous laser therapy and external laser irradiation of an ulcer cruris.
图10显示了用静脉内光疗和体外光照射小腿溃疡治疗糖尿病患者。

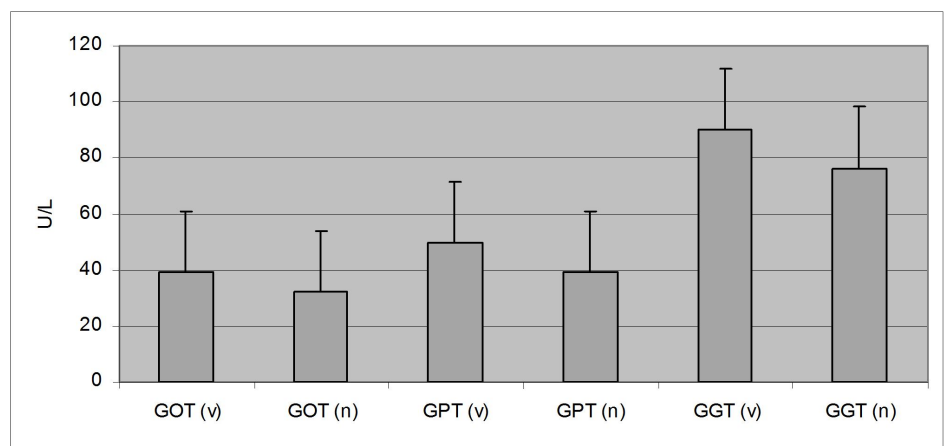


Fig. 11: Data from first pilot study: Lab values before and after treatment
图 11: 初试研究的数据: 治疗前后的实验室值

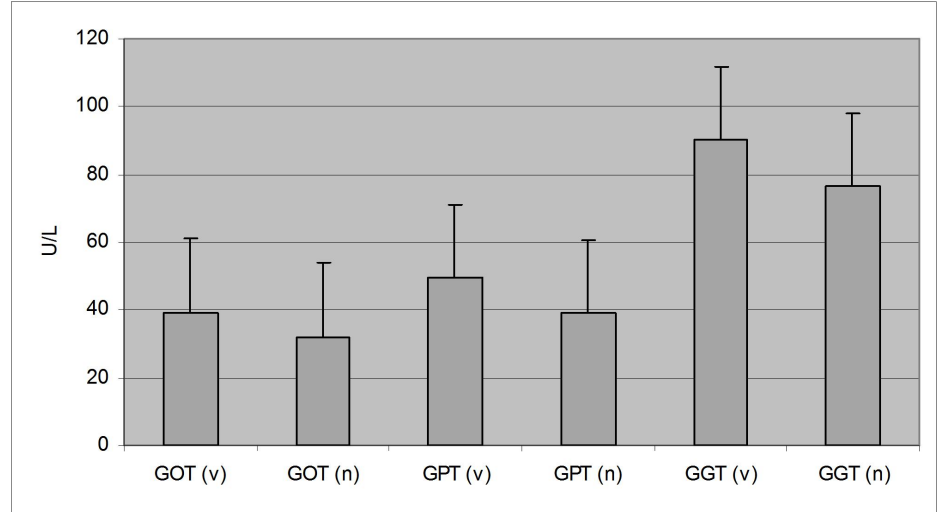


Fig. 12: Data from first pilot study: Lab values before and after treatment
图 12: 初试研究的数据: 治疗前后的实验室值

In conclusion, the results of the Russian literature could be confirmed to a huge extent. Actually there was a significant decrease of chronically increased liver and lipid parameters but especially the reduction of LDL-cholesterol was strongly significant.

总之，俄罗斯文献的成果可以在很大程度上得到证实。实际上，慢性肝脏和脂质参数增加的症状显著降低，尤其是低密度脂蛋白胆固醇的降低极其显著。

In individual cases, a drop of pathological HbA1c values was observed. However, the validity of these figures is limited as the majority of diabetics were already well adjusted. Due to ethical arguments, a discontinuation of antidiabetic medication could not be justified.

在个体病例中，可见一滴病理性糖化血红蛋白值。然而，这些数字的有效性是有限的，因为大多数糖尿病患者调养得都很好。由于道德争议，停止使用抗糖尿病药物是不合乎情理的。

A maximum of improved laboratory parameters was observed after six to twelve weeks. However, immediate effects have been observed, too, especially a tendency of hypoglycemia on well-adjusted diabetics.

6至12周后可见实验室参数的最大改善。还观察到了直接的疗效，特别是针对经过良好调养的糖尿病患者也产生低血糖倾向。

5.8.3 Treatment data from 2005

5.8.3 治疗数据（2005年）

In 2005, 114 patients with a variety of clinical syndromes were treated and evaluated by the author himself. The treatments were carried out according to the Russian principle as a combination of intravenous laser therapy and local (external) laser application. Many of the patients showed unsatisfactory results after conventional therapy, acupuncture or external laser therapy only. 2005年，作者自己对114名伴有各种临床综合症的患者进行了治疗和评估。根据俄罗斯原理进行治疗，静脉内光疗配合局部（体外）光照射。许多患者仅对常规治疗的疗效不满意后接受针灸或体外光疗。

- fat metabolism disorders (n = 20)
- 脂肪代谢紊乱 (n = 20)
- diabetes mellitus (n = 20)
- 糖尿病 (n = 20)
- chronic pain syndromes (n = 12)
- 慢性疼痛综合症 (n = 12)
- rheumatoid arthritis (n = 5)
- 类风湿性关节炎 (n = 5)
- polyneuropathies (n = 4)
- 多发性神经病变 (n = 4)
- chronic-inflammatory bowel diseases (n = 5)
- 慢性炎症性肠病 (n = 5)
- fibromyalgia (n = 7)
- 纤维肌痛 (n = 7)
- hypertension (n = 6)
- 高血压 (n = 6)
- tinnitus (n = 3)
- 耳鸣 (n = 3)
- macular degeneration (n = 4)
- 黄斑变性 (n = 4)
- multiple sclerosis (n = 9)

- 多发性硬化症 (n = 9)
- burn-out-syndrome (n = 9)
- 疲劳综合症 (n = 9)
- allergies and eczemas (n = 10)
- 过敏和湿疹 (n = 10)

The following effects could be verified by a questionnaire survey and the evaluation of clinical tests and laboratory parameters:

通过问卷调查、临床测试和实验室参数评估验证了以下疗效:

General effects:

一般疗效:

- significant improvement of general fitness
- 显著改善一般健康症状
- improvement of sleeping behaviour and vigilance
- 改善睡眠行为和警醒症
- positive effect on general mood
- 对一般情绪产生积极疗效
- reduction of drug consumption
- 减少药剂量

Special effects:

特殊疗效:

- optimization of diabetic metabolism
- 优化糖尿病代谢
- partially statin comparable influence on hypercholesterinemia
- 与部分他汀类药物对高胆固醇血症的疗效相当
- significant lowering of pathological increased liver values
- 显著降低病理性肝脏值的增加
- reduction of relapse in chronic-inflammatory bowel diseases
- 减少慢性炎症性肠病的复发
- improvement of general well-being and mobility in multiple sclerosis
- 改善多发性硬化症的一般健康病症和活动能力
- positive influence on therapy-resistant pain syndromes
- 对治疗顽固疼痛综合症有积极疗效
- positive influence on tinnitus
- 对耳鸣有积极疗效
- reduction of antihypertensive medication in severe hyper-tension
- 减少重度高血压的降压药剂量

Since its introduction and approval in March 2005, the laser blood irradiation method was established in more than 300 centres in Germany, Austria, Switzerland, Italy and Australia until end of 2006. Approximately 100,000 treatments were carried out in this timeframe.

自2005年3月认可并推出以来，截止到2006年底，光血液照射疗法已在德国、奥地利、瑞士、意大利和澳大利亚的300多个中心成熟应用。在此期间进行了大约100,000次治疗。

A major poll was held at the end of 2006, asking for the following points:

2006年底进行了一项重大民意调查，就以下几点询问：

- Acceptance by the patients
- 患者接受
- Side effects
- 副作用
- Effects on the general state of health
- 对一般健康病症的疗效
- Presentation of special effects and case studies
- 介绍特效和案例研究

This survey was the first major multicenter evaluation. The effects mentioned above could be confirmed entirely. Acceptance by patients was rated positive by everyone. There were no reports of severe side effects.

该调查是第一次重大的多中心评估。上述疗效被完全肯定。每个人都认为评估患者的接受程度是积极的。没有严重副作用的报告。

5.8.4 A pilot study in diabetics with intravenous laser blood irradiation

5.8.4 糖尿病患者静脉内光血液照射的初步研究

A. Wirz from Switzerland (2008) presented a pilot study with intravenous laser therapy on 100 diabetics at the 3rd international congress of the European Society for Biological Laser Therapy and Acupuncture (EGLA). Blood sugar levels were assessed before and after intravenous low level laser therapy. The results were as follows: An average decrease of 1,54 mmol/l in 70,5, % of the patients, an average increase of 0,82 mmol/l in 28 %, whereas blood sugar remained unchanged in 1,5 %. Long-term sugar HbA1C was reduced by an average of 1,23%. The red laser with the recently discovered insulin frequency of 3323 Hz [57] proved to be most successful. This very promising data needs to be confirmed in bigger studies, preferably multi-centred and double blinded.

来自瑞士的 A. Wirz（2008 年）在欧洲生物光疗和针灸学会第三届国际大会上发表了对 100 名糖尿病患者进行的静脉内光疗的初步研究。静脉内低强度光疗前后评估血糖水平。疗效如下：70.5% 患者平均降低 1.54 mmol/l，28% 患者平均增加 0.82 mmol / l，而 1.5% 患者的血糖保持不变。长期糖化血红蛋白平均降低了

1.23%。最近发现频率为 3323 Hz 红光配合胰岛素 [57]是最成功的。这一前途无量的数据需要在更多的研究中证实，最好选用多中心和双盲试验。



Fig. 13: Combined laser therapy in a patient with Diabetes mellitus

图 13：糖尿病患者的组合光疗

5.8.5 Studies on Multiple Sclerosis

5.8.5 多发性硬化症的研究

Multiple sclerosis (MS) is an isolated central nervous system disorder of unclear origin. Initially, inflammatory processes predominate with degenerative developments ensuing during the progression. Main symptoms are disturbances of the motor and sensitive system, culminating in inflammatory processes of the central nervous system with symptoms like restrictions of visual capacity. Chronic exhaustion is often observed and may lead to inability to work and other restrictions in daily life. No effective therapy is known up to now. Concordance to the HLA system is known, affecting autoimmune and inflammatory processes. In terms of aetiology, autoimmune, neurodegenerative and inflammatory origins are discussed.

多发性硬化症是一种不明原因的孤立性中枢神经系统疾病。最初，在累进发作期后接踵而来的主要是伴随着退行性发展的发炎过程。主要症状是运动和感觉系统紊乱，最终诱导中枢神经系统的炎症过程，伴有视觉能力受限的症状。经常可见慢性疲惫，会诱导在日常生活中无法工作和其他限制。到目前为止还没有有效的疗法。与已知人类白细胞抗原系统的一样，影响自身免疫和炎症过程。或是在病因学上，讨论的自身免疫、神经变性和炎症起源类似。

The current prevailing doctrine assumes that a T-cell-dependent disorder with initial secondary macrophage activity and myelin sheath destruction is

concerned. An immunosuppressive treatment is normally carried out nowadays.

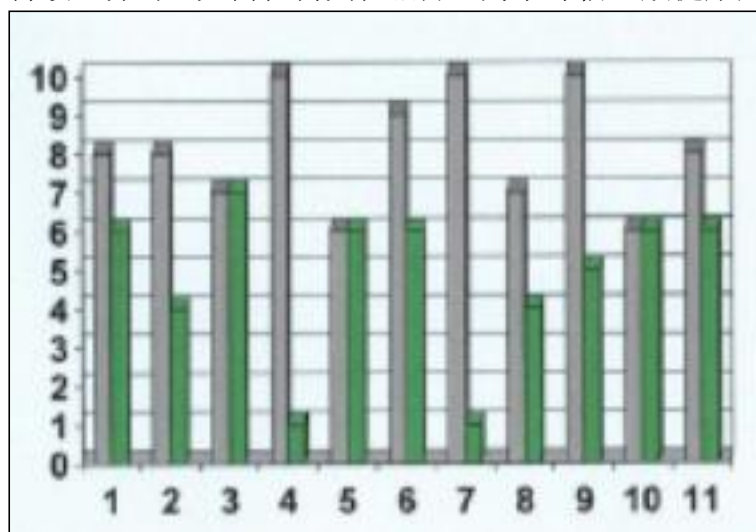
目前流行的学说假设具有初始继发性巨噬细胞活性和髓鞘破坏的T细胞依赖性疾病。现在通常进行免疫抑制治疗。

First pilot study on Multiple Sclerosis

多发性硬化症的初步研究

The German neurologist Schumm published a first pilot study on 16 patients with Multiple Sclerosis in 2006 [42]. The patients were treated ten times in total with red light laser only (632 nm, 1,5 mW, Weberneedle® Blood-device) and a treatment duration of 30 minutes without any additional treatment. For the evaluation of the general well-being and the sensomotor disorders, the so-called EDSS (Expanded Disability Status Score) was used. As a result, an improvement of chronic fatigue syndrome (fig. 14) could be observed in 73 % of the patients, while 64 % reported an improvement of sensomotor disorders (fig. 15). The very experienced neurologist Schumm concludes that the positive effects of intravenous laser blood irradiation are comparable with interferon therapy of Multiple Sclerosis but are not burdened with any side effects.

德国神经学家Schumm于2006年发表了一项关于16例多发性硬化症患者的初步研究[42]。患者仅用红光（632nm，1.5mW，韦伯针®血液装置）治疗10次，每次持续30分钟，无需任何其他治疗。为了评估一般健康症状和感觉运动障碍，使用



所谓的扩展残疾状况评分。结果，73%的患者可见慢性疲劳综合症的改善(图14)，而64%的患者报告感觉运动障碍的改善（图15）。经验丰富的神经专科医生Schumm得出结论，静脉内光血液照射的积极疗效与多发性硬化症的干扰素治疗相当，但无任何副作用。

Fig. 14: Self-assessment of patients regarding chronic fatigue syndrome before and after therapy (source: N. Schumm (37))

图 14：慢性疲劳综合症患者治疗前后的自我评估（资料来源：N. Schumm（37））

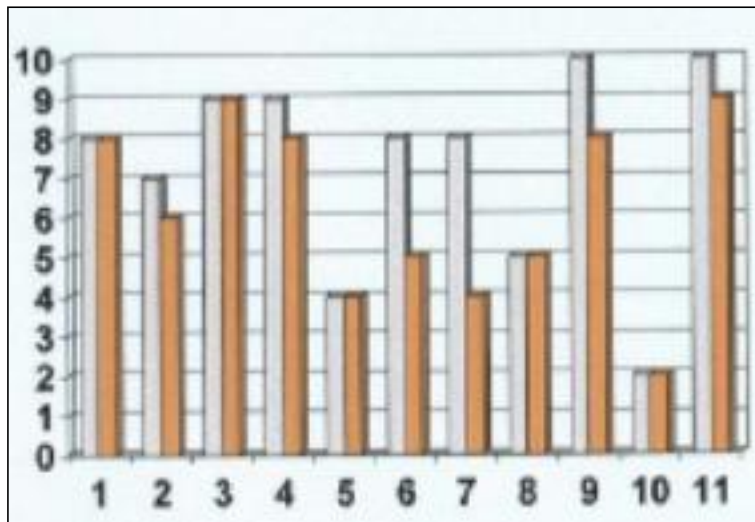


Fig. 15: Self-assessment of patients regarding sensomotor disorders
before and after therapy (source: N. Schumm (37))

图 15：感觉运动障碍患者治疗前后的自我评估（资料来源：N. Schumm（37））

Second study on Multiple Sclerosis

关于多发性硬化症的第二项研究

In 2008, Schumm published a new article called “Laser blood irradiation for Multiple Sclerosis: A new treatment procedure with significant improvement of quality of life” in the “Journal of Integrative and Complementary Medicine” [43].

2008年，Schumm在《全科医学与补充医学杂志》上发表了一篇文章，名为“多发性硬化症的光血液照射：一种显著改善生活质量的新疗法” [43]。

Methods

方法

In this study, the “weberneedle® blood” system was used again but treatments were done with a combination of red (635 nm) and green laser (532 nm) irradiation this time.

这项研究中，再次使用“韦伯针®血液”系统，但这次用红光（635nm）和绿光（532nm）组合照射进行治疗。

20 patients were included in this study. 10 patients of this group showed an exacerbated form of clinical course, whereas the remaining 10 patients showed a chronic progressive course. The mean age of the investigated patient group was 34 ± 12 years. Amongst the subjects studied, 16 patients (80 %) were female.

该研究包括20名患者。本组的10名患者表现出恶化的临床病程，而其余10名患者表现出慢性进行性病程。调查患者组的平均年龄为 34 ± 12 岁。所研究的受试者中，16名患者（80%）是女性。

An initial therapeutic cycle of ten treatments was designed for each proband. The therapy was carried out on a daily basis, with a break over the weekend. On average, the initial treatment course comprised of 9 ± 2 individual

treatments. The first cycle was performed during an average period of 21 ± 9 days. The first treatment of each patient was performed for 20 minutes with 50 % of laser power (2.5 mW) on the first day. On the next day, 75% of laser power (3.75 mW) was used for 25 minutes. Afterwards, all other treatments were done for 40 minutes with 100% of laser power (5 mW).

针对每名原发病患设计了10次治疗的初始疗程。治疗每天进行，周末休息。通常，初始治疗过程包括 9 ± 2 次个体治疗。第一个周期平均 21 ± 9 天内完成。每名患者的第一个疗程中，第一天以50%的光功率（2.5mW）照射20分钟。第二天以75%的光功率（3.75mW）照射25分钟。然后，所有其他治疗都以100%光功率（5mW）照射40分钟。

Following cycles were carried out dependent on individual clinical progress. If there was deterioration, other treatments were performed. A second cycle with an average of three treatments was done in four subjects (20 %) after an average of 2.5 months. The treatment was implemented until deterioration was averted and a subjective improvement occurred. Two subjects received a third cycle with an average of 2.5 treatments after another two months. In one of those patients, a fourth cycle of only one treatment was carried out after further two months.

根据个体病例临床进展情况进行以下疗程的治疗。如果出现恶化，则使用其他疗法。在平均2.5个月后的第二个疗程中，四名受试者（20%）平均3次照射。实施治疗未见恶化且出现主观改善。又过两个月后，两名受试者接受第三个疗程的治疗，平均2.5次照射。又过两个月后，这些患者之一接受第四个疗程的治疗，仅照射一次。

The average follow-up of all studied patients was 8 ± 3 months.

参与研究的所有患者平均随访时间为 8 ± 3 个月。

A pre-existing immunomodulating therapy with interferones in eight subjects (40 %) was continued unchanged during the study. This immunomodulating therapy in these eight subjects already existed before the study for more than two years and was not changed before, during or after the study (during follow-up period).

研究期间，8名受试者（40%）使用干扰素预先免疫调节疗法的继续保持不变。这8名受试者的这种免疫调节疗法在研究之前已经使用超过两年并且在研究之前、期间或之后（随访期间）未改变。

Data survey and statistics

数据调查和统计

The data survey on patient's quality of life was carried out using the "SF12 questionnaire on general health conditions". This questionnaire is a standardized system for the compilation of physical and psychological quality of life in MS patients. The SF12 was completed by the subjects before and after the first treatment cycle. Another self-assessment was done every four weeks within the scope of normal consultations. If there was a second or third treatment cycle, the SF12 survey was carried out again before and after

treatment. The use of this procedure allowed collecting data on the therapeutic effect directly after the treatment as well as in the long-term.

关于患者生活质量的数据调查，使用“关于一般健康病症的SF12调查问卷”进行。该问卷是一个标准化的系统，用于汇总多发性硬化症患者的生理和心理生活质量。在第一个疗程前后，受试者完成SF12。在常规会诊范围内每四周完成一次自我评估。如果有第二个或第三个疗程的，则在治疗前后再次进行SF12调查。使用该程序可以在治疗后直接收集疗效数据，也可以长期收集。

Statistical evaluation was performed by SPSS for Windows, Version 15.0 (SPSS Inc., USA). Continuous variables are shown as mean values and standard deviation was selected as a measure of variation. The continuous variables were validated by means of the Kolmogorov-Smirnov test with respect to their normal distribution. None of the tested variables demonstrated a normal distribution (Kolmogorov-Smirnov test: $p < 0.05$). Therefore, the t-test for paired random samples was used as a non-parametric test by comparing the means. In contrast, the categorized data were evaluated by using the chi-square test and/or the exact Fisher test.

统计评估通过统计分析软件社会学统计包（微软视窗操作系统，版本15.0，美国SPSS公司）进行。连续变量显示为平均值，选择标准偏差作为变异测量。在其正态分布方面，连续变量通过柯尔莫哥罗夫-斯米尔诺夫检验得到验证。所测试的变量均未见正态分布（柯尔莫哥罗夫-斯米尔诺夫检验： $p < 0.05$ ）。因此，通过比较平均值，将成对随机小样本t试验用作非参数检验。相反，使用卡方检验和/或精确费希尔试验来评估分类数据。

A two-sided significance testing was carried out in all tests in which a p-value < 0.05 was considered as statistically significant for all statistical tests.

在所有试验中进行双面显著性测试，其中p值 < 0.05 认为对所有统计试验具有统计学显著性。

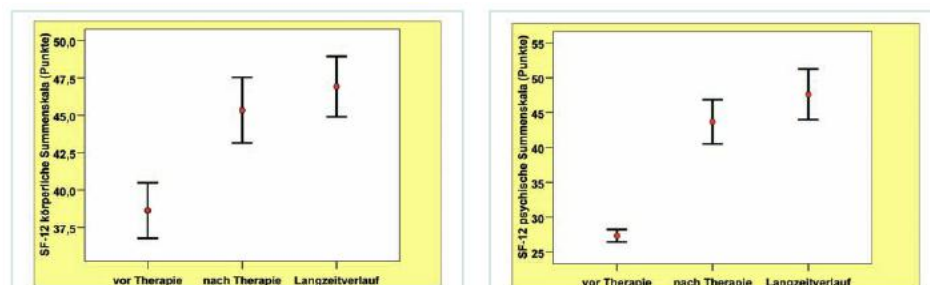


Fig. 16: Physical sum scale before and after therapy

图 16: 治疗前后生理总和量表

Fig. 17: Psychological sum scale before and after therapy

图 17: 治疗前后心理总和量表

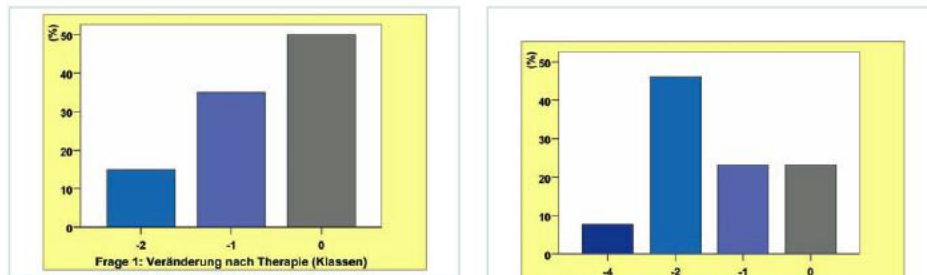


Fig. 18: Question directly after therapy: “How would you describe your general health condition?” The number of categories of an increased general health condition is shown.

图18：治疗后直接提出询问：“描述您的一般健康病症如何？”表示改善一般健康病症的分类数量。

Fig. 19: Same question (fig. 18) in a long-term measurement

图 19：长期测量的相同问题（图 18）

Results

成果

A significant improvement of the physical sum scale from 38.2 ± 5.8 points before the therapy to 43.4 ± 8.1 points (fig. 16) could be obtained directly after the intravenous laser therapy ($p = 0.002$).

生理总和量表从治疗前 38.2 ± 5.8 点到静脉内光疗后直接获得 43.4 ± 8.1 点（图16），显著提高（ $p = 0.002$ ）。

The psychological sum scale improved even more (fig. 17) from 28.6 ± 6.9 to 43.6 ± 13.0 points ($p < 0.001$).

心理总和量表从 28.6 ± 6.9 点增加到 43.6 ± 13.0 点（ $p < 0.001$ ），提高得更多（图17）。

A non-significant trend for further improvement of both scales could be observed during measurement of the long-term progress of both physical as well as psychological sum scales (physical sum scale = 46.9 ± 7.3 points; psychological sum scale = 47.6 ± 13.1 ; the p-value was insignificant for both scales when compared to the scales directly after the therapy).

在生理和心理总和量表长期进行测量期间，可见进一步提高两种量表的非显著趋势（生理总和量表= 46.9 ± 7.3 点；心理总和量表= 47.6 ± 13.1 点；与治疗后直接量表相比，p值对于两种量表均无显著性）。

The evaluation of question 1 in SF12 (“How would you describe your general health condition?”) directly after intravenous laser therapy is shown in fig. 18. Possible answers were “excellent” (Class 1), “very good” (Class 2), “good” (Class 3), “less good” (Class 4) and “bad” (Class 5). 15 % of the subjects reported an improvement of two classes directly after the first therapy cycle. In 35% of the patients, there was an improved condition of one class. No improvement was observed in 50 % of the patients.

静脉内光疗后直接评估SF12中的问题1（“描述您的一般健康病症如何？”），如图18所示。可能的答案是“优秀”（等级1），“很好”（等级2），“良好”（等级3），“不太好”（等级4）和“不良”（等级5）。第一个疗程后15%的

受试者报告直接改善了两个等级。35%的受试者改善了一个病症等级。50%的受试者未见改善。

Fig. 19 illustrates the evaluation of question 1 in the long-term. Improvements of four classes were reported by 10 % of the patients (two subjects), improvement of two classes by 50 % (ten subjects) and improvement of one category by 20% (four subjects). 20 % of the patients (four subjects) experienced no modification.

图19显示了长期问题1的评估。10%的患者（2名受试者）报告改善了4个等级，50%的患者（10名受试者）报告改善了2个等级，20%的患者（4名受试者）报告改善了1个等级。20%的患者（4名受试者）未见变化。

Another question of SF12 asked “How often did you feel full of energy in the last few weeks?” The possible answers were given in the following categories: “Always” (category 1), “mostly” (category 2), “fairly often” (category 3), “sometimes” (category 4), “rarely” (category 5) and “never” (category 6). The evaluation of this question on the energy level directly after the first treatment cycle is shown by fig. 20.

SF12的另一个问题是“您在过去几周内感到精力充沛时多久一次”？可能给出的答案分为以下几类：“一直”（等级1），“大部分时间”（等级2），“经常”（等级3），“有时”（等级4），“很少”（等级5）和“从来不”（等级6）。在第一个疗程后就精力水平直接评估该问题，如图20所示。

35 % of the subjects reported an improvement of three categories. Improvement of two categories was reported by 25 % of the patients while 10 % felt an improvement of one category (two subjects). There was no change in energy conditions in 30 % of the patients.

35%的受试者报告改善了三个等级。25%的受试者报告改善了两个等级，而10%的受试者感觉改善了一个等级（2名受试者）。30%受试者的精力病症未见变化。

Fig. 21 shows the influence of intravenous laser therapy on the energy condition in the long-term. 55 % of the patients (eleven subjects) reported an improvement of three categories, whereas improvement of two categories was observed in 15 %. Six subjects (30 %) reported no modification of their energy condition

图21显示了长期静脉内光疗对精力病症的效应。55%的患者（11名受试者）报告改善了三个等级，15%的患者报告改善了两个等级，30%的患者报告精力病症未见改变

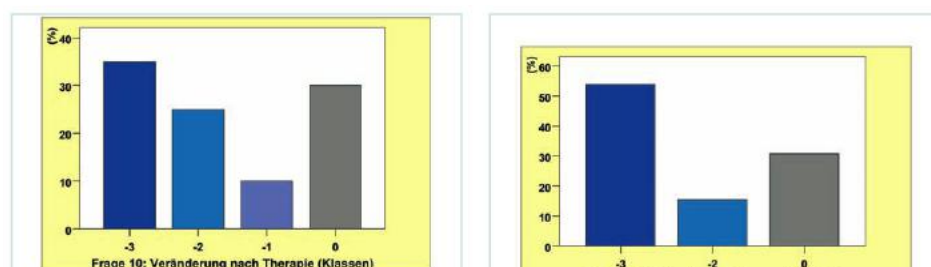


Fig. 20: Question 10 in SF12 directly after therapy: “How often did you feel full of energy

in the last few weeks?" The number of categories of an increased energy condition is shown.

图20: 治疗后直接询问SF12中的问题10: “您在过去几周内感觉精力充沛多久一次”? 显示了精力病症改善等级数。

Fig. 21: Same question (fig. 20) in a long-term measurement

图 21: 长期测量相同问题 (图 20)

Discussion

讨论

Intravenous laser blood irradiation leads to a highly significant improvement in the quality of life in patients with Multiple Sclerosis. This concerns both the physical as well as the psychological sensitivity. A highly significant improvement was produced in both sum scales directly after first treatment cycles. No side-effects have been observed (what is confirmed by other studies as well, i.e. Gasparyan and Siposan et al.).

在多发硬化症患者的生活质量上, 静脉内光血液照射诱导了显著改善。这涉及生理和心理敏感性。在第一个疗程后两个总和量表均直接产生了显著的改善。未见副作用 (其他研究也证实了这一点, 诸如Gasparyan和Siposan等人的研究)。

The questionnaire SF12 was used for evaluation as it addresses both the physical condition as well as the psychological well-being.

问卷调查SF12用于评估, 提出生理病症和心理健康病症问题。

Approximately 70 % of MS patients suffer excruciating severe exhaustion (fatigue syndrome). The effect of intravenous laser therapy on this symptom could be confirmed by the current study by evaluation of question 10 (increase of energy level) in SF12. After the first laser cycle with an average of nine treatments was terminated, other treatments were carried out when a clinical deterioration reappeared. However, fewer treatments were required to produce improvement in the subsequent cycle compared to the first cycle. According to the author, the dosage of following therapy cycles has to be performed individually.

大约70%的多发性硬化症患者遭受极度严重的疲惫 (疲劳综合症)。通过评估SF12中问题10 (精力水平的提高) 的当前研究, 可以证实静脉内光疗对该症状的疗效。在第一个光照射疗程中平均完成了9次治疗, 当临床恶化出现时改用其他疗法。然而, 与第一个疗程相比, 在后续疗程中改善只需更少的治疗次数。据作者所言, 下列疗程的剂量必须单独管理。

In the current study, repeated treatment cycles were never performed until deterioration was observed. However, it seems reasonable to use laser therapy regularly and prior to reduction of its positive effects. A long-term improvement in the quality of life might be possible using a regular treatment course.

目前的研究, 在恶化之前从未进行过重复疗程。因此, 在积极疗效降低之前, 定期使用光疗似乎是合理的。定期疗程可以长期改善生活质量。

Conclusion

结论

According to the experience of the author, there is no established therapy available for successful treatment of fatigue syndrome in MS-patients that can be compared to the effects of intravenous laser therapy.

根据作者的经验，多发性硬化症患者没有成功治疗疲劳综合症的既定疗法，所以静脉内光疗的疗效是无与伦比的。

Another interesting question for further research is whether the effect can be further improved by using additional laser wavelengths (i.e. blue and yellow lasers) or simultaneous laser irradiation of head zones (or simultaneous laser acupuncture).

进一步研究中的另一个令人关注的问题是，通过使用其他光波长（如蓝光和黄光）或头部区域的同时光照射（或同时光针灸）是否可以进一步提高疗效。

Studies observing the exclusive use of intravenous laser therapy without accompanying immunomodulating treatment are also important. The current results within this context are expected to initiate further studies on large numbers of patients with longer observation times and evaluation of changes in relapse rate and EDSS (Expanded Disability Status Score).

研究可见，专用静脉内光疗，不配合免疫调节治疗，也很重要。在此背景下的当前疗效预计会激发进一步研究，对大批患者治疗，延长观察时间且评估复发率变化和扩展残疾状况评分。

5.8.6 Intravenous laser therapy for treatment of fibromyalgia

5.8.6 静脉内光治疗纤维肌痛

In 2008, the anaesthetologist Wieden published a new study [56] performed in the pain centre of Celle in Germany.

2008年，麻醉师Wieden发表了一项在德国策勒疼痛中心完成的新研究[56]。

Fibromyalgia is one of the most common chronic pain disorders. In Europe, the estimated disorder rate range is between 10 and 13 %; in the United States of America, this proportion is merely 2 %. Women, who mostly have the onset of disease between 20 and 35 years of age, are predominantly affected at a ratio of 8:1.

纤维肌痛是最常见的慢性疼痛疾病之一。在欧洲，估计患病比例为 10%-13%；在美国，估计患病比例仅为 2%。该病的大多数妇女患者开始发作年龄在 20 至 35 岁之间，主要影响比例为 8: 1。

The term fibromyalgia is derived from its components, fibra = fibre, myos = muscle and algos = pain so that its naming already indicates the localisation of the complaint.

术语纤维肌痛来源于其成分，fibra = 纤维，myos = 肌肉和疼痛=肌痛，因此其命名已经表明了疾病的部位。

Symptoms

症状

The onset of the disease mostly occurs subtly as unspecific symptoms, exhaustion and sleep disorders; gastrointestinal symptoms also arise at a later stage. The typical pain development starts in the arms and legs after a certain latency period. Later, pain is also distributed over the torso. Normally, seven to eight years expire before the disease is completely progressed, leading from depressive alienation to manifest depression and partially severe vegetative disturbances. Organ or tissue damages are undetectable by diagnostic measures and procedures, leading to stigmatism of the affected patients.

这种疾病的发作敏锐，主要表现为微妙的非特异性症状、疲惫和睡眠障碍；晚期也会出现胃肠道症状。在一定的潜伏期后，典型的疼痛发展始于手臂和腿部。后来，疼痛也分布于躯干。通常情况下，完全发展到该病需要七到八年的时间，导致从抑郁异化发展到明显的抑郁症和部分重度的营养紊乱。通过诊断措施和治疗无法检查到器官或组织损伤，诱发受影响患者的耻辱感。

List of symptoms:

症状概览：

- unspecific complaints, exhaustion and sleep disorders
- 非特异性疾病、疲惫和睡眠障碍
- morning stiffness, subjectively sensitised swelling of the hands, arms and legs
- 晨僵、主观敏感的手、手臂和腿部肿胀
- subjective discomforts like pins and needles as well as numbness predominantly in the hands
- 主观不安、如坐针毡以及手部明显麻木
- nervous extremities (restless legs), spasms in leg muscles
- 紧张不安的四肢（多动腿）、腿部肌群肌肉痉挛
- tense headaches in the temples and occipital region
- 太阳穴和枕部紧张得头痛
- violent pain attacks interspersed with periods that show little pain or are even painless
- 剧痛发作穿插于数个表现出少痛或甚至无痛的周期
- chills, wetness or external stress that leads to aggravation
- 寒冷、潮湿或外部压力诱导恶化
- hoarseness, difficulties in swallowing, lumpy sensation in the throat, ear ringing (tinnitus)
- 声音嘶哑、吞咽困难、喉咙肿块感、耳鸣
- cardiac rhythm disturbances, dyspnoea
- 心律紊乱、呼吸困难
- gastrointestinal disturbances, irritable bladder
- 胃肠道紊乱、膀胱过敏
- sensitive skin, alopecia, increased perspiration
- 敏感性皮肤、脱发、大汗淋漓
- fatigue and incapacity

- 疲劳和无行为能力
- severe physical and mental exhaustion after mild exposure
- 轻度接触后重度生理和精神疲惫
- rare somnolence, frequent hypersomnia
- 罕见嗜睡、频繁睡眠过度
- cognitive and concentration disturbances, depressive alienation
- 认知和注意力紊乱、抑郁异化
- tendency to develop intolerance and pseudo-allergies
- 倾向于发展到不耐受和假过敏
- reduced sexual interest
- 性欲减弱

Disease origin

病因

The origin of the symptoms is unknown; indications of infectious, immunological or hormonal imbalances are being discussed. To date, the theory of an infectious disease caused by Streptococci or Borrelia could also neither be confirmed nor contradicted.

症状的起因不明，争议于传染病、免疫系统或激素失衡之间。迄今为止，由链球菌或疏螺旋体诱导的传染病理论既不能确认也不能驳斥。

Involvement of genetic causes is investigated strongly. Significant mutations at chromosome 22 (COMT-GEN, position 158 Val/Met) that have also been found in the ADHS hyperactivity syndrome could be proven in affected patients, probably leading to cognitive alteration and an increase in the subjective pain sensation. However, origin of premature exhaustion in the physical capacity remains unclear. In this context, psychological reasons are predominantly discussed.

深入研究涉及的遗传病因。在受影响的患者中证实，在注意力缺乏综合症和活动过度综合症中可见22号染色体（儿茶酚氧位甲基转移酶基因，158位缬氨酸/蛋氨酸）显著突变，可能诱导认知改变和主观疼痛感增加。然而，生理能力过早衰竭的病因仍不清楚。在这种情况下，主要争议点是心理原因。

Therapy

治疗

Due to the subtle progress of the disease, fibromyalgia is often diagnosed not until a late stage of the disease. Therefore, therapy has to address both the specific symptoms as well as the subsequent damages from chronification that has already occurred.

由于疾病的微妙进行，通常纤维肌痛直到疾病晚期才能诊断出来。因此，治疗必须解决特异性症状以及随后发生的疼痛迁延化损害。

Because of long-term medication with different pain-killers, permanent physical damage, medication abuse or even addiction are often observed.

由于长期服用不同的止痛药，经常会发现永久性的生理损害、药物滥用甚至成瘾。

A causal therapy in accordance with generally valid standards or directives is currently impossible. However, different aspects are advocated within the scope of a multimodal therapy:

目前不可能根据通常的有效标准或指令使用病因疗法。然而，在多模式治疗范围内提倡不同尝试：

- economical use of conventional analgesics such as NSAR
- 使用常规而经济的镇痛药，如肌氨酸乙酯亚硝酸胺
- abstinence from opiates (especially stage III according to WHO) in order to prevent euphoric side effects or sleep inducement
- 禁止阿片类药物（特别是根据世界卫生组织的III个级规定），以防止欣快的副作用或诱导睡眠
- anti-depressive therapy by tricyclic or modern serotonin reuptake inhibitors
- 三环或现代5-羟色胺再摄取抑制剂的抗抑郁治疗
- antineuropathic treatment by Gabapentin or Pregabalin
- 加巴喷丁或普瑞巴林的抗神经病治疗
- cryotherapy (cold room), physical therapy
- 冷冻疗法（冷藏室）、物理疗法
- muscle relaxation and lymph drainage
- 肌肉松弛和淋巴引流
- additional psychotherapeutic and psychosomatic treatment for systematic increase of load
- 系统性增加负荷的其他精神治疗和心身治疗

Pathophysiological considerations

病理生理学观点

Fibromyalgia is characterized – from a purely physical point of view – by pain and rapid exhaustion of the muscle system, even after mild exertion.

从纯粹的生理角度看，纤维肌痛的特征在于肌肉系统的疼痛和快速衰竭，即使在轻度运动后也是如此。

The muscle structure is composed of individual fibres from a multitude of myofibrils that consist of individual actin filaments bound to one another and interspersing myosin filaments. Muscle contraction is achieved by the filament sliding over one another what is accompanied by a corresponding muscle shortening.

肌肉结构由来自众多的肌原纤维的单根纤维组成，所述肌原纤维又由彼此结合并散布于肌球蛋白微丝的单个肌动蛋白微丝组成。通过相互滑动的微丝实现肌肉收缩，伴随着相应的肌肉缩短。

A constant supply of adenosine triphosphate (ATP) from the ribosomes of muscle's mitochondria is required for this process. The energy obtained from this ATP is only sufficient for a few muscle contractions. If the supply is depleted, the muscle cells start to search for other energy sources: In a first step, creatine phosphate (CP) is used to convert energy-deficient adenosine

diphosphate (ADP) to ATP (that is essential for permanent energy delivery). If creatine phosphate is also declining, the aerobic metabolism turns into anaerobic metabolism. During this process, the muscle cells get ATP by conversion of glucose to lactic acid (lactate), leading to accumulation in muscle fibres, acidosis and constant pain. The energy balance resulting from this process cannot cover the demand constantly: While in an aerobic metabolism there are 38 ATP molecules generated out of one sugar molecule, the anaerobic conversion leads to the formation of 2 ATP molecules from one sugar molecule only. In consequence, there is progression of a constant energy deficit. If we consider that even the muscle fibre tension is an energy-consuming process, it is obvious that oxygen demand of the muscle (even when resting) is not or only insufficiently achieved. The result is a constant lack of energy of the musculature system with permanent contractions, continuous pain and formation of “hot spots” with lack of blood circulation (trigger points or even tender points which are pathognomic for fibromyalgia).

该过程需要从肌肉线粒体的核糖体中持续供应三磷酸腺苷。从这种三磷酸腺苷获得的能量仅满足一些肌肉收缩。如果供应耗尽，肌肉细胞开始寻找其他能源：第一步，磷酸肌酸用于将缺乏能量的二磷酸腺苷转化为三磷酸腺苷（对于永久性能量传递是至关重要）。如果磷酸肌酸也在下降，有氧代谢转变为无氧代谢。在此过程中，肌肉细胞通过葡萄糖转化为乳酸（乳酸盐）而获得三磷酸腺苷，在肌纤维中诱导酸中毒和持续疼痛的积聚。由此过程产生的能量平衡不能持续地满足需求：在有氧代谢中，一个糖分子产生38个三磷酸腺苷分子，厌氧转化仅诱导从一个糖分子形成2个三磷酸腺苷分子。因此，存在连续的能量不足。如果我们认为肌纤维张力是一个耗能的过程，很明显肌肉的氧气需求（即使休息时）没有满足或只是不充分地获得。结果是肌肉组织系统持续缺乏能量，伴有永久性收缩、持续疼痛和形成缺乏血液循环的“热点”（刺痛点或乃至脆弱点。这是纤维肌痛的病理）。

Implications for fibromyalgia therapy

纤维肌痛治疗的意义

If the disturbed energy balance of the muscle can be improved successfully, continuous contractions and constant pain can be reduced in most cases.

如果能够成功地改善肌肉的受干扰能量平衡，则大多数病例均可以减少连续收缩和持续疼痛。

It is known from sports sciences that performance of athletes is improved by laser light irradiation that targets the muscular system.

从运动科学可知，通过靶向肌肉系统的光照射，运动员的成绩得到改善。

If this technique is supplemented by additional acupuncture of fibromyalgia-related acupuncture points and by intravenous laser blood irradiation (for stimulation of mitochondria and increase of energy), a new and efficient procedure for treating fibromyalgia (at least in a complementary way) could be developed.

如果通过针对纤维肌痛相关穴位的其他针灸和静脉内光血液照射（用于刺激线粒体和增加能量）来补充这种技术，可以研发一种治疗纤维肌痛的新型而高效的疗法（至少以互补的方式）。

Thus, the objective of the current observation was the evaluation of treatment of fibromyalgia symptomatology by combining intravenous laser application, local laser irradiation of muscles and laser acupuncture.

因此，目前观察的目的是通过配合静脉内光应用、局部光照射肌肉和光针灸来评估纤维肌痛总症状的疗效。

Data sheet: M. Mustermann, born on 16.05.1942												
■ MPSS: chronification stage 3 is present at the time of the initial study.												
■ Last psychological test: highly affective pain evaluation												
■ Special points of note: high depression value												
Psychological test	Onset : 2008	Quarter:										
	Pain scale	Value: 0 up to 10	6									
	Well-being	Value: 0 up to 10	3									
	Confinement (PDI)	Standard value: up to 5	8.0									
	Veg. score (von Zerssen)	Standard value: M=24, F=26	42									
	Affective components	Standard value: up to 42 P	49									
	Sensory components	Standard value: up to 42 P	22									
	A-SES / S-SES Quotient	Standard value: up to 1	2.2									
	Depressivity (ADS)	Standard value: up to 23 P	38									
Therapy schedule	Meaningful addictive/ withdrawal behaviour											
	Phamacotherapy	X										
	Therapeutic localised anaesthesia											
	Invasive procedures											
	Acupuncture	X										
	Physiotherapy											
	Psychotherapy	X										
	Social work											
	Other	X										
	Stationary therapy											

Fig. 22:

Psychological and pain-specific profile regularly evaluated before and during therapy

图22：在治疗前和期间定期评估心理和疼痛特异性简况

The pain centre Celle is a facility where only patients suffering from chronic pain disorders have been treated by multimodal and interdisciplinary directives for more than 10 years. Besides conventional medication, practically all interventional and many complementary therapy forms are also applied. Another focal point is traditional Chinese acupuncture that is also applied to a wider extent in accordance with the directives of the “Bundesärztekammer” (Federal Medical Board), corresponding to the indication list of the World Health Organisation (WHO).

策勒疼痛中心是只为治疗已经通过多模式和跨学科规定治疗超过10年的慢性疼痛患者的机构。除常规药物外，实际上也应用所有介入和许多辅助治疗形式。

另一个焦点是中国传统针灸，根据“联邦医师公会”（联邦医疗委员会）的指示，对应于世界卫生组织的适应症清单，也被广泛使用。

All patients experience an intensive initial survey as well as a standardised progress control that also includes a psychological and pain-specific profile. Previous and current pain extent, pain disability index (PDI), sensory and affective components, the von Zerssen vegetative score, the depression index (ADS) as well as the Gerbershagen chronification stage are also documented in all patients.

所有患者都经历了密集的初步试验以及标准化的进展控制，其中还包括心理和疼痛特异性的概况。所有患者均记录了既往史、目前的疼痛程度、疼痛残疾指数、感觉和情感成分、冯·泽尔森营养评分、抑郁指数（焦虑抑郁量表）以及格贝尔斯哈根疼痛迁延化阶段。

Axis	Item	Description	Value			Stage					
1	Temporal aspects	Frequency of incidence	Once per day or rarer 1 Several times per day 2 Persistent 3	3	Axis = sum 7 3	Axis = stage 3	Total of anal stages 10				
		Duration	Up to several hours 1 Several days 2 Longer than one week or permanent 3	3							
			Intensity change	Frequent 1 Occasional 2 Never 3				1			
	2	Spatial aspects						Monocular 3 Bilateral 2 Multifocal or panalgia 3	3	3	Total chronic stage (MPSS):
								3			
	3	Med. consumption behaviour	Medication consumption	Irregular consumption of a max. 2 peripheral analgesics 1 max. 4 peripheral analgesics, maximum of 2 regular 2 Regular, more than 2 peripheral Analgesics or analgesics affecting the central nervous system 3				1	2	1	3
Number of withdrawal treatments				none 1 one 2 More than one withdrawal treatment 3	1						
4			Patient medical history	Change of family doctor	No change 1 max 3 changes 2 More than 3 changes 3	3	3	3			
					Hospital stay caused by pain	Up to 1 1 2 to 3 2 More than 3 3					
	Operations due to pain	Up to 1 1 2 to 3 2 More than 3 3				1					
		Rehabilitation measures due to pain		None 1 Up to 2 2 More than 2 3	3						

Fig. 23: Evaluation of the Gerbershagen chronification index at the onset of therapy

图 23：治疗开始时格贝尔斯哈根疼痛迁延化指数的评估

Methodology

方法

In the observed patients of the current study, fibromyalgia has been diagnosed either as a primary disease or as a reactive disorder accompanied by other pain conditions. Overall, 246 patients who have received medication treatment as well as physical therapeutic procedures and, if necessary, psychotherapy or conventional acupuncture, could be reprocessed within the scope of a retrospective view.

当前研究中观察的患者，纤维肌痛被诊断为原发疾病或伴有其他疼痛病症的反应性紊乱。总体而言，246名接受过药物治疗以及物理疗程的患者，必要时还给予过心理治疗或常规针灸治疗，可以在回顾性研究的范围内进行再治疗。

The average duration of disease was 8 years; six pre-therapy experts on average had performed medication procedures (99%), physical therapy (86%), psychotherapy (22%) or other procedures (20%).

平均病程为8年;6名患者治疗前专家均进行了药物治疗（99%）、物理治疗（86%）、心理治疗（22%）或其他治疗（20%）。

In another group, 82 patients have been treated with acupuncture additionally.

在另一组中，82名患者另外接受过针灸治疗。

Finally, 72 patients have received laser treatment either as a purely percutaneous therapy of specific acupuncture points or as a combined procedure using intravenous laser blood irradiation.

最后，72名患者接受过光疗，既有特定穴位的纯经皮治疗，也有静脉内光血液照射的組合治疗。

For local muscle irradiation and laserneedle acupuncture, the weberneedle® basic system with 6 red (658 nm, 50 mW) and 6 infrared lasers (810 nm, 100 mW) was applied.

对于局部肌肉照射和光针灸，应用配备6支红光（658nm，50mW）和6支红外光（810nm，100mW）的韦伯针®基础系统。

For intravenous laser therapy, the weberneedle® blood system (Weber Medical, Germany) with red (632 nm, 5 mW) and green laser (532 nm, 5 mW) irradiation was used.

对于静脉内光疗，使用配备红光（632nm，5mW）和绿光（532nm，5mW）照射的韦伯针®血液系统（德国韦伯医疗）。

Each patient received 10 laser acupuncture treatments as well as a minimum of three intravenous laser blood irradiations. The treatment duration was limited to five weeks.

每位患者接受10次光针灸治疗以及至少3次静脉内光血液照射。治疗时间限于五周。

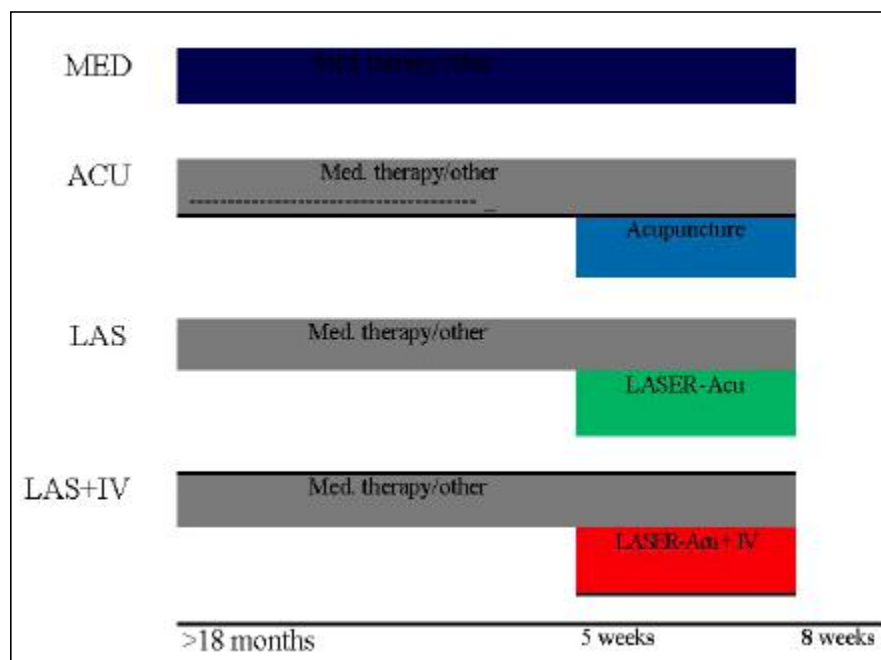


Fig. 24: Therapy structure: All patients have received conventional medication (MED), one group received additional needle acupuncture (AKU) and one group received laser acupuncture (LAS) or a combination of laser acupuncture and intravenous laser blood irradiation (LAS+IV).

图24：治疗结构：所有患者均接受常规药物治疗，一组另接受针灸（AKU），一组接受光针灸或光针灸配合静脉光血液照射（LAS）。

Observations

观察疗效

The effects on the fibromyalgia-related symptoms “pain”, “vegetative disorders” and “depression” have been evaluated.

评估了对纤维肌痛相关症状“疼痛”、“营养失调”和“抑郁症”的疗效。

1. Pain

1.疼痛

During treatment, the average pain intensity decreased significantly on the visual analogue scale (VAS) in all treatment groups as compared to the initial study (conventional medication). Best results on pain characteristics were achieved in the group treated with combination of external and intravenous laser therapy.

在治疗期间，与最初研究（常规药物）相比，所有治疗组的平均疼痛强度在视觉模拟评分上显著降低。在用体外和静

	Onset	End
MED	8.7	6.8
ACU	8.5	6
LAS	8.5	4.4
LAS+IV	8.9	2.9

MED = medication procedure, ACU = needle acupuncture, LAS = laserneedle acupuncture, LAS+IV = combination of laserneedle acupuncture with intravenous laser irradiation.

脉内光疗法组合治疗组中获得了疼痛病症的最佳疗效。

Fig. 25: Pain Index (VAS) before and after therapy

图 25：治疗前后的疼痛指数（视觉模拟评分）

2. Pain Disability Index

2.疼痛残疾指数

Within the scope of the von Zerssen vegetative score, vegetative disturbances (such as excessive perspiration, tachycardia, globus sensation etc.) underwent significant improvement due to all acupuncture treatments with and without laser as compared to the initial study where medication treatment only led to a marginal change of the original value. Again, best results were achieved with combined laser therapy.

在冯·泽尔森营养评分的范围内，用带和不带光的所有针灸治疗营养失调（例如大汗淋漓、心动过速、癔球症等）诱导显著改善。与最初研究相比，药物治疗仅诱导了初始值的边际变化。同样，组合光疗取得了最佳疗效。

	Onset	End
MED	54	51
ACU	48	36
LAS	49	35
LAS+IV	52	22

MED = medication procedure, ACU = needle acupuncture, LAS = laserneedle acupuncture, LAS+IV = combination of laserneedle acupuncture with intravenous laser irradiation.

Fig. 26: Pain Disability Index (VAS) before and after therapy

图 26：治疗前后疼痛残疾指数（视觉模拟评分）

3. Depression Index

3.抑郁症指数

Frequently occurring depression of fibromyalgia patients also decreased most significantly in groups treated with laserneedle acupuncture or a combination of laserneedle acupuncture and intravenous laser irradiation.

在用光针灸或光针灸配合静脉内光照射治疗组中，纤维肌痛患者发生的抑郁症的

	Onset	End
MED	34	23
ACU	37	24
LAS	42	12
LAS+IV	40	12

MED = medication procedure, ACU = needle acupuncture, LAS = laserneedle acupuncture, LAS+IV = combination of laserneedle acupuncture with intravasal laser irradiation.

频率显著降低。

Fig. 27: Depression Index (VAS) before and after therapy

图 27：治疗前后抑郁症指数（视觉模拟评分）

4. Overview of effects of combined laser therapy

4.组合光疗效概述

Measurement of the score estimated by patients themselves for affective and vegetative adverse effects as well as for their general well-being, all values for the combined laser treatment after five weeks showed a significant improvement when compared with those at the beginning of the therapy.

测量中，由患者自我评估情感和营养不良疗效及其总体健康症状的评分。与治疗开始时相比，五周后可见组合光疗的所有值显著改善。

	Onset	End
Sense of well-being	30	70
Veg. score	51	21
Affective comp.	48	31

Fig. 28: General effects of combined laser therapy

图 28：组合光疗的一般疗效

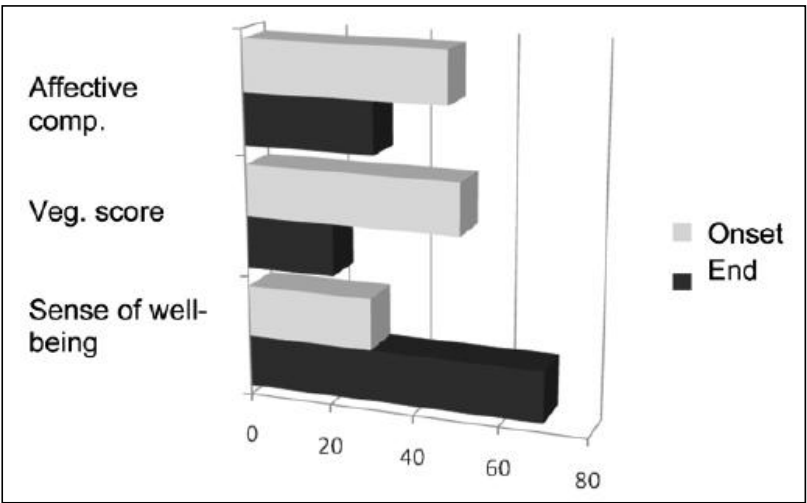


Fig. 29: General effects of combined laser therapy

图29：组合光疗的一般疗效

Conclusion

结论

The conventional procedures to treat fibromyalgia primarily consist of medication, physiotherapy and psychotherapy. A significant reduction of symptoms is barely achieved by these methods. However, they are often able to prevent aggravation.

纤维肌痛的常规治疗主要包括药物、物理疗法和心理疗法。这些方法几乎不能获得症状缓解的显著疗效。但是，通常能防止恶化。

According to the classical Chinese model, needle acupuncture treatments represent another option to limit the individual symptoms. In the current observation of the individual patient groups, however, a slightly limited effect of acupuncture was evaluated, mainly due to fact that painful stimulation of acupuncture points with metal needles isn't well tolerated by most of the patients.

根据中国传统疗法，针灸治疗代表另一种受限于个体症状的选择。然而，在目前对个体患者组的观察中，评估针灸的疗效略受限，主要是由于大多数患者不堪忍受金属针的穴位疼痛刺激。

On the other hand, much better results have been achieved by using laserneedle acupuncture treatment. Additional intravenous laser blood irradiation with red and green lasers improved the results significantly. This is especially demonstrated by the indicator "general well-being" that was improved by approximately a factor of 3. An energetic concentration of the cell lines present in blood and the accompanying improvement and acceleration of ADP conversion to ATP seems to have considerable effects both in the muscular system as well as in other different factors.

此外，通过使用光针灸治疗获得了更好的疗效。其他用红光和绿光进行的静脉内光血液照射的患者，疗效显著提高。这一点尤其通过“一般健康病症”指标得到证实，该项指标提高了大约3倍。血液中的细胞系的高能浓度，以及伴随改善二磷酸腺苷加速转化为三磷酸腺苷似乎都具有相当大的疗效。无论在肌肉系统还是在其他不同因素中。

The observations presented in this work do not fulfil the requirements for a controlled application observation or for a treatment study. However, they show a significant positive trend for the therapy of fibromyalgia- a disease that is normally very difficult to treat. Thus, further studies using controlled methods are required for development of optimum treatment protocols and confirmation of these first observations.

本研究中的观察结果不符合受控应用观察或治疗研究的要求。然而却显示出治疗纤维肌痛的积极显著的趋势，而纤维肌痛通常非常难以治疗。因此，需要使用受控方法进一步研究以制定最佳治疗方案并确认这些首次研究成效。

5.8.7 Study: LLT and Myocardial Perfusion of Patients with Chronic Stable Angina

5.8.7研究：慢性稳定型心绞痛患者的低强度光疗和心肌灌注

In 2009, a new study on heart patients was presented at the congress of the Iranian Heart Association in cooperation with the American College of Cardiology (F. Noohi, MD. FACC , M. Javdani, MD*, M. kiavar, MD Shaheed Rajaei Cardiovascular Medical & Research Center. IRAN University of Medical Science, Tehran, IRAN):

2009年，伊朗心脏学会与美国心脏病学会合作，对心脏病患者进行了一项新的研究（美国心脏病学院院士医学博士F. Noohi，医学博士*M. Javdani和M. kiavar，心血管医学研究中心医学博士Shaheed Rajaei。伊朗德黑兰医科大学）：

Background:

背景:

In the vast majority of patients with angina pectoris caused by underlying coronary artery disease, effective treatment is available. Most patients respond to antianginal medication, and for the remainder either percutaneous coronary Revascularization or coronary artery bypass grafting can be performed. (1)

绝大多数由潜在冠状动脉疾病诱发心绞痛的患者，均可以进行有效的治疗。大多数患者对抗心绞痛药物有反应，其余患者进行了经皮冠状动脉血运重建术或冠状动脉旁路移植术。（1）

Low-energy laser radiation through its direct influence on tissue repair processes without heating effect may have vital importance in the therapy of patients with advanced coronary artery disease (CAD).(2)

治疗中，低强度光照射通过其对组织修复过程的直接效应而无需加热作用就可对晚期冠状动脉疾病的患者的具有至关重要的意义。（2）

The purpose of the study was to assess the safety and efficacy of low energy laser therapeutic procedures in patients with advanced multi-vessel CAD not suitable for myocardial revascularization. Many clinical parameters as well as results of laboratory tests were evaluated to find any indices of potential impact of the laser therapy in the examined population.

该研究的目的是评估低功率光疗方案对不适合心肌血运重建的晚期多血管冠状动脉疾病患者的安全性和有效性。评估了许多临床参数以及实验室试验结果，以找出光疗在检查人群中的潜在的疗效指标。

Method:

方法:

22 patients with advanced CAD were assigned (mean age 61, male gender 68.1%, 100% with history of myocardial infarction), to undergo two sessions of irradiation of low energy laser. Each session was 10 time and each time of radiation was 20 min. Pre laser evaluation was included, blood pressure, heart rate, basic biochemical test , ECG, 6 minute walk test, TTE, gated MPI. Before the first and the second period of laser therapy with 3 months break pre and post laser parameters, were measured.

选定22例晚期冠状动脉疾病患者（平均年龄61岁，68.1%男性，100%心肌梗死史），接受两个疗程的低功率光照射。每个疗程为10次，每次照射20分钟。包括预照评估、血压、心率、基础生化测试、心电图、6分钟步行测试、经胸超声心动图、门控心肌灌注显像。在光照射的第一和第二疗程之前，中断3个月前后的光参数，然后进行测量。

Results:

疗效:

No side effects associated with the laser biostimulation or performed clinical tests were noted. Improvement in SBP, Higher functional class, longer distance of 6-min walk test in both group were noted. There was significant change in myocardial perfusion of most anterior segments of heart by single photon emission computed tomography (SPECT) (visually and by computer soft ware) ($P < 0.05$). There was no significant change in DBP, HR, and in LVEF by TTE and gated MPI.

可见与光生物刺激或进行临床试验相关的治疗均无副作用。两组中收缩压和功能等级得到较好改善，长于6分钟步行测试距离。单光子发射计算机断层扫描（视觉和计算机软件）大多数心脏前段的心肌灌注，可见显著变化（ $P < 0.05$ ）。通过经胸超声心动图和门控心肌灌注显像，舒张压、心率、左心室射血分数没有显著变化。

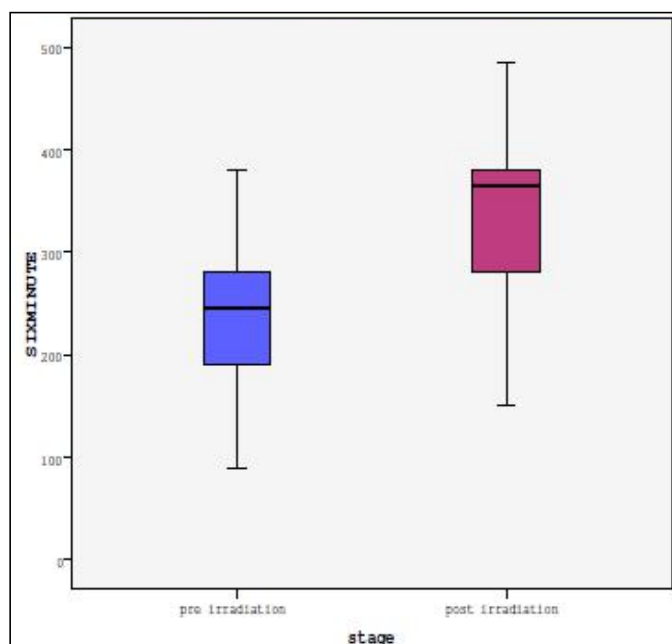


Fig. 30: Six minute walk test pre and post laser

图 30: 光疗前后 6 分钟步行测试

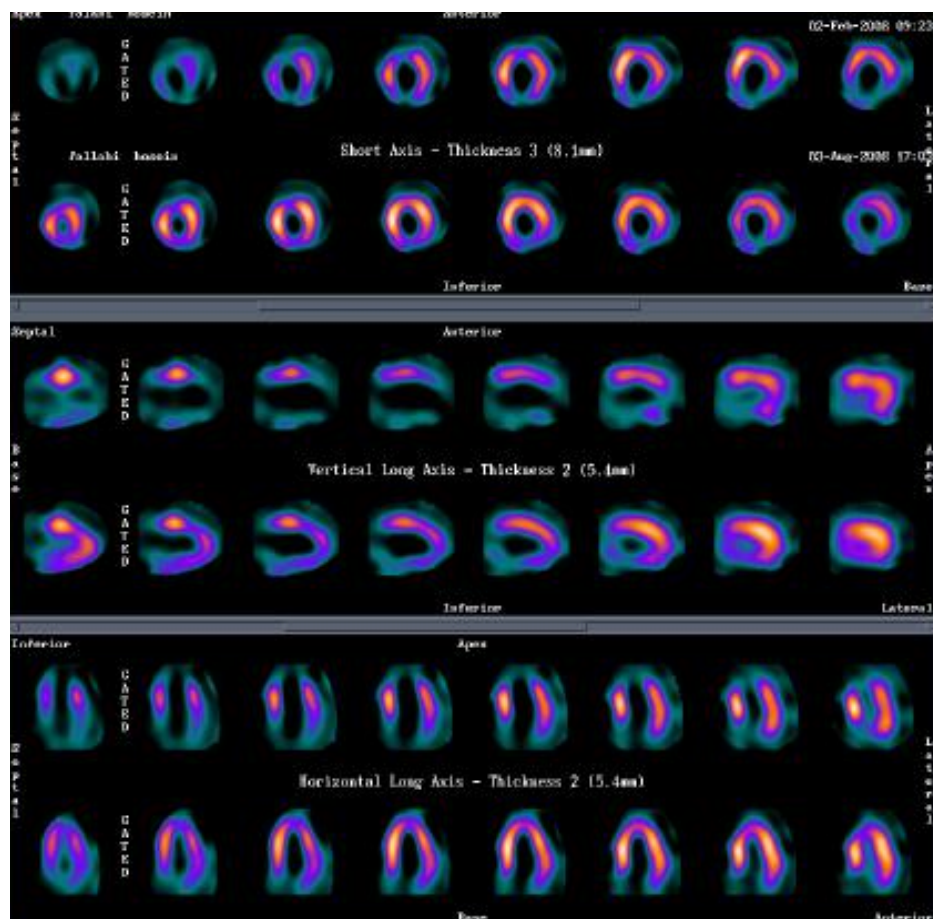


Fig. 31: Myocardial perfusion of most anterior segments of heart by single photon emission computed tomography (SPECT) pre and post laser

图31：光疗前后单光子发射计算机断层扫描大多数心脏前段的心肌灌注

Conclusion:

结论:

An improvement of functional capacity and myocardial perfusion and less frequent angina symptoms during 6-min walk test, without significant change in left ventricular function by TTE and gate MPI, were observed. Low level laser in short term was a very safe method. These encouraging results should be confirmed in a larger, placebo-controlled study.

6 分钟步行测试期间，可见功能和心肌灌注改善以及心绞痛症状缓解。经胸超声心动图和门控心肌灌注显像，可见左心室功能没有显著改变。短期内低强度光疗是一种非常安全的方法。这些令人鼓舞的疗效应该在更大安慰剂量的对照研究中得到证实。

5.8.8 Intravenous laser therapy: An integrative procedure in immunology

5.8.8静脉内光疗：免疫学的综合治疗

In 2014, a new article on intravenous laser therapy in immunology was published by Prof. Dr. Claus Schulte-Uebbing (Munich/ Germany):

2014年，Claus Schulte-Uebbing教授兼博士（德国慕尼黑）发表了一篇关于免疫学静脉内光疗的新文章：

Intravenous laser therapy is used in his clinic for gynaecology since approx. 10 years with exciting success in a holistic concept with main focus on oncology, immunology, endocrinology, environmental medicine, naturopathic medicine, acupuncture and psychosomatic medicine. The therapy is well-accepted by patients and often combined with other therapies such as acupuncture, physiotherapy, chelat therapy, conventional therapy etc. Intravenous laser application is a central component in most of the treatment protocols used in daily practice.

在他的诊所静脉内光疗用于妇科，已约10年的时间，在整体概念上取得令人兴奋的成功，主要集中在肿瘤科、免疫科、内分泌科、环境病科、自然疗法科、针灸科和心身科。该疗法被患者广泛接受，并且经常配合其他疗法如针灸、理疗、螯合疗法、常规疗法等一起使用。静脉内光应用是日常实践中使用的大多数治疗方案的核心组成部分。

Integrative immunologic therapy

综合免疫疗法

According to the patient/ disease/ symptoms, there are different lasers available for specific effects. The intravenous laser can be used to modulate/improve the immune system. Especially the blue laser ("immuno-laser") is very effective in immunologic applications. Additionally, there is red laser ("energy laser"), green laser ("infla-laser") and yellow laser light ("sun laser") available.

根据患者/疾病/症状，有不同的光可用于特异性治疗。静脉内光可用于调节/改善免疫系统。特别是蓝光（“免疫光”）在免疫科应用中非常有效。另外，还有红光（“能量光”）、绿光（“消炎光”）和黄光（“太阳光”）。

Effects of different laser wavelengths:

不同光波长的效应：

The red laser activates ATP-production, leading to increased energy, better blood circulation, improvement of heart and circulation, support of neuronal functions (in CNS), improvement of immune defence (NK-, T-helper-, T-suppressor- cells).

红光激活三磷酸腺苷的生成，诱导能量增加，改善血液循环和心脏及其循环，支持神经元功能（中枢神经系统），提高免疫防御（自然杀伤细胞、辅助性细胞、T-抑制细胞）。

The green laser has a strong anti-inflammatory effect. Thus, green light is used therapeutically for prevention of infection, against inflammatory swellings (oedema) or pain related to inflammations and swellings and against ulcers or infectious tumours.

绿光具有很强的抗炎作用。因此，绿光在治疗上用于预防感染、抵抗炎性肿胀（水肿）或与炎症和肿胀相关的疼痛以及抵抗溃疡或感染性肿瘤。

The yellow laser is known to improve the serotonin and vitamin-D metabolism. Vitamin-D is our “sun vitamin”. Thus, the yellow laser is also called “sun laser”. Serotonin is a hormone responsible for happiness. A lack of serotonin may lead to psychological disorders. Thus, yellow laser is very effective in treatment of depression. Vitamin-D is also important for bones, connective tissue, immune defence and prevention of infection. Furthermore, it plays a central role in our hormone system and general metabolism.

已知黄光可改善5-羟色胺和维生素D的代谢。维生素D是我们的“太阳维生素”。因此，黄光也称为“太阳光”。5-羟色胺是一种负责幸福的激素。缺乏5-羟色胺可诱导心理障碍。因此，黄光治疗抑郁症很奏效。维生素D对骨骼、结缔组织、免疫防御和预防感染也很重要。此外，维生素D在我们的激素系统和一般新陈代谢中起着重要作用。

The blue laser has very positive effects on our immune system. Furthermore, wound-healing is improved significantly. There is also a strong anti-inflammatory and anti-bacterial effect as well as positive influence on hormone harmonisation and pain reduction.

蓝光对我们的免疫系统有非常积极的疗效。还显著改善伤口愈合。强烈的抗炎和抗菌作用以及对激素调节和疼痛缓解具有积极的疗效。

Blue laser light improves cell perfusion and oxygen uptake. The biochemical mechanisms are quite complex. However, there is an improvement of ATP metabolism (leading to more cell energy) and positive influence on haemoglobin-nitric oxide (HbNO) release after blue laser blood irradiation.

蓝光改善细胞灌注和吸氧。生化机制相当复杂。然而，在蓝光血液照射后，改善三磷酸腺苷代谢（产生更多的细胞能量）和对血红蛋白-一氧化氮释放具有积极作用。



Fig. 32: Application of intravenous laser therapy

图 32: 静脉内光疗的应用

Intravenous laser therapy in integrative oncology

综合肿瘤科的静脉内光疗

Intravenous laser therapy can also be applied successfully in integrative oncology. Tumour patients often have a weak immune system. A lack of t-helper and t-suppressor cells or b-lymphocytes is often observed.

静脉内光疗也可成功应用于综合肿瘤科。肿瘤患者通常具有脆弱的免疫系统。经常可见缺乏t辅助细胞和t抑制细胞或b-淋巴细胞。

Thus, intravenous laser therapy can help to re-build immune defence significantly.

因此，静脉内光疗可以高效地帮助重建免疫防御。

Oxidative stress

氧化应激

Intravenous laser therapy can also reduce oxidative stress by improvement of microcirculation and positive influence on the NO-metabolism.

静脉内光疗还可以通过改善微循环和对一氧化氮代谢的积极作用来减少氧化应激。

Intravenous laser and chelat therapy

静脉内光疗和螯合疗法

Intravenous laser therapy can also be combined successfully with chelat therapy in environmental medicine, leading to positive effects on important enzymes and detoxification.

静脉内光疗也可以成功地配合环境病科中的螯合疗法，对重要的酶和解毒作用产生积极的效应。



Fig. 33: Blue laser in intravenous application

图33: 静脉内应用蓝光

Intravenous laser for inflammations

静脉内光治疗炎症

Chronic infections can lead to a disturbed redox balance. Thus, intravenous laser therapy can help to normalize the pH-value.

慢性感染可导致氧化还原平衡受到干扰。因此，静脉内光疗可以使pH值正常化。Additionally, it is observed that intravenous laser therapy can reduce inflammation-related lab values (i.e. CRP, IL2, IL6, TNF alpha, Leptin, PGE2, cytokines, chemokines, ROS, RNS etc.) and activate detoxification enzymes for regulation of increased NAC, GSH, Ubichinon and NAD uptake.

此外，可见静脉内光疗可以减少与炎症相关的实验室值（诸如C型反应性蛋白、白介素2和6、肿瘤坏死因子 α 、瘦素、前列腺素E2、细胞因子、趋化因子、活性氧、活性氮等）并激活解毒酶以调节N-乙酰-L-半胱氨酸、谷胱甘肽、辅酶Q6和烟酰胺腺嘌呤二核苷酸的摄取量。

Another important factor is the strong improvement of the immune system that can be proved by lymphocyte differentiation.

另一个重要因素是免疫系统的强大改善，可以通过淋巴细胞分化证实。

Furthermore, it is well-known that inhibition of NF-kB is an important target in anti-inflammatory therapy. Intravenous laser therapy has shown to be effective in this area as well.

此外，家喻户晓，转录因子的抑制是抗炎治疗中的重要靶标。静脉内光疗也显示出在该领域的有效性。

In anti-inflammatory therapy, intravenous laser is often combined with infusion therapy, curcumin, coenzyme Q10, vitamin D or others.

在抗炎治疗中，静脉内光疗通常配合灌注疗法、姜黄素、辅酶Q10、维生素D等等的其他疗法一起使用。

Intravenous laser therapy for regeneration of mitochondria

静脉光疗的线粒体再生

Chronic inflammations often lead to a disorder of mitochondrial functions and reduction of total mitochondria. Subsequently, there is less ATP, less cell energy and less differentiated cell power with a possible burn-out of healthy cells. As the positive effects of intravenous laser therapy on mitochondria, ATP-production and cell-burnout are well-known it can be an effective method for regeneration of mitochondria.

慢性炎症通常诱导线粒体功能紊乱和线粒体总数减少。随后，三磷酸腺苷减少，细胞能量减少，细胞分化能力降低，导致健康细胞萎缩。由于静脉内光疗对线粒体的积极作用，三磷酸腺苷生成和细胞萎缩缓解是众所周知的。因此这可能是线粒体再生的有效疗法。

Important enzymes like CAT, GSH-PX or SOD are often negatively influenced if chronic inflammations are blocking the mitochondrial metabolism. Intravenous laser therapy is known to improve functions of those enzymes.

如果慢性炎症阻断线粒体代谢，则过氧化氢酶、谷胱甘肽过氧化物酶或超氧化物歧化酶等重要酶通常会受到负面影响。已证实静脉内光疗可改善这些酶的功能。

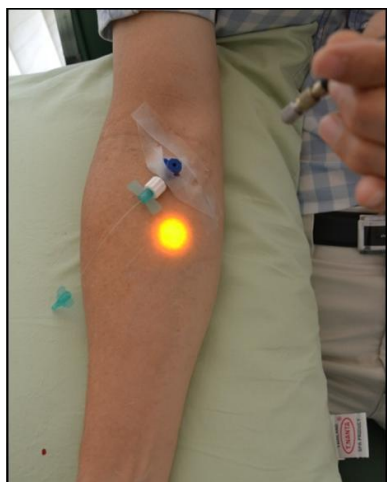


Fig. 34: The new yellow laser („Sun Laser“)

图 34: 新型黄光 (“太阳光”)

Conclusion

结论

Intravenous laser therapy is used by the author in his clinic for gynaecology since approx. 10 years with exciting success in a holistic concept with main focus on oncology, immunology, endocrinology, environmental medicine, naturopathic medicine, acupuncture and psychosomatic medicine.

作者在其临床上使用静脉内光疗进行妇科检查已达约10年之久，在整体概念上取得令人兴奋的成功，主要集中在肿瘤科、免疫科、内分泌科、环境病科、理疗科、针灸科和心身科。

Effects of the different lasers can be proved by measurements like lymphocyte differentiation.

通过淋巴细胞分化等测量可以证明不同光的疗效。

Quantity of important cells such as NK-, T-helper- or T-suppressor- cells increase right after the first treatments and support the immune defence of the patient against cancer or inflammation cells.

重要细胞如转录因子、t辅助细胞和t抑制细胞的数量在第一个疗程后增加，并支持患者对癌症或炎症细胞的免疫防御。

Intravenous laser is also very successful for environmental diseases, detoxification, hormonal problems, infections and immunologic disorders.

静脉内光对环境疾病、解毒、激素问题、感染和免疫疾病也有非常成功的疗效。

In gynaecology, laser therapy proved of value in the treatment of sterility, infertility, hormonal disorders, endometriosis, myoma or various cancers (i.e. Mamma-CA, Ovarial-CA, Corpus-CA, Cervix-CA).

妇科中，光疗证明在治疗不育、不孕症、激素紊乱、子宫内膜异位症、肌瘤或各种癌症（诸如乳腺癌、卵巢癌、宫颈腺癌、宫颈癌）中具有价值。

Most of the patients are excited about the immediate positive effects of the therapy. Thus, intravenous laser therapy is an essential part of every integrative therapy concept today.

大多数患者对该疗法立竿见影的积极效果感到兴奋。因此，静脉内光疗是当今各种综合治疗观念的重要组成部分。

5.8.9 Intravenous laser blood irradiation in sports medicine

5.8.9运动医学科中静脉内光血液照射

The Italian researchers Raggi and Vallesi performed a first study in athletes for investigating the effect of intravenous laser therapy on strength and endurance. The data was published in the German journal “Schmerz & Aupunktur” in 2008 [40].

意大利研究人员Raggi和Vallesi对运动员进行了首次研究，探索静脉内光疗对力量和耐力的作用。该数据于2008年在德国期刊《疼痛和穴位针灸》上发表[40]。

Introduction

介绍

The idea to test the application of intravenous laser blood irradiation in sports medicine started in July 2007 when a young patient reported surprising effects after receiving intravenous laser blood treatment.

测试静脉内光血液照射在运动医学科中应用的想法始于2007年7月，当时一名年轻患者在接受静脉内光血液治疗后报告了惊人的效果。

He was aged 34 and came for a problem of tinnitus. This problem developed 1 year before and he had undergone many diagnostic examinations (MRI, Doppler, CAT), but without any findings. In the previous year, he received a three months treatment with steroids without any success. He wasn't taking any drugs and did no other kind of therapy at the moment he came for intravenous laser therapy.

这位患者34岁，因耳鸣问题来就诊。耳鸣是1年前开始发作的，他尝试了许多诊断检查（核磁共振成像、多普勒、过氧化氢酶），但未见任何疗效。在过去的一年里，他接受了三个月的类固醇治疗，未见成功。在他进行静脉内光疗时，他没有服用任何药物，也没有采取任何其他治疗方法。

The following treatment protocol was used:

使用的治疗方案如下：

- Intravenous Laser application
- 静脉内光应用
- Laser shower (locally) treatment of the ear
- 光淋浴器（局部）治疗耳部

After 10 sessions of laser treatment, tinnitus was lowered (about 50 %) but did not disappear. Nevertheless, the patient experienced some interesting and unexpected “side effects”: He said he was feeling less tired in the evening, his sleeping was improved and he reported a better concentration during the day. But most importantly he was an athlete (body building) and noticed that his

maximum lifting power was increased, running time was doubled and the number of swimming lanes in the training session was increased. His trainer was surprised by his improvements, too and confirmed the observations.

经过10个疗程的光疗后，耳鸣症状得到缓解（约50%），仍未消除。然而，患者体验到了许多意想不到的奏效“副作用”：他说晚上感觉不那么疲倦，睡眠得到改善，并且在白天注意力较为集中了。最重要的是，他是一名健身运动员，可见他的最大提升力增加了，跑步速度提高了一倍，训练期间的泳道数量增加了。教练对他的进步感到惊讶，同时证实了疗效。

Many scientific papers have been written so far, showing biological actions and therapeutic effects of intravenous laser blood irradiation. This new medical technology is currently used for treatment of different pathologies like rheumatic, cardiovascular, pulmonary or neurological diseases. But no scientific work has been performed so far on laser blood irradiation in sports medicine.

到目前为止，已发表了许多科学论文，彰显了静脉内光血液照射的生物学作用和治疗效果。目前这种新型医疗技术用于治疗风湿、心血管、肺或神经疾病等的不同病症。但截止日前，尚未对运动医学科中的光血液照射进行过科学研究。

Thus, it was decided to perform a first small-scale study in order to confirm the effects that had been observed in the patient mentioned above.

因此，决定进行第一次小规模研究以确认在上述患者中观察到的疗效。

Materials and methods

材料和方法

Study population

研究群体

4 male body building athletes were enrolled in the study. Mean age was 23.2 years.

4名男性健身运动员参与了这项研究。平均年龄为23.2岁。

Treatment protocol:

治疗方案:

All athletes underwent 10 sessions of intravenous laser blood irradiation with the following treatment schedule:

所有运动员均接受10次静脉内光血液照射，治疗时间表如下：

- red laser 635 nm, 2 mW, 20 min (first session)
- 红光635纳米，2 兆瓦，20分钟（1次治疗）
- red laser 635 nm, 2 mW, 20 min. + green laser 532 nm, 2 mW 10 min (9 sessions)
- 红光635纳米，2兆瓦，20分钟+绿光532纳米，2兆瓦，10分钟（9次治疗）

3 sessions per week were performed.

每周进行3次治疗。

All athletes were told to avoid any drugs or vitamins during the period of study.

要求所有运动员在研究期间都避免使用任何药物或维生素。

Outcomes

疗效

The following outcomes were measured:

疗效测量如下：

a) Maximum strength tests:

a) 最大强度试验：

1. Pectoral muscle maximum lifting power. Weight is lifted in the supine position, while athlete lies on the bench (fig. 35/1). Maximum weight had to be confirmed by 8 repeated liftings of submaximal weight (80 % of maximum).

1. 胸肌最大提升力。仰卧位时举重，运动员坐在板凳上（图35/1）。最大重量必须通过8次重复举起次级最大重量（最大值的80%）来确定。

2. Weight lifting from the floor. Weight is on the floor and athlete has to lift it from standing position (fig. 35/2). Maximum weight had to be confirmed by 8 repeated liftings of submaximal weight (80 % of maximum).

2. 从地板起测定举重。地板上的重物，运动员必须从站位举起（图35/2）。最大重量必须通过8次重复举起次级最大重量（最大值的80%）来确定。

3. Squat. Weight is put on athlete's shoulders and athlete has to move up and down. Maximum weight had to be confirmed by 8 repeated liftings of submaximal weight (80 % of maximum).

3. 蹲位。重物放在运动员的肩膀上，运动员必须上下移动。最大重量必须通过8次重复举起次级最大重量（最大值的80%）来确定。

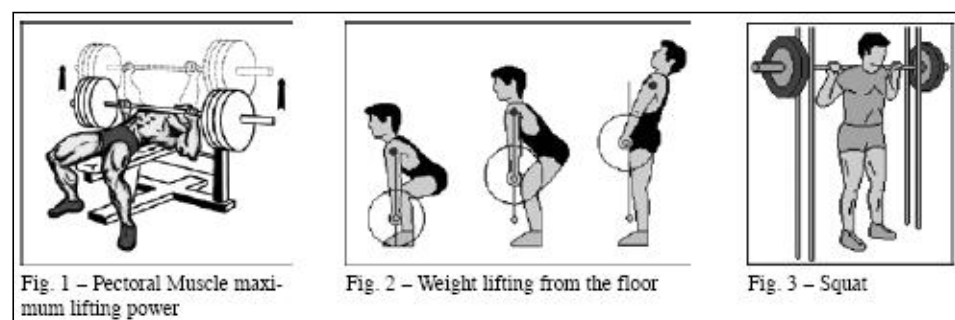


Fig. 35: Strength indicators in this study

图35：本研究中的强度指标

b) Endurance tests:

b) 耐力测试：

1. Nr. of swimming lanes: Maximum number of swimming pool lanes that athlete could perform until he felt tired. This test is not time dependent.

- 泳道数量：运动员在感到疲倦之前完成游泳池泳道的最大数量。该测试不依赖于时间。
- Cord jumping: Maximum time that athlete could perform in cord jumping until he felt tired.
- 跳绳：运动员在跳绳中可以跳最长时间，直到感到疲倦为止。

Measurements:

测量：

All athletes were evaluated in 8 different times of the period of study:

所有运动员在研究期间的8个不同时间点进行评估：

- Before the treatment.
- After the treatment.
- Every 4 weeks after the end of the treatment.

Results

成果

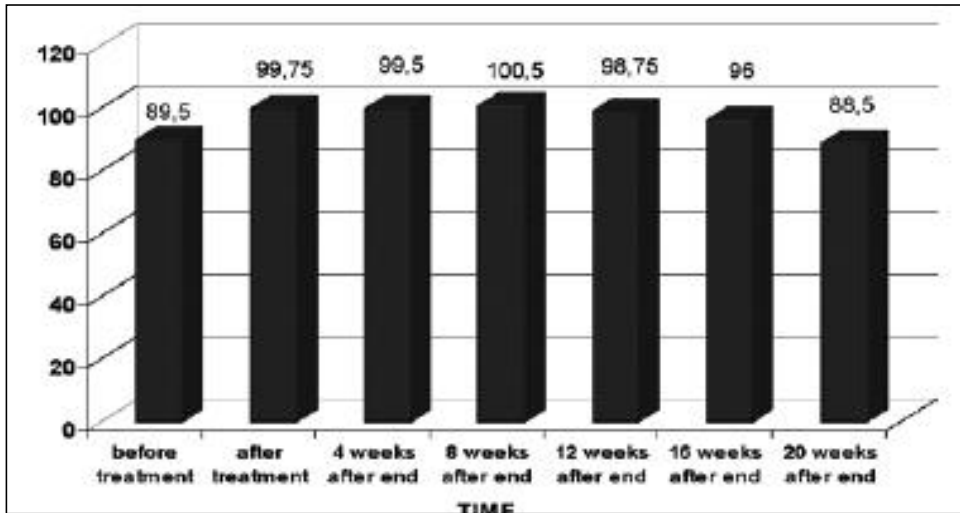


Fig. 36: Mean pectoral muscle maximum lifting power at any time of

measurement

图36：任何测量时间点的平均胸肌最大提升力

Mean value increases immediately after the treatment. This effect seems to last for approx. 16 weeks. Afterwards, it seems to disappear and previous condition is restored. This trend is shown in fig. 37, where mean pectoral muscle maximum lifting power percentage variation is reported.

治疗后平均值立即增加。这种效果似乎持续约 16 周。之后，似乎消失了，之前的病症恢复。这种趋势如图 37 所示，报告平均胸肌最大提升力百分比的变化。

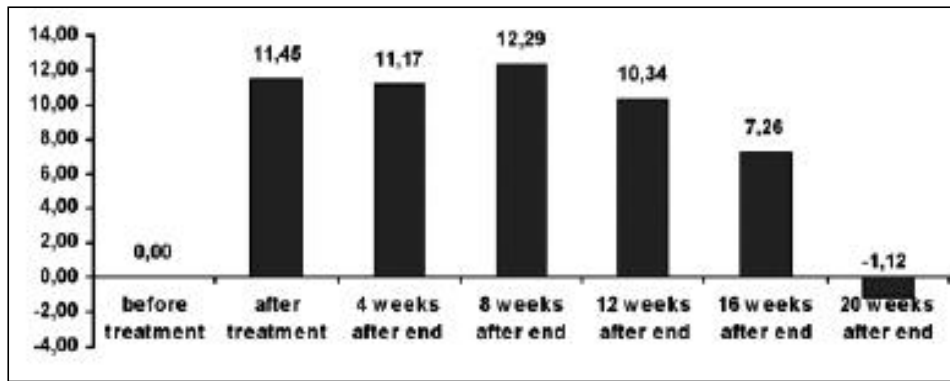


Fig. 37: Mean pectoral muscle maximum lifting power percentage variation at any time of measurement

any time of

measurement

图 37: 任何测量时间点平均胸肌最大提升力百分比变化

Very similar results were obtained in all the other tests that were performed (fig. 38-41). The effects on endurance (swimming and cord jumping) are even more significant.

在所有其他测试中获得了非常相似的疗效（图 38-41）。对耐力（游泳和跳绳）

的效应更为显著。

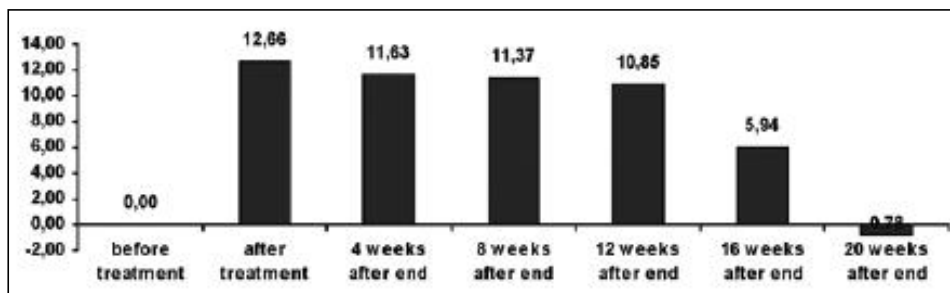


Fig. 38: Weight lifting from the floor: mean percentage variation at any time of measurement

mean percentage variation at any time of measurement

图 38: 从地板上举重: 任何测量时间点平均百分比变化

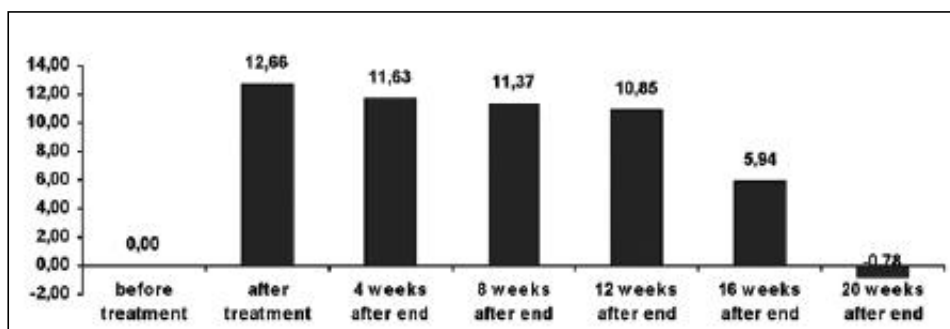


Fig. 39: Squat: mean percentage variation at any time of measurement

图 39: 蹲位: 任何测量时间点平均百分比变化

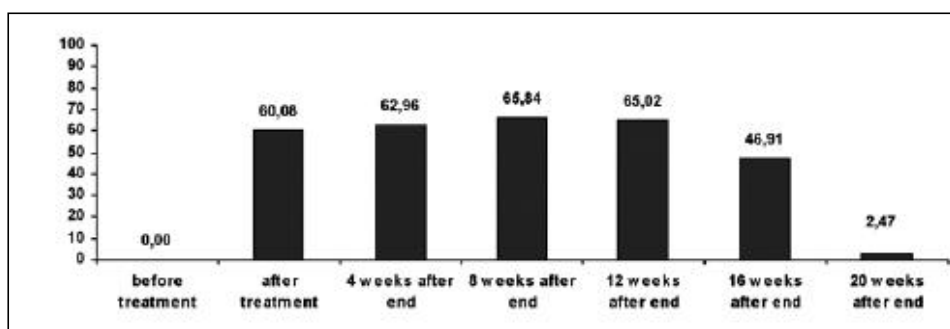


Fig. 40: Number of swimming pool lanes:

mean percentage variation at any time of
measurement

图 40: 游泳池道数: 任何测量时间点平均百分比变化

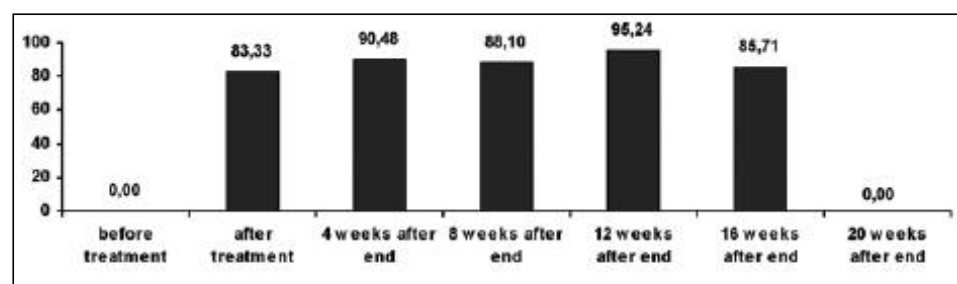


Fig. 41: Cord Jumping time: mean percentage variation at any time of measurement

图41: 跳绳时间: 任何测量时间点平均百分比变化

Discussion

讨论

In this first small-scale study, intravenous laser treatment seemed to be effective in sports medicine; even though it is to be highlighted that the number of cases was very small. Furthermore, there is big lack of data from the literature on this topic and further studies are needed in this field.

在第一项小规模的研究中, 静脉内光疗似乎对运动医学科有效; 尽管需要强调的是病例数量非常少。此外, 关于该主题的文献中缺乏大量数据, 该领域需要进一步研究。

For all athletes in this study, the muscular empowerment appeared to last for 16 weeks after the end of treatment. Despite this data have to be confirmed in bigger studies, it can be hypothesized that this effect is related to the erythrocytes' mean living time of 12-15 weeks. One can imagine that all circulating red blood cells are "activated" after a complete cycle of treatment. Since they have different "ages", they will survive for different times; but, in any case, the youngest among them will disappear from circulating blood after approx.15 weeks and, after that, the therapeutic effect will be lost.

对本研究中所有运动员, 在治疗结束后肌肉增加力量的疗效似乎持续了16周。尽管这些数据必须在更大的研究中得到证实, 但可以假设这种疗效与红细胞12-15周的平均生存时间有关。可以认为, 在完整的疗程后, 所有循环的红细胞都被“激活”。由于红细胞有不同的“年龄”, 存活不同的时间; 但是, 在任何情况下, 其中最年轻的红细胞将在大约15周后从循环血液中消失, 治疗效果随之消失。

In order to verify the plausibility of these findings, a deep review of the medical literature on Low Level Laser Therapy (LLLT) is necessary. The review was conducted by looking for "low level laser blood irradiation" in the Pub Med Library. Only articles related to the topic of sports medicine were considered.

为了验证这些研究成果的合理性, 需要对低强度光疗的医学文献进行深入研究。通过在公共医疗图书馆中寻找“低强度光血液照射”进行审查。只考虑与运动医学科课题相关的文章。

First of all, a polish study can be mentioned, showing higher exercise capacity, longer exercise time and longer distance of 6 minute walk test in 39 coronary artery disease patients treated with LLLT on the chest area.

首先，提到第一项波兰研究，在接受对胸部进行低强度光疗的39名冠心病患者中，显示其运动能力提高，运动时间延长，6分钟步行距离延长。

In a second study, isolated rat tibial anterior muscle was fatigued with electric stimulation until initial strength was lowered to 50 %. Then, the rats were divided into one LLLT treated group and one control group. In the laser irradiated group, a significantly longer time was needed to reach 50 % reduction of strength. Additionally, significantly higher peak force and significantly lower creatine kinase blood levels (muscle damage index) were observed in the LLLT group.

在第二项研究中，分离大鼠，电刺激其胫骨前肌诱导疲劳，直到初始强度降低至50%为止。然后，将大鼠分成一个低强度光疗组和一个对照组。在光照射组中，需要显著延长时间才能使强度降低50%。此外，在低强度光疗组中，可见峰值力显著增高和肌酸激酶血液水平（肌肉损伤指数）显著降低。

Thus, it can be concluded that the outcomes observed in the presented study could be considered plausible if compared to other studies showing biological properties of LLLT.

因此，可以得出结论，与其他低强度光疗的生物学特性的研究相比，本研究中观察到的疗效可被认为是合理的。

However, the mechanisms of action behind these effects still remain unclear. Many studies show various biological effects of laser irradiation related to the presented topic.

然而，这些疗效背后的作用机制仍不清楚。许多研究显示光照射的各种生物学效应与所提及的主题相关。

A very important effect is the improvement of blood circulation. A Japanese research group performed LLLT on common carotid artery area: Blood flow volume in central retinal artery and ophthalmic artery increased.

一个非常重要的疗效是改善血液循环。日本研究小组对颈总动脉部位进行了低强度光疗：视网膜中央动脉和眼动脉的血流量增加。

A similar experiment was carried out by Makihara et al: LLLT on right temporomandibular joint area resulted in expansion of blood vessels and increase in blood flow volume in superficial temporal artery. Surprisingly, this effect was observed bilaterally.

Makihara等人进行了类似的实验：右颞下颌关节部位进行低强度光疗，诱导颞浅动脉的血管扩张和血流量增加。令人惊讶的是，这种疗效双侧可见。

Wasik et al. observed PO₂ and SaO₂ increasing after whole blood sample irradiation with 632 nm laser.

Wasik等人用632nm光照射全血样后，可见血气和血氧饱和度升高。

Other important referred effects are increased erythrocytes' deformability and microcirculation enhancement.

其他提到的重要疗效是增强红细胞的可变形性和改善微循环。

Mittermayr et al. showed that blue laser releases Nitric Oxide (NO) from Haemoglobin (Hb). HbNO is a form of met-Hb, with low O₂ linking power. This, free NO released from Hb is a powerful molecule producing vasodilatation and perfusion enhancement. At the same time, Hb O₂ linking power is increased.

Mittermayr等人证实，蓝光从血红蛋白中释放出一氧化氮。血红蛋白-一氧化氮是高铁血红蛋白血症低氧结合能力的一种形式。这种从血红蛋白释放的游离一氧化氮是一种强大分子，诱导血管扩张和灌注增强。同时，血红蛋白和氧的结合能力增加。

Besides, irradiation of monocytes leads to increase of NO levels from a preformed store without activation of NO synthesis and release of endothelial NO.

此外，单核细胞照射诱导储存的预先形成的一氧化氮水平的增加，既不激活一氧化氮合成也不释放内皮一氧化氮。

In a study performed by Simonian et al., isolated erythrocyte membrane was irradiated and Cit b 558 III activities were measured; Cit b 558 III is a membrane enzyme that restores met-Hb (H⁺-Hb, CO₂-Hb, DPG-Hb) to normal Hb, with higher O₂ linking power. Cit b 558 III activity was enhanced after laser irradiation.

Simonian等人进行的一项研究中，照射了分离的红细胞膜并测量了Cit b 558 III活性; Cit b 558 III是一种膜酶，可将高铁血红蛋白血症（H⁺-血红蛋白、CO₂-血红蛋白、二磷酸甘油酸-血红蛋白）恢复至正常血红蛋白，具有较高的氧结合能力。光照射后，Cit b 558 III活性增强。

In conclusion, the data from the literature review seem to confirm the plausibility of the presented results, even though obtained from a very small study population. We hope that the preliminary data on intravenous laser therapy in sports medicine will contribute to focus the attention of other researchers on this interesting topic in order to achieve deeper scientific knowledge.

总之，文献综述中的数据似乎证实了所呈现疗效的合理性，尽管从非常少的研究人群中获得。我们希望运动病医学科中静脉内光疗的初步数据将有助于将其他研究人员的注意力集中在这个很有疗效的课题上，以获得更深入的科学知识。

Subsequent studies:

后续研究:

In 2009, Raggi/ Vallesi collected new data from 3 cyclists to measure the effects of intravenous laser therapy on performance and physical regeneration after exhaustion.

2009年，Raggi / Vallesi收集了3名骑自行车运动员的新数据，以测量静脉内光疗对疲劳后绩效和生理性再生的效果。

Methodology

方法

- Exercise intervals: 5 days/ week 10-50 km cycling. One race per month (30-50 km)
- 锻炼间隔：5天/周骑行10-50公里。每月一场比赛（30-50公里）
- 10 treatments with intravenous laser therapy (3 times/ week)
- 10次静脉内光疗（3次/周）
- Combination of red (15-25 min) and green laser (5-15 min)
- 红光（15-25分钟）和绿光（5-15分钟）的组合
- No other substances except for potassium ascorbate and magnesium
- 除抗坏血酸钾和镁外，没有其他物质

Results

疗效

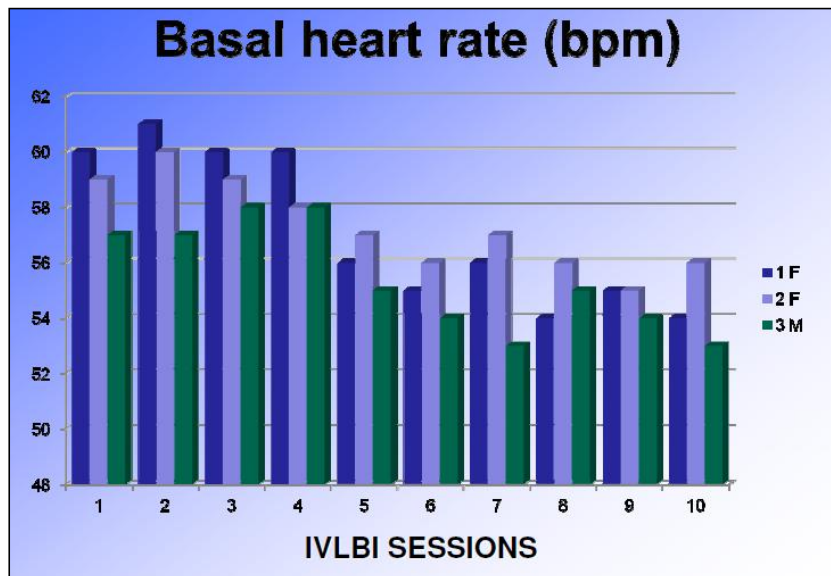


Fig. 42: Reduction of basal heart rate after 10 treatments in 3 athletes (f= female, m=male)

图42：3名运动员10次治疗后基础心率降低（f=女性，m=男性）

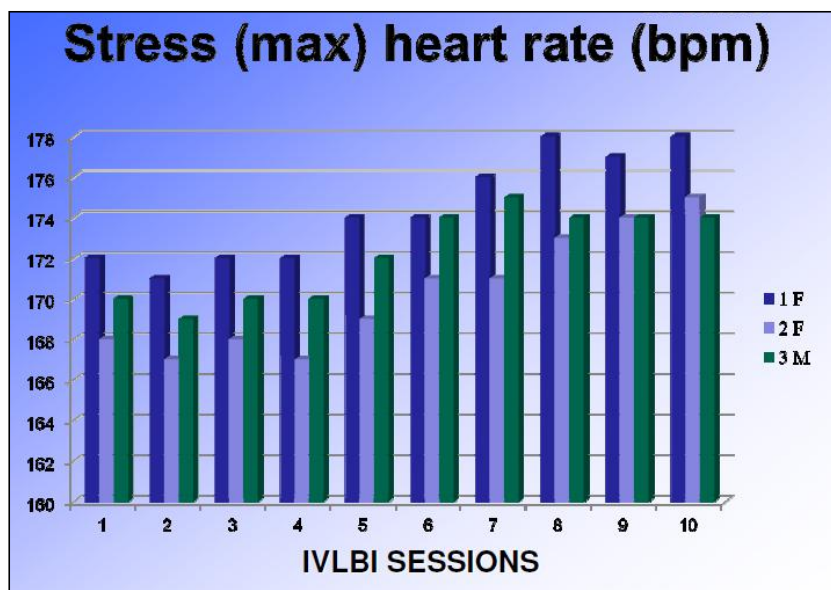


Fig. 43: Increase of stress heart rate (max) after 10 treatments in 3 athletes
(f= female, m=male)

图43: 3名运动员10次治疗后应激心率（最大值）增加（f=女性，m=男性）

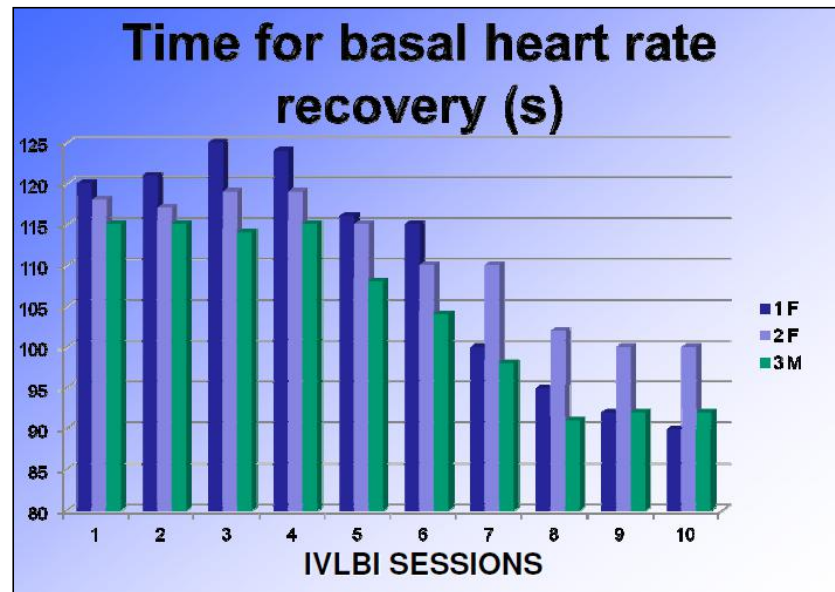


Fig. 44: Reduction of basal heart rate recovery time after 10 treatments in 3 athletes (f= female, m=male)

图44: 3名运动员10次治疗后基础心率恢复时间缩短（f=女性，男性=男性）

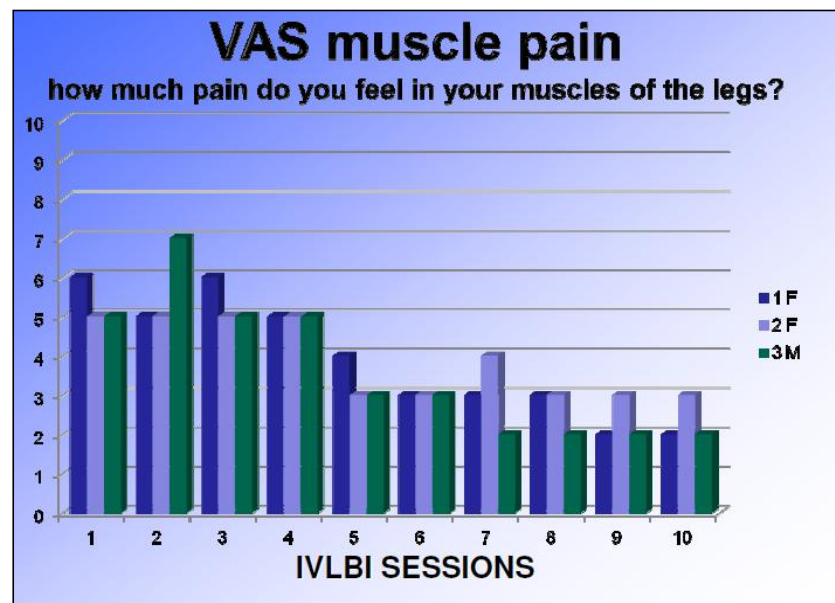


Fig. 45: Reduction of muscle pain after 10 treatments in 3 athletes (f= female, m=male)

图45: 3名运动员10次治疗后肌肉疼痛缓解（f=女性，男性=男性）

Conclusion:

结论:

A significantly accelerated regeneration after high physical exertion could be proved.

可以证明在超强体力消耗后显著加速再生。

Is intravenous laser therapy doping?

静脉内光疗是兴奋剂吗?

Statement of the GERMAN ANTI-DOPING AGENCY (NADA):

德国反兴奋剂机构声明:

“Thank you very much for your request of laser blood irradiation. We proofed this new field of therapy since a while. After detailed analysis it's our estimation that the laser therapy is conform to the doping regulations of the WADA (The World Anti-Doping Code. The 2010 Prohibited List. International Standard. 1.1.2010).

“非常感谢您对光血液照射的请求。我们一段时间以来论证了这一新型治疗领域。经过详细分析，我们评估光疗遵守了世界反兴奋剂机构的兴奋剂规定（《世界反兴奋剂规范》。2010年禁用清单。国际标准1.1.2010）。

It's, in this case, neither an Infusion, nor an add-on of blood or constituents of blood.”
因此，静脉内光疗既不是输液，也不是血液或血液成分的附加物”。

5.8.10 Intravenous laser blood irradiation in oncology

5.8.10肿瘤科的静脉内光血液照射

The German oncologist Frank Andrae tried to show the effects of the intravenous low level laser therapy on oncological patients and published a first article in 2007 in the German Journal of Oncology [1].

德国肿瘤学家Frank Andrae试图证明静脉内低功率光疗对肿瘤患者的疗效，并于2007年在德国《肿瘤学》杂志上发表了第一篇文章[1]。

He compared the effect of the Talberg bioimmune therapy with the intravenous laser and showed that a combination of both methods was most effective in the treatment of oncological patients with different tumours.

他比较了塔尔伯格生物免疫疗法与静脉内光疗的效果，并表明这两种疗法组合在治疗不同肿瘤的患者中最为有效。

Intravascular laser blood irradiation and the bioimmunotherapy according to Tallberg appear to have additive and synergistic effects in the redifferentiation of tumour cells. The bioimmunotherapy exerts effects on tumour cell mitochondria. By means of mitochondria-nuclear communication malignantly transformed cells can regain their normal gene expression. Intravascular laser blood irradiation changes mitochondria morphologically and activates metabolic energy processes. In an application study these two methods were compared with each other both individually and in combination in maximally chemotherapeutically pre-treated tumour patients. Clinically and morphologically synergistic and additive effects were observed.

根据Tallberg所述，血管内光血液照射和生物免疫疗法似乎在肿瘤细胞的再分化中具有累加和协同作用。生物免疫疗法对肿瘤细胞线粒体发挥作用。通过线粒体-细胞核通信，恶性癌变细胞可以恢复其正常的基因表达。血管内光血液照射在形态上改变线粒体并激活代谢能量过程。在应用研究中，将这两种疗法的单独和组合使用相比较，配合之前最大程度的进行了化学治疗的肿瘤患者。可见临床和形态学上的协同和累加效应。

In the 1950s many articles were published on therapeutic experiments with mitochondria, including tumour mitochondria. The results of these papers point in the same direction: To restore normal mitochondrial function or an application of healthy mitochondria means a regeneration impulse for degenerated cells and could assume a key position in the treatment of chronic and progressive diseases. The bioimmunotherapy according to Tallberg, in which amino acids and trace elements in individual concentrations and in accordance with a tumour specific code are administered, functions in accordance with this principle. Tallberg proved experimentally that tumour cell mitochondria modify their morphological structure on application of special amino acid/trace element mixtures and clustered around the cell nucleus of transformed cells, partially penetrated into it, and apparently via the paths of mitochondria-nuclear communication effected a normalisation of gene expression and thus a cell redifferentiation to normal body cells or induced apoptosis. The redifferentiation process progresses in three phases: Proliferation reduction, proliferation inhibition and complete degeneration of the tumour tissue. However, since this process takes months to years, the therapeutic concept of tumour redifferentiation therapy should be further optimised by integrating additional procedures such as intravascular laser blood irradiation.

20 世纪 50 年代，发表了许多关于线粒体治疗实验的文章，包括肿瘤线粒体。这些论文的结果指向相同的方向：恢复正常的线粒体功能或健康线粒体的应用，意味着退化细胞的再生刺激，并且可以在慢性和进行性疾病的治疗中占据关键位置。Tallberg 根据生物免疫疗法、不同浓度的氨基酸和微量元素以及肿瘤特异性代码应用，按照其原则进行。Tallberg 通过实验证明，在应用特种氨基酸/微量元素混合物时，肿瘤细胞线粒体会改变其形态结构，并聚集在癌变细胞的细胞核周围，部分渗入其中，并且显然通过线粒体-细胞核通信的路径实现了基因表达的正常化，从而细胞再分化为正常的人体细胞或诱导细胞凋亡。再分化过程分三个阶段：增殖减少、增殖抑制和肿瘤组织完全退化。然而，由于该过程需要数月至数年，因此通过整合其他治疗方案诸如血管内光血液照射，肿瘤再分化疗法的治疗概念应进一步优化。

Laser blood irradiation activates metabolic processes

光血液照射激活代谢过程

Intravascular laser blood irradiation has been applied and systematically studied for decades in the former Soviet Union and indeed for chronic diseases such as Diabetes mellitus, liver diseases, cardiac and renal insufficiency. In the relevant literature it has been e.g. reported that as a result

of laser blood irradiation mitochondria are morphologically altered and metabolic energy processes are activated. This method allows the mitochondria of human lymphocytes to morphologically form so-called "giant mitochondria" (these are reactive phenomena, and in no case pathological giant chromosomes, such as those described in diverse degenerative diseases) and simultaneously the ATP and RNA synthesis rates increase significantly. In the process, cells with a low (acidic) pH and hypoxia are said to react better than normal cells. Based on this data, we presumed that the laser blood irradiation and the bioimmunotherapy according to Tallberg exerted similar or equivalent target functions on tumour cells and that synergistic or additive effects could be achieved.

血管内光血液照射已在前苏联应用并系统研究了数十年，的确，用于治疗糖尿病、肝病、心脏和肾功能不全等慢性疾病。在相关文献中，例如据报道，由于光血液照射，线粒体的形态发生了改变，能量代谢过程被激活。该疗法允许人淋巴细胞的线粒体在形态上形成所谓的“巨线粒体”（这些是反应性现象，绝非病理性的巨型染色体，犹如在多种退行性疾病中描述的那些），同时三磷酸腺苷和核糖核酸合成率显著增加。在该过程中，据说具有低（酸性）pH和缺氧的细胞比正常细胞反应更好。基于该数据，我们推测，根据Tallberg的光血液照射和生物免疫疗法，在肿瘤细胞上应用相似或等同的靶标功能，可以实现协同或累加疗效。

Materials and methods of AWB

AWB的材料和方法

Seventeen patients with advanced metastatic carcinomas of different tumour entities were treated. All patients had been pre-treated; the conventional treatment was considered to have been completed at that time. Clinically, the patients were in acceptable condition; they were mobile and stable with regard to their haematological situation (Hb, Hkt, thrombocytes, leukocytes, etc.).

对17名不同肿瘤实体的晚期转移癌的患者进行了治疗。所有患者之前均接受过其他治疗；当时认为传统治疗已经完成。临床上，患者处于可接受的症状；其血液病症（血红蛋白、Hkt、血小板、白细胞等）具有流动性和稳定性。

The patients were divided into three groups:

患者分为三组：

n Group I: Five patients received an intravascular laser blood irradiation.

n组I：5名患者接受血管内光血液照射。

n Group II: Five patients were treated with bioimmunotherapy. Clinically proven formulation mixtures plus phospholipids from animal brain tissue (so-called neurofood) plus vaccine from the patient's own tumour tissue (for detailed information, see Tallberg).

n组II：5名患者接受生物免疫治疗。临床验证混合配方药（动物脑组织的磷脂（所谓的神经食物）和患者自身肿瘤组织疫苗）的疗效（详细信息见Tallberg）。

n Group III: Seven patients were concurrently treated with intravascular laser blood irradiation and bioimmunotherapy.

n组III：7名患者同时接受血管内光血液照射和生物免疫治疗。

Intravascular laser blood irradiation

血管内光血液照射

The “Weberneedle blood” unit with red light laser, 5 mW, 632 nm, continuous irradiation

(Weber medical GmbH, D-37696 Lauenförde) was used.

使用配备红光（5兆瓦、632纳米）的“韦伯针血液”单元，连续照射（德国韦伯医疗有限公司的Lauenförde研发的D-37696）。

Laser blood irradiation was performed 10 times for 30 minutes duration.

10次光血液照射，每次持续30分钟。

Treatment frequency: Twice every week.

治疗频率：每周两次。

Application location: Left cubital vein.

应用部位：左肘静脉。

Laboratory parameters

实验室参数

Initially and at the end of each five-week observation period examinations were performed to detect the presence of circulating atypical cells, determine their quantification and morphological comparison examinations of the tumour cell mitochondria (subsequent to fluorescent labelling) under a laser scan microscope (= high-resolution morphology). Weekly determination of the relevant tumour markers and examination of a native blood smear with laser scan microscopy to depict immunocomplex aggregates adhering to the erythrocyte membrane (Fluoview, Olympus, x30,000).

最初和每个五周观察期结束时，在光扫描显微镜（=高分辨率形态）下，进行检查以检测非典型细胞循环的存在，确定肿瘤细胞线粒体的定量和形态学比较检查（荧光标记后）。每周用光扫描显微镜测定相关的肿瘤指标，检查天然血涂片以描绘粘附于红细胞膜的免疫复合物聚集体（奥林巴斯Fluoview光扫描显微镜，x30,000）。

Isolation, identification and semi-quantification of circulating atypical cells

非典型细胞循环的分离、测定和半定量

In each case 50 ml of fresh heparin blood. PBS centrifugation to separate mononuclear cells. Multiple washing, pelleting and resuspension as well as transfer to a cell culture medium (MEM plus glutamine solution plus foetal bovine serum). Duration of culture 2 to 3 weeks at 37° C, under CO₂. Immunocytological examination and, if necessary, DNA cytophotometry. Quantification in a Neubauer counting chamber (fig. 46).

每个病例中，50毫升新鲜肝素血液。磷酸缓冲盐溶液离心以分离单核细胞。多次洗涤、造粒和再悬浮，以及转移至细胞培养基（必需培养液、谷氨酰胺溶液和胎牛血清）。在37℃，CO₂下培养2至3周的时间。免疫细胞检查，必要时进行脱氧核糖核酸细胞分析。在Neubauer计数室中进行定量（图46）。

Laser scan microscopy

光扫描显微镜

Typically, plasma proteins are adsorbed onto the erythrocyte membrane. They are not visible in conventional light microscope, but can be discerned in the high-resolution laser scan microscope (fig. 47). Malignant cells produce abnormal proteins, which in turn stimulate B cells to antibody formation. As a consequence immunocomplex aggregates which have a high affinity for the erythrocyte membrane. As a result of the absorption of such immunocomplex aggregates on the erythrocyte membrane and simultaneous desorption of the physiological membrane-bound plasma proteins, characteristic images are formed which gradually demonstrate the deviations from the immunologically normal findings. The deviations from normal findings are assigned a diagnostic score of 0 to 30, where a score of 30 indicates a maximum on atypia.

通常，血浆蛋白质被吸附到红细胞膜上。在传统的光学显微镜下不可见，但在高分辨率光扫描显微镜下可见（图47）。恶性细胞产生异常蛋白质，进而刺激B细胞形成抗体。因此，免疫复合物聚集体对红细胞膜具有高亲和力。由于这种免疫复合物聚集体在红细胞膜上的吸收和生理膜结合的血浆蛋白同时解吸，形成了特征性图像，其逐渐显示出与免疫学正常检查结果的偏差。这种偏差被指定为0至30的诊断评分，其中评分30表示肿瘤异型性的最大值。

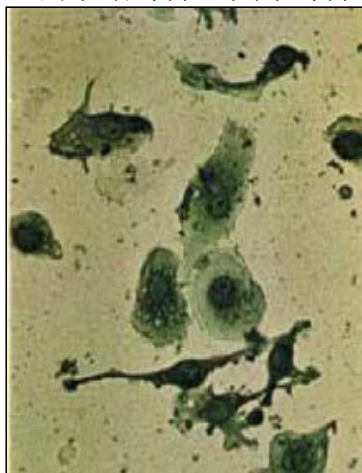


Fig. 46: Typical tumor cell culture

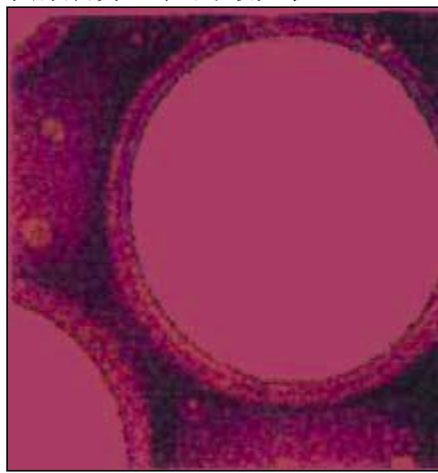


Fig. 47: Normal finding: Erythrocyte

with adsorbed

plasma proteins

图 46：典型肿瘤细胞培养

图 47：正常检查结果：具有吸附血浆蛋白的红细胞

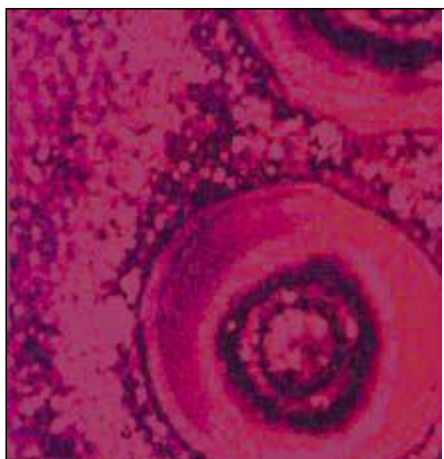


Fig. 48: Pathological finding: Immunocomplex aggregates, desorption of the plasma protein zone and apposition of metalloproteins in the pallor region.

图 48：病理性检查结果：免疫复合物聚集体，血浆蛋白区解吸和苍白区域中金属蛋白并置。

Application study confirms the effect of the laser therapy *应用研究证实了光疗的效果*

The important examination results are presented in the following tables. The comparative morphological examination of the tumour cell mitochondria yielded conformity of changes in the mitochondrial morphology in all three groups. Tumour-specific modifications of the mitochondria occurred, which possibly allow new diagnostic approaches. A comprehensive report on this will be published separately in the near future.

重要的检查结果如下表所示。肿瘤细胞线粒体的比较形态学检查共得到了三组线粒体形态的一致性的变化。发生了线粒体的肿瘤特异性修改，这为新型诊断法提供了可能。就此的综合报告将在不久的未来单独出版。

CONCLUSION

结论

Based on diverse information in the literature, we expected that intravascular laser therapy could be effective in the scope of a redifferentiation therapy. This assumption appears to have been confirmed by the results of our application study. Merely as a result of the sole application of intravascular laser therapy, the quantity of circulating tumour cells was reduced and the patient's pathological immune response modulated in the direction of the standard. The bioimmunotherapy according to Tallberg was even more effective in the comparison. Both procedures applied simultaneously obviously exhibit synergistic and possibly also additive effects. We presume that the intravascular laser therapy, like the bioimmunotherapy according to Tallberg, influences the mitochondria-nuclear communication by means of a direct effect on the mitochondria, and that malignantly transformed cells redifferentiate to normal somatic cells or transition into apoptosis (additive effect) In addition the known positive immunomodulatory effects of this therapy are likely to be of additional importance (synergism). Our patients were all chemotherapeutically maximally pre-treated and have additionally responded well to the intravascular laser treatment. The use of intravascular laser blood irradiation can therefore also be appropriate during conventional oncological treatments. On the basis of the existing data, it can be assumed that the efficacy of chemotherapy (induction of tumour cellular apoptosis) can

be increased as a result of intravascular laser therapy. Further investigations are planned in this regard.

根据文献中的各种信息，我们预计血管内光疗应该于再分化治疗的范围内有效。我们的应用研究结果似乎证实了这一假设。仅作为血管内光疗唯一的应用结果，循环的肿瘤细胞的数量减少，患者的病理性免疫应答向标准方向调节。根据 Tallberg 的研究，生物免疫疗法在比较中更胜一筹。同时应用的两种疗法，协同和累加作用突出。我们假设血管内光疗，像 Tallberg 的生物免疫疗法一样，通过对线粒体的直接作用影响线粒体-细胞核通信，恶性癌变细胞再分化为正常的体细胞或转变为细胞凋亡（累加作用）。此外，该疗法已知的积极的免疫调节作用可能具有更重要的意义（协同作用）。我们的患者之前都最大程度的进行了化学治疗，对血管内光疗也有很好的反应。因此，在常规肿瘤治疗期间，血管内光血液照射的使用也是适当的。在现有数据的基础上，可以假设血管内光疗可以增加化学疗法（诱导肿瘤细胞凋亡）的功效。在这方面计划进一步研究。

Type of tumour	TZ	LSM1	LSM2	LSM3	LSM4	LSM5	TU marker
Squamous cell cancer /ENT	-25%	26	17	14	6	4	SC : negative CEA : -9%
Adeno cancer colorectal	-10%	30	26	18	11	8	CA 19-9: -8%
Mucinous ovarian cancer	-11%	30	24	22	15	11	CA 72-4: -12%
Adenopapillar urothelial cancer	-9%	28	22	14	14	11	TPA : -6%
Hepatocellular cancer	-12%	24	24	21	19	14	AFP : -13%

Fig. 49:
Group 1
(Laser
Therapy)
图 49：第 1
组（光疗）

Type of tumour	TZ	LSM1	LSM2	LSM3	LSM4	LSM5	TU marker
Hepatocellular cancer	-70%	22	20	12	11	2	AFP : -22%
Ductal breast cancer	-28%	28	22	14	2	4	CA 15-3: -64%
Prostatic cancer	-35%	30	30	12	11	4	PSA : -24%
Prostatic cancer	-64%	17	12	11	5	0	PSA : -48%
Lung cancer	-53%	30	25	17	14	2	CYFRA 21-1: -34%

Fig. 50: Group 2 (Bioimmunotherapy)
图 50：第 2 组（生物免疫疗法）

Type of tumour	TZ	LSM1	LSM2	LSM3	LSM4	LSM5	TU marker
Ductal breast cancer	-100%	28	14	4	4	2	CA 15-3: -87%
Renal cell cancer	-89%	26	11	6	2	2	No marker
Non-small cell lung cancer	-78%	30	17	7	6	6	NSE : -74%
Prostatic cancer	-100%	22	8	2	2	1	PSA : -83%
Pancreatic cancer	-84%	30	28	7	7	5	CA 19-9: -56%
Endometrial cancer	-100%	18	4	2	2	0	CA 125: -49%
Cervical-uterine cancer	-100%	25	2	2	1	0	CEA : -71%

Table 1: Results of the application study. TZ: Change in the quantity of circulating tumour cells after 5 weeks
LSM 1-LSM 5: Score of the weekly laser scan microscopic findings. TU marker: Total change in the respective tumour marker after 5 weeks.

Fig. 51: Group 3 (combination therapy)
图 51：第 3 组（组合治疗）

5.8.11 Intravenous laser therapy of horses

5.8.11 马的静脉内光疗

A. Wirz-Ridolfi, M. Baumgartner, D. Burger and K. Gerber published a first study on intravenous laser therapy on horses in 2008 (58).

A. Wirz-Ridolfi, M. Baumgartner, D. Burger 和 K. Gerber 于 2008 年发表了对马进行的静脉内光疗的第一项研究 (58)。

Intravenous blood laser therapy was performed on horses in Germany, France and Switzerland and its effect on the clinical course of diseases as well as on laboratory values was assessed. As no such studies have been published so far it will be worthwhile to deepen this pilot study by further investigations with statistically significant numbers.

对德国、法国和瑞士的马进行静脉内血液光疗，评估其对疾病临床进程和实验室值的效应。由于迄今尚未公布此类研究，因此需要进一步调查来深化这项初步研究，具有统计学意义。

Between July 2007 and 2008, 14 horses were treated with intravenous laser therapy. 69 treatments were performed: 59 times with red (632nm), device weberneedle blood from weber medical GmbH in Germany and 10 times with blue laser (405 nm).

2007 年 7 月至 2008 年间，14 匹马接受了静脉内光疗。69 次治疗中：59 次红光（632nm），10 次蓝光（405nm），设备来自德国韦伯医疗有限公司的韦伯针血液。

Case reports:

病例报告：

Horse 1: One horse was suffering from a malignant melanoma with metastases. After 17 intravenous laser therapies no further tumour proliferation could be observed. The horse recovered from its energetic weakness and got the golden medal in distance riding 2007 and the championship of Switzerland 2007 over 138 kilometres. In laboratory, haemoglobin increased from 126 g/l to 158 g/l (25,4%). The number of erythrocytes increased from 7,69 t/l to 9,7 t/l (16,4%).

马1：一匹马患有转移性恶性黑色素瘤。在 17 次静脉内光疗后，未见肿瘤进一步增殖。这匹马从疲惫不堪中恢复过来，在 2007 年远距离骑马比赛中获得金牌和同年还在瑞士 138 公里冠军赛中获得了金牌。实验室中，血红蛋白从 126 g/l 增加到 158 g/l（25.4%）。红细胞数量从 7.69 t/l 增加到 9.7 t/l（16.4%）。

Horse 2: A second horse with bronchial asthma lost these symptoms after eight treatments with the weber needle blood device.

马2：第二匹患有支气管哮喘，在使用韦伯针血液设备进行 8 次治疗后摆脱了这些症状。

Horse 3: Tertia is a 7 year old Paso Fino mare. This horse should have been euthanized due to chronic lameness by chronic inflammation of hoof and fetlocks. Special orthopedic horseshoeing did not help, the horse could no

longer be ridden and had pain when standing up and just lay still. After 8 times intravenous red laser, the horse could be ridden again and lied down only for sleeping.

马3: Tertia是一只7岁的巴索芬诺母马。由于蹄和距毛的慢性炎症导致慢性跛蹄，这匹马应该被安乐死。专门马蹄铁整形外科没有帮助，马站立时不能再骑行且疼痛，只能卧位静止不动。经过8次静脉内红光照射后，该马可以再次骑行，只有睡觉时卧位。

Horse 4: Lidador, a 13 year old Lusitano stallion, suffered from chronic skin affection of unknown aetiology with a dull coat, dan-druff and hair loss. All local applications had no effects and the horse was irradiated intravenously 6 times with the red. This the-rapy led to a “restitutio ad integrum”, shiny coat, and - as a “side effect”: 2 first places in the German championship course riders.

马4: Lidador, 一只13岁的卢西塔诺种马，患有慢性皮肤病，病因不明，马毛无光泽、头皮屑和脱发严重。所有局部治疗均无效果，用红光静脉照射马6次。马“完成康复”，闪亮的马毛。此外还有一种“副作用”：二次德国冠军赛中荣获二次第一名。



Fig. 52: Lidador receiving intravenous laser therapy (Horse 4)

图52: Lidador接受静脉光疗 (马4)

Further 10 horses were treated at the Federal Stud in Avenches by Mireille Baumgartner et al. under the direction of Dr. Dominik Burger.

在Dominik Burger医生的指导下，Mireille Baumgartner等人在阿旺什联邦种马基地治疗了另外10匹马。

There was an increase in leucocytes of 8.33% and in neutrophils of 8,48%. Lymphocytes increased by 14.6% respectively, which is in accordance with the various Russian studies on lymphocyte stimulation. In contrast, the eosinophils were reduced impressively by 52.21% and monocytes by 26%, possibly as an expression of the laser-related immunostimulation. The anti-allergic effect of the blood chemistry showed the following striking changes: a 22,9%-reduction of LDH from 552 to 426.2 U / litre (standard values from 140 to 440 U / l). CK-values declined in a similar manner by 22,4% from 349 to 270 U/l (standard values from 0-260 U / l). It can be concluded that intravenous laser irradiation is leading to a detoxification of the body by activating the antioxidative enzyme system and improving kidney function.

白细胞增加8.33%，中性粒细胞增加8.48%，淋巴细胞增加14.6%。这与俄罗斯对淋巴细胞刺激的各种研究一致。相比之下，嗜酸性粒细胞显著减少了52.21%，单核细胞减少了26%，可能是相关光免疫刺激的反应。血液化学的抗过敏作用表现出以下显著的变化：22.9%的乳酸盐脱氢酶从552减少到426.2 U / l（标准值140-440U/l）。肌酸激酶值以类似方式下降22.4%，从349降至270 U / l（标准值从0-260 U / l）。可以得出结论，静脉内光照射通过激活抗氧化酶系统和改善肾功能诱导马周身解毒。

The intravenous laser enables successful treatment of hard to treat diseases by improving physiological parameters. Especially oxygen capacity of the blood may be one of the most effective performance-enhancing effects.

静脉内光通过改善生理参数成功治疗难以治疗的疾病。特别是血液的氧容量可能是最有效的绩效增强疗效之一。

5.8.12 Side effects and risks of intravenous laser blood irradiation

5.8.12 静脉内光血液照射的副作用和风险

From a hypothetical point of view, side effects seem to be unlikely due to the administered low power of 1-5 mW. This is confirmed by all clinical data as there was no report on any serious side effects of intravenous laser blood irradiation until today.

从假设的角度来看，因1-5 兆瓦低功率治疗，副作用似乎不太可能。所有临床数据都证实了这一点，因为直到今天仍未见关于静脉内光血液照射的任何严重副作用的报告。

External laser therapy is a method established over decades and virtually free of risk whereas also in external application light is penetrating the body (with considerably higher power) and getting in contact with blood. The above mentioned ultraviolet irradiation of the blood has been established for many decades whereas the potential danger of the administered short wavelength in theory must be rated considerably higher. In addition, there is a huge amount of data from about 30 years of use in thousands of clinics in Russia and other Eastern European countries where no serious side effects have been described until today, too.

体外光治疗是一种成功使用数十年，几乎没有风险的方法，然而在体外治疗中，光穿透人体（需要相当高的功率）并与血液接触。上述血液的紫外光照射已经成功使用了数十年，而理论上使用短波长治疗的潜在危险性必定高得多。此外，俄罗斯和其他东欧国家的数千家诊所使用了大约30年提供了大量的数据，直到今天还未见严重的副作用。

Nevertheless, a conforming education of the patient should take place when using this treatment in a country where it is not well-established yet. The relevant legal aspects for the responsible doctor have been worked out extensively by the lawyer Bodenburg. It is recommended to explain this new therapy to the patient in detail and let him sign a document for informed consent. The juristic aspects are explained and discussed in the publication of Bodenburg [3].

尽管如此，在国家使用这种疗法尚未完善之前，应该对患者进行一致的介绍。Bodenburg 律师已经广泛制定了医生的相关法律责任。建议向患者详细说明这种新疗法，让其签署一份知情同意文件。在《博登堡》[3]的出版物中解释和讨论了法律方面的内容。

5.8.13 Discussion

5.8.13 讨论

The various positive effects of intravenous laser blood irradiation that are described in the literature could be affirmed to a large extent by the author

and the other pilot studies mentioned above. However, mechanisms of action remain kind of unclear, especially how the administered photon-energy is able to reach the particular organ cells.

文献中描述的静脉内光血液照射的各种积极疗效,在很大程度上由作者和上述其他初步研究得到证实。然而,作用机制仍然有几分不清晰,尤其是所使用的光子能量如何能够到达特定的器官细胞。

Whether there is a transfer of information by bio-photons or a transport of energy through other ways of metabolism with increased ATP production in the end needs an intensive scientific research in the next years.

最终随着三磷酸腺苷生成的增加,无论通过生物光子传递信息还是通过其他代谢方式传递能量,都需要在未来几年进行深入的科学研究。

In former explanation models the transfer of electrons is responsible for the separate steps of energy transport in cells. There are various electron carriers in the mitochondria like cytochrome-systems, flavins, Fe-S-complexes and others.

在以前的解释模型中,电子转移负责细胞中能量转移的不同步骤。线粒体中存在各种电子载体,如细胞色素系统、黄素、铁-硫-络合物等。

Typical absorption maxima of the various carrier-systems for electromagnetic radiation are well-known. At the absorption maximum, the system can pick up the maximum electromagnetic energy whereby the process of oxidative phosphorylation is increased. In further research, the calculated use of specific wavelengths with absorption maxima of the different biochemical structures should be of fundamental importance. By this way, stimulation or inhibition of enzymes of the metabolic pathways can be investigated.

对电磁辐射的各种载体系统的典型最大吸收值是非常清晰的。在最大吸收值时,系统获得最高电磁能量,从而增加氧化磷酸化过程。在进一步的研究中,计算使用具有不同生化结构的吸收最大值的特定波长应该是至关重要的。通过这种方式,可以研究代谢途径的酶刺激或抑制。

The new type of intravenous laser blood treatment presents a very promising systemic therapy for various diseases, leading especially to an improvement of the immune system and positive effects on liver and fat metabolism disorders, diabetes mellitus and its resulting complications or coronary heart disease and circulatory problems.

新型静脉内光血液治疗为各种疾病提供了非常有前途的周身治疗,特别是改善了免疫系统,对肝脏和脂肪代谢紊乱、糖尿病及其引起的并发症或冠心病和循环问题产生了积极的疗效。

The biological mechanisms are extremely complex and require further clinical research and extensive basic studies. This research could help to better understand the effects of light photons within the organism.

生物学机制极其复杂,需要进一步的临床研究和广泛的基础研究。这项研究有助于更好地了解光子在生物体内的效应。

5.8.14 Conclusion

5.8.14结论

The described connections and results of the intravascular laser irradiation method promise the therapy to be an important new treatment procedure for various diseases in the future. A lot of new data is expected to be published within the next years. New ways for the treatment of widespread diseases open up: Especially diabetes mellitus, chronic hepatitis, cirrhotic liver and toxic liver diseases, cardiovascular diseases and autoimmune diseases including allergies must be emphasized.

所描述的血管内光照射疗法的连接和疗效使得其成为未来各种疾病重要的新治疗方法。预计很多新数据将在未来几年内发布。广泛治疗疾病的新方法展示：特别是对糖尿病、慢性肝炎、肝硬化和中毒性肝病、心血管疾病和过敏等自身免疫性疾病的疗效必须加以强调。

But the treatment options don't seem to be limited with that. The described immunological activation also opens up new therapeutical approaches in adjuvant tumour therapy. Extensive studies will be essential to explore the potential of intravenous laser treatment and to find an answer to the fundamental questions of mechanisms of action.

但治疗方案似乎不受限。所描述的免疫活化还在辅助肿瘤治疗中开辟了新的治疗方法。广泛的研究对于探索静脉内光疗的潜力以及寻找作用机制等基础问题的答案至关重要。

The possibility of treatments with laser light of different wavelengths (red, green, infrared, blue and yellow) and the setting of various laser frequencies facilitate even more distinguished strategies of treatment and a new and very exciting field of research.

使用不同波长（红光、绿光、红外光、蓝光和黄光）的光进行治疗的可能性。各种光频率的设置有助于制定更加卓越的治疗方案和探索新的令人兴奋无比的研究领域。

Literature

文献

- Andrä Frank. The Effects of intravascular Low Level Laser Therapy in the Scope of a Redifferentiation Therapy of Malignant Tumours. German Medical Journal of Oncology; No 6/2007

- Andrä Frank, 血管内低强度光疗在恶性肿瘤再分化治疗中的疗效。德国《肿瘤学》医学期刊; 2007年6期
- Bakeeva L, Manteiffel V, Rodichev E, Karu T. Formation of gigantic mitochondria in human blood lymphocytes under the effect of an He-Ne laser. Mol-Biol-Mosk. 1993 May-Jun; 27 (3):608-17
- Bakeeva L, Manteiffel V, Rodichev E, Karu T, 氦氖光作用下在人血淋巴细胞中形成巨线粒体。《莫斯科分子生物学》杂志1993年5月至6月; 27卷(3期): 608-17页
- Bodenbunrg R. Laserneedle-acupuncture and intravascular laser blood-irradiation from a legal point of view. Pain & Acupuncture, 2007; 33,1:42-48
- Bodenbunrg R, 从法律角度看光针-针灸和血管内光血液照射。《疼痛与针灸》2007年; 33卷,1期: 42-48页
- Boev S, Selivonenko V. The impact of the intravenous He-Ne-Laser therapy on the antioxidant system in patients with stable insertion angina and postinfarkt cardiosclerosis. Klin-Med-Mosk, 1997; 75,12:30-3
- Boev S, Selivonenko V, 静脉内氦氖光疗对稳定性插入心绞痛和心肌梗塞硬化患者抗氧化系统的疗效。《莫斯科临床医学》1997年; 75卷,12期: 30-3页
- Brill G, Grigoriev S, Romanova T. Changes of leucocyte metabolism in He-Ne laser blood irradiation in vitro. Proceedings of SPIE. 1993; 1981:204-209
- Brill G, Grigoriev S, Romanova T, 体外氦氖光血液照射中白细胞代谢的变化。《国际光学工程学会论文集》1993年; 1981年: 204-209页
- Dimitriev A, Iudin V, Aparov N, Matyrnov V. Effect of intravascular laser irradiation of the blood on blood cells in pancreatitis. Klin Med (Mosk.). 1989; 67, 5:108-110
- Dimitriev A, Iudin V, Aparov N, Matyrnov V, 血管内光照射血液对胰腺炎血细胞的疗效。《莫斯科临床医学》1989年; 67卷,5期: 108-110页
- Driianskaia V. The clinico-immunological effects of immunotherapy in patients with acute pyelonephritis. Lik-Sprava. 1997; Jul- Aug; (4):89-92
- Driianskaia V, 急性肾盂肾炎患者免疫疗法的临床免疫疗效。《临床症状》1997年; 7月至8月; (4卷): 89-92页
- Dube A, Hausal H, Gupta PK. Modulation of macrophage structure and function by low level He-Ne irradiation. Photochem. Photobiol. Sci. 2003; 2, 8:851-855
- Dube A, Hausal H, Gupta PK, 低强度氦氖光照射对巨噬细胞结构和功能的调节。《光化学和光生物学》杂志2003年; 2卷,8期: 851-855页
- Frick G, Dehmlow R. Practice Guideline UVBund HOT. Fundamentals and use of stimulus-reaction-therapy. Stuttgart: Hippokrates 2001
- Frick G, Dehmlow R, 实践指南: 紫外光波照射基础和刺激-反应-治疗的使用。斯图加特《希波克拉底》2001年

- Funk J, Kruse A, Kirchner H. Cytokine production after helium-neon laser irradiation in cultures of human peripheral blood mononuclear cells. *Journal Photochem. Photobiol. Biology*, 1992; 16, 3-4: 347-355
- Funk J, Kruse A, Kirchner H, 在人外周血单核细胞培养中氦氛光照射后生成细胞因子。《光化学和光生物学》杂志1992页; 16卷,3-4期: 347-355页
- Gasparyan L. Laser Irradiation of the blood. *Laser Partner - Clinixperience - All Volumes - 2003*:1-4
- Gasparyan L, 光照射血液。光合伙公司 - 《临床试验》全卷 - 2003年: 1-4页
- Grubnik V, Dotsenko S, Chuev P, Basenke I, Salemekh A. Laser in the prevention of early postoperative complications in the surgical treatment of obesity. *Klein-Khir*. 1994; 8:25-27
- Grubnik V, Dotsenko S, Chuev P, Basenke I, Salemekh A, 光预防肥胖手术治疗中早期术后并发症。《克莱因基尔》1994年; 8卷: 25-27页
- Gulsoy M, Ozer G, Bozkulak O, Tabakoglu H, Aktas E, Deniz G, Ertan C. LLLT increases lymphocyte proliferation. *Journal Photochem. Photobiol. Biology*, 2006; 82, 3:199-202
- Gulsoy M, Ozer G, Bozkulak O, Tabakoglu H, Aktas E, Deniz G, Ertan C, 低强度光疗改善淋巴细胞增殖。《光化学和光生物学》杂志2006年; 82卷,3期: 199-202页
- Gür A, Karacoc M, Nas K, Cevik R, Sarac A, Ataoglu S. Effects of low power laser and low dose amitryptiline therapy on clinical symptoms and qualità of life in fibromyalgia: a single-blind, placebo-controlled trial. *Rheumatology International* 2002; 22, 5:188-193
- Gür A, Karacoc M, Nas K, Cevik R, Sarac A, Ataoglu S, 低功率光和低剂量阿米替林治疗对纤维肌痛临床症状和生活质量的疗效: 单盲、安慰剂对照试验。《国际风湿病》2002年; 22卷,5期: 188-193页
- Hamblin R, Viveiros J, Changming Y, Ahmadi A, Ganz R, Tolkoff J., helicobacter pylori accumulates photoactive porphyrins and is killed by visible light. *Antimicrobial Agents and Chemotherapy*, 2005; 49, 7:2822-2827
- Hamblin R, Viveiros J, Changming Y, Ahmadi A, Ganz R, Tolkoff J, 幽门螺杆菌积累光活性卟啉并被可见光杀死。《抗菌药物和化疗》2005年; 49卷,7期: 2822-2827页
- Heine H. *Lehrbuch der biologischen Medizin*. Stuttgart: Hippokrates, 3. Auflage 2007
- Heine H, 《生物化学医学》教科书。斯图加特《希波克拉底》3卷。2007年版
- Heine H, Schaeg G: Origin and function of „roodlike structures“ in mitochondria. *Acta anat*. 1979; 103:1-10
- Heine H, Schaeg G: 线粒体中“类似结构”的起源和功能。阿克塔大学《解剖学》1979年; 103卷: 1-10页
- Karp G. *Molekulare Zellbiologie*. Heidelberg: Springer, 4. Auflage 2005

- Karp G, 分子细胞生物学。海德堡《施普林格》4卷。2005年版
- Karu T. The Science of Low-Power Laser Therapy. Amsterdam: Gordon and Breach Science Publishers, 1998
- Karu T, 低功率光疗科学。阿姆斯特丹《戈登与突破科学》出版社, 1998年
- Kassak P, Sikurova L, Kvasnicka P, Bryszewska M. The response of Na/K-ATPase of human erythrocytes to green laser light treatment. *Physiol Research*, 2006; 55,2:189-194
- Kassak P, Sikurova L, Kvasnicka P, Bryszewska M, 人红细胞的钠-钾-三磷酸腺苷酶绿光疗法的反应。《生理学研究》2006年; 55卷,2期: 189-194页
- Khotiaintsev K, Doger-Guerrero E, Glebova I, Svirid V, Sirenko J. Laser blood irradiation effect on electrophysiological characteristics of acute coronary syndrome patients. *Proc. SPIE*. 2929: 1996:132-137
- Khotiaintsev K, Doger-Guerrero E, Glebova I, Svirid V, Sirenko J, 光血液照射对急性冠状动脉综合症患者电生理特征的疗效。《国际光学工程学会论文集》 2929卷: 1996年: 132-137页
- Kipshidze N, Chapidze G, Bokhua M, Marsagishvili L. Effectiveness of blood irradiation using a Helium-Neon-Laser in the acute period of myocardial infarction. *Sov-Med*. 1990; 3:9-12
- Kipshidze N, Chapidze G, Bokhua M, Marsagishvili L, 在心肌梗塞急性期使用氦-氖光血液照射的疗效。《苏联医学》1990年; 3卷: 9-12页
- Kolarova H, Ditrichova D, Smolan S. Effect of He-Ne laser irradiation on phagocytotic activity of leukocytes in vitro. *Acta-Univ-Palcki-Olmuc-Fac-Med*. 1991; 129:127-132
- Kolarova H, Ditrichova D, Smolan S, 氦-氖光照射对体外白细胞吞噬活性的影响。阿克塔大学《光生物化学肿瘤突变基因因子医学》1991年; 129卷: 127-132页
- Kovalyova T. Ambulatorische Applikation von kombinierter Lasertherapie an Patienten mit Diabetes mellitus und Dyslipidämie. Übersetzung Prof. Dr. Peter Marti, Institut für LLLT & Naturheilkunde, Internet: www.marti-inst.ch/IntLF_Diabetes_mellitus.asp
- Kovalyova T, 针灸配合光疗糖尿病和异型增生血脂患者。厄理工学院 Übersetzung教授, Peter Marti博士, 《低强度光疗和针灸》, 互联网: www.marti-inst.ch/IntLF_Diabetes_mellitus.asp
- Kovalyova T, Pimenov L, Denisov S. Die Dynamik der Hyperlipidaemie und des peripheren Blutflusses bei Patienten mit Diabetes mellitus nach Behandlung mit kombinierter Laser-Therapie bei ambulant-poliklinischen Bedingungen. Der 2. internationale Kongress „Laser und Gesundheit-99“, Moskau, 1999: 313. (deutsche Übersetzung von Marti: www.marti-institut.ch)
- 非英语
- Kozhura V, Dvoretiskii S, Novoderzhkina I, Berezina T, Kirsanova A, Iakimento D, Kozinets GI. The effect of intravascular helium neon laser

blood irradiation on the state of the compensatory processes in the acute period of hemorrhagic shock and after resuscitation. *Anesteziol Reanimatol.* 1993; 4:43-8

- Kozhura V, Dvoretiskii S, Novoderzhkina I, Berezina T, Kirsanova A, Iakimento D, Kozinets GI, 血管内氦氖光血液照射对失血性休克和复苏后急性期补偿过程的疗效。《心肺复苏》1993年; 4卷: 43-8页
- Ledin A, Dobkin V, Sadov A, Galichev K, Rzeutsky V. Soft-laser use in the preoperative preparation and postoperative treatment of patients with chronic lung abscesses. *Proc. SPIE.* 1999; 3829:2-5
- Ledin A, Dobkin V, Sadov A, Galichev K, Rzeutsky V, 弱光用于慢性肺脓肿患者的术前准备和术后治疗。《国际光学工程学会论文集》1999年; 3829卷: 2-5页
- Leonova G., Maistrovskaja O, Chudnovskii V. Helium-neon laser irradiation as inducer of interferon formation. *Vopr-virolog.* 1984; 39, 3:119-121
- Leonova G., Maistrovskaja O, Chudnovskii V, 氦氖光照射作为干扰素形成的诱导物。《Vopr-virolog》1984年; 39卷,3期: 119-121页
- Lindgard A, Hulten L, Svensson L, Soussi B. Irradiation at 634 nm releases nitric oxide from human monocytes. *Lasers Med Sc* 2007; 22:30-36
- Lindgard A, Hulten L, Svensson L, Soussi B, 以 634 nm 照射人单核细胞释放一氧化氮。《光医学》2007 年; 22 卷: 30-36 页
- Lutoshkin M, Tsypilev M, Lutoshkina M. Application of a Helium-Neon Laser (HNL) for the correction of renal function in patients with chronic glomerulonephritis. *Uro. Nefrol (Mosk.).* 1993; 2:17-20
- Lutoshkin M, Tsypilev M, Lutoshkina M, 氦-氖光修复慢性肾小球肾炎患者的肾功能。《肾泌尿科学》(莫斯科)1993年; 2卷: 17-20页
- Manteifel V, Bakeeva L, Karu T. Ultrastructural changes in chondriome of human lymphocytes after irradiation with He-Ne laser: appearance of giant mitochondria. *Journal Photochem. Photobiol. Biology,* 1997; 38, 25-30:
- Manteifel V, Bakeeva L, Karu T, 用氦-氖光照射后人体淋巴细胞线粒体系统的超微结构变化: 出现巨线粒体。《光化学和光生物学》杂志1997年; 38卷,25-30页
- Manteifel V, Karu T. Structure of Mitochondria and Activity of their Respiratory Chain in successive Generations of Yeast Cells exposed to He-Ne Laser Light. *Biology Bulletin* 2005; 32, 6:556-566
- Manteifel V, Karu T, 氦-氖光照射酵母细胞的连续再生中线粒体的结构及其呼吸链的活性。《生物学通报》2005年; 32卷,6期: 556-566页
- Meshalkin E. (ed.) *Application of Direct Laser Irradiation in Experimental and Clinical Heart Surgery [in Russian],* Novosibirsk: Nauka, 1981

- Meshalkin E (编辑), 直接光照射实验和临床心脏手术的疗效[俄语], 新西伯利亚《学问》1981年
- Mi X, Chen J, Cen Y, Liang Z, Zhou L. A comparative study of 632,8 and 532 nm laser irradiation on some rheological factors in human blood in vitro. J. Photochem. Photobiol. B., 2004; 74,1:7-12
- Mi X, Chen J, Cen Y, Liang Z, Zhou L, 632.8和532 nm光体外照射人体血液中流变因子的比较研究。《光化学和光生物学》杂志2004年; 74卷,1期: 7-12页
- Moshkovska T, Mayberry J. It is time to test low level laser in Great Britain. Postgraduate Medical Journal. 2005; 81:436-441
- Moshkovska T, Mayberry J, 是时候在英国测试低强度光了。《研究生医学》期刊2005年; 81卷: 436-441页
- Mouayed A, Fareed F, Ihsan F, Ahmad Y. Estimation of IgM & IgG values in the serum after intravenous irradiation of blood with diode laser. First UAE International Conference on Biological and Medical Physics, Al-Ain. 2005; Abstract No. 70
- Mouayed A, Fareed F, Ihsan F, Ahmad Y, 用二极管光静脉内照射血液后血清中免疫球蛋白M和免疫球蛋白mG值评估。《第一届阿联酋生物和医学物理国际会议》, 拉斯艾因, 2005年;摘要, 70期
- Neeb G. Das Blutstasesyndrom. Verlag für Ganzheitliche Medizin. Kötzing: 2001
- 非英文
- NeimarkA, Muzalevskaia N. Low-intensity laser radiation in preoperative preparation of patients with benign prostatic hyperplasia. Urologiia. 2000; 1:11-5
- NeimarkA, Muzalevskaia N, 术前准备中, 低强度光照射良性前列腺增生患者。《泌尿科学》2000年; 1卷: 11-5页
- Noohi F, Javdani M, Kiavar M. Study of the Efficacy of Low level laser in Myocardial Perfusion of Patients with Chronic Stable Angina. Abstracts: 16th Congress of Iranian Heart Association, Tehran; Nov 18-21, 2008; 91
- Noohi F, Javdani M, Kiavar M, 低强度光疗慢性稳定型心绞痛患者心肌灌注的疗效研究。摘要, 《德黑兰伊朗心脏学会第16届大会》2008年11月18日至21日; 91页
- Raggi Francesco, Vallesi Giuseppe. Intravenous Laser Blood Irradiation in Sports Mecicine. Schmerz & Akupunktur 3/2008; 34:126-129
- Raggi Francesco, Vallesi Giuseppe, 运动医学科中静脉内光血液照射。《疼痛和针灸》2008年3月; 34卷: 126-129页
- Romberg H. Physikalische Grundlagen der Lasertherapie. Dt. Ztschr. f. Akupunktur 2005; 48,1:33-42
- Romberg H, 光疗生理学基础。兹切尔《针灸》2005年; 48卷,1期: 33-42页
- Schumm N. Intravasale Laser-Blutbestrahlung des Blutes. Schmerz & Akupunktur 2006; 32,4:211-215

- Schumm N, 血管内光血液照射。《疼痛和针灸》2006年; 32卷,4期: 211-215 页
- Schumm N. Komplement. Integr. Med. KIM-11-12/2008
- Schumm N, 综合补充, 《综合补充医学》2008年11月12日
- Siposan G, Lukacs A. Relative variation to received dose of some erythrocytic and leukocytic indices of huma blood as a result of low-level-laser radiation. Journal of Clinical Laser Medicine & Surgery. 2001; 19, 2:89-103
- Siposan G, Lukacs A, 低强度光照射后人体血液的红细胞和白细胞指标的接受剂量的相对变化。《临床光医疗与外科》杂志2001年; 19卷,2期: 89-103 页
- SkvorcovV, Nedogoda V. Niederleistungs-lasertherapie gegen chronische Lebererkrankungen. Raum & Zeit, 2002, 119: 5-12, übersetzt aus dem Russischen von Veronika Müller, Würzburg
- 非英文
- Sluga E, Monneron A. Über die Feinstruktur und Topochemie von Riesenmitochondrien und deren Einlagerungen bei Myopathien. Virchows Archiv. 1970; 350, 3:250-260
- 非英文
- SpasovA, Nedogoda V, Konan K, Kucheriavenko A. Effect of the intravenous laser blood irradiation on efficacy of drug preparations. Eksp Klin Farmakol. 2000; 63, 5:65-7
- SpasovA, Nedogoda V, Konan K, Kucheriavenko A, 静脉内光血液照射对药物制剂功效的影响。《药理临床疗效》2000年; 63卷,5期: 65-7 页
- Stadler I, Evans R, Kolb B, Naim J, Narayan V, Buehner N, Lazafame R. In vitro effects of low level laser irradiation at 660 nm on peripheral blood lymphocytes. Lasers Surg. Med. 2000; 27, 3:255-261
- Stadler I, Evans R, Kolb B, Naim J, Narayan V, Buehner N, Lazafame R, 体外660 nm低强度光照射外周血淋巴细胞的效应。《光外科医学》2000年; 27卷,3期: 255-261 页
- Stroev E, LarionovV, Grigoreva L, Makarova V, Dubinina I. The treatment of diabetic angiopathies by endo-vascular low-intensity laser irradiation. Probl-Endokrinol-Mosk. 1990; 36, 6:23-5
- Stroev E, LarionovV, Grigoreva L, Makarova V, Dubinina I, 通过血管内低强度光照射治疗糖尿病血管病。《莫斯科内分泌科学》1990年; 36卷,6期: 23-5 页
- Tuner J, Hode L. Laser Therapy - Clinical Practice and Scientific Background. Grängesberg: Prima Books AB, 2002
- Tuner J, Hode L, 光疗-临床实践和科学背景。Grängesberg《天然能》2002 年
- Vinck E, Cagnie B, Cornelissen M, Declerque H, Cambier D. Green light emitting diode Irridation enhances Fibroblast Growth impaired by high glucose levels. Photomedicine and laser surgery. 2005, 23, 2:167-171

- Vinck E, Cagnie B, Cornelissen M, Declerque H, Cambier D, 二极管绿光照射促进高葡萄糖水平损害的成纤维细胞生长。《光学医学和光外科》2005年,23卷,2期: 167-171页
- Weber M. Vorrichtung zur intravasalen Laserblutbestrahlung und Verfahren zur Herstellung eines Einmal-Katheters für eine solche Vorrichtung. Deutsche Patentanmeldung 10 2005 019 006.5-55; www.webermedical.com
- 非英文
- Weber M. Der blaue Laser. Schmerz & Akupunktur, 2006, 32, 4:208-210
- Weber M, 蓝光。《疼痛和针灸》2006年,32卷,4期: 208-210页
- Weight R, Viator J, Dale P, Caldwell C, Lisle A. Photoacoustic detection of metastatic melanoma cells in the human circulatory system. Optical Letters. 2006; 31, 20:2998-3000
- Weight R, Viator J, Dale P, Caldwell C, Lisle A, 光声检测人体循环系统中转移性黑素瘤细胞。《光信》2006年; 31卷,20期: 2998-3000页
- Wieden Torsten. Schmerztherapie der Fibromyalgie. Schmerz & Akupunktur 3/2008; 34:130-136
- Wieden Torsten, 治疗纤维肌痛,《疼痛和针灸》2008年3月; 34卷: 130-136页
- Wirz-Ridolfi, A. Frequencies with consequences. Schmerz & Akupunktur 2/2008; 61-65
- Wirz-Ridolfi, A, 频率效应。《疼痛和针灸》2008年2月; 61-65页
- Wirz-Ridolfi, A. Intravenous laser therapy in horses, Preliminary results of a Multi-Center Pilot Study. Schmerz & Akupunktur 3/2008; 120-124
- Wirz-Ridolfi, A, 马匹静脉内光疗, 多中心试验性研究的初步成果。《疼痛和针灸》2008年3月; 120-124页
- www.wissenschaft.de, News 4.4.2005-Gesundheit, publiziert im Journal of Antimicrobial Agents and Chemotherapy, Bd. 49; 139
- www.wissenschaft.de, 新闻2005年4月4日-《健康》出版物,《抗菌剂和化疗》期刊, 49卷; 139页
- Yu H, Chang K, Yu C, Chen J, Chen G. Low-energy helium-neon laser irradiation stimulates interleukin-1 alpha and interleukin-8 release from cultured human keratinocytes. Journal of investigative Dermatology. 1996; 107:593-596
- Yu H, Chang K, Yu C, Chen J, Chen G, 低功率氦氖光照射刺激培养的人角质细胞释放白细胞介素-1 α 和白细胞介素-8。《皮肤病学研究》杂志 1996年; 107卷: 593-596页
- Zhou J. Chinesische Medizin. OZV Bad Pyrmont - Beijing: 1. Auflage 2004
- Zhou J, 中医疼痛医疗。《OZV》巴特皮尔蒙特 - 北京: 1卷。2004年版
- Schulte-Übbing, C (2014): Die Intravenöse Lasertherapie als integratives Verfahren in der Immunologie.

- Schulte-Übbing C, (2014年): 《免疫系统疾病综合治疗中的静脉内光疗》。

Chapter 6: Photodynamic laser therapy

第 6 章：光动力疗法

6.1 Basics

6.1 基础知识

Photodynamic Therapy (PDT) is one of the most interesting and promising treatment approaches in modern medicine: Up to now it is already used very successfully in oncology and dermatology.

光动力疗法是现代医学中最有效和最前途的疗法之一：到目前为止光动力疗法已经在肿瘤科和皮肤病科中鲜有成效。

The principle is the stimulation of a nontoxic light-sensitive substance (photosensitizer) that had been injected to the blood stream by specific (laser-) light. Due to their molecular structures, the pathogen-specific photosensitizers bind to the targeted malignant or other diseased cells in the organism with very high specificity. Before it has been stimulated with (laser-) light, the photosensitizer does not induce any alteration of cell structures. After stimulation with (laser-) light, the targeted (tumour) cells are destroyed by the formation of radical oxygen species and other molecules that are toxic for the targeted cells (Type I or Type II photo-oxidative processes). The (laser-) light can thereby be applied topically (to treat skin cancer or other tumours

that are located close to the surface of the skin), interstitially (for other types of tumours), with special catheters (e.g. bladder or prostate cancer) or endoscopically.

原理是刺激通过特定光注入血流的无毒光敏物质（光敏剂）。由于它们的分子结构，病原体特异性光敏剂以极高的特异性结合生物体中靶标恶性或其他患病细胞。在用光刺激之前，光敏剂不会诱导细胞结构的任何改变。在用光刺激后，通过形成氧化活性分子破坏靶向的肿瘤细胞，和破坏对靶细胞有毒的其他分子（I型或II型光氧化过程）。而且，光可以局部施用（用于治疗皮肤癌或位于浅表皮肤的其他肿瘤），间质施用（用于其他类型的肿瘤），专用导管施用（例如膀胱癌或前列腺癌）或内窥镜下施用。

Besides its usage in oncology and dermatology, the photodynamic therapy is of great interest for the treatment of bacterial, viral or parasitic diseases such as malaria or tuberculosis. Photosensitizers can be activated through the blood stream (intravenous laser therapy) to unfold their anti-microbial effects.

除了在肿瘤科和皮肤病科中的应用外，光动力疗法对于治疗细菌、病毒或寄生虫疾病如疟疾或结核病等也具有重要意义。光敏剂可以通过血流（静脉光疗）激活，以展现其抗菌疗效。

As photosensitizers can be differentiated towards the type of cells at which they accumulate and towards their level of selectivity during accumulation processes, it is of highest importance to select an appropriate photosensitizer for the corresponding treatment (see chapter 6.2).

由于光敏剂可按其累积的细胞类型和累积过程选择的水平区分，因此选择适合的光敏剂进行相应的治疗是最重要的（见第 6.2 节）。

One of the major advantages of Photodynamic Therapy is that it can be applied without any side-effects. Due to their selectivity, the pathogen-specific photosensitizers have almost no effects on healthy/ non-targeted cells.

光动力疗法的一个主要优点是，使用中没有任何副作用。由于它们的选择性，病原体特异性光敏剂对健康/非靶向细胞几乎没有影响。

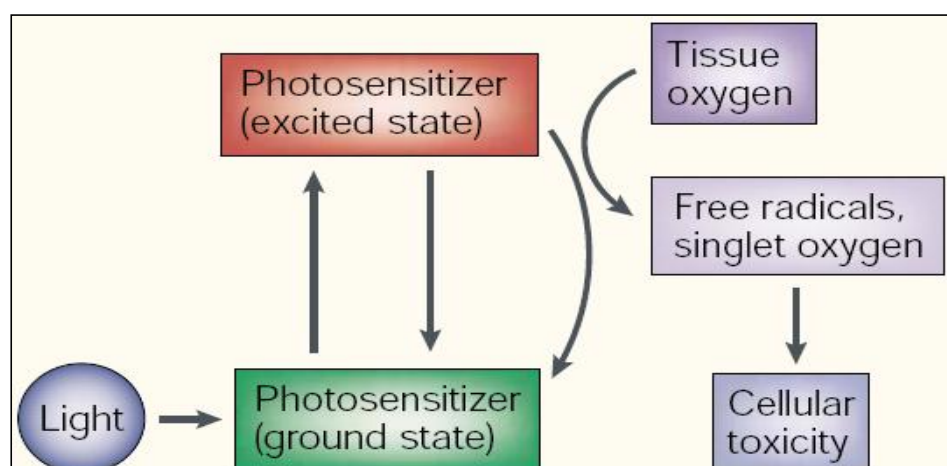


Fig. 1:
Mode of action

photodynamic tumour therapy

图 1：光动力肿瘤治疗的作用方式

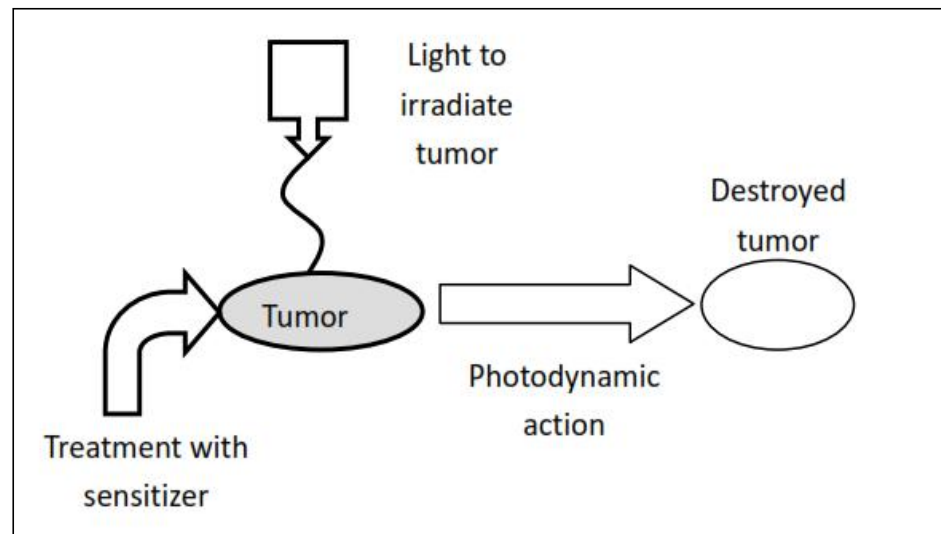


Fig. 2: Mode of action

photodynamic tumour therapy

图 2：光动力肿瘤治疗的作用方式

6.2 Overview photosensitizers

6.2 概述光敏剂

6.2.1 Characteristics of photosensitizers

6.2.1 光敏剂的特性

In general, the following criteria should be considered to assess in how far photosensitizers are appropriate to be employed in clinical indications (Allison et al.):

一般而言，应考虑以下标准来评估光敏剂适用于临床适应症的程度（Allison等人）：

(1) Toxicity: One does not want a toxic chemical; otherwise chemotherapeutic agents could be used. Further, metabolism of the photosensitizer should not create new toxic byproducts.

（1）毒性：人们不想用有毒化学品;否则可以使用化学治疗剂。因此，光敏剂代谢不得产生新的有毒副产物。

(2) Mutagenicity/ carcinogenicity: The photosensitizer should not cure one disease only to create another.

(2) 致突变性/致癌性：光敏剂不能治愈一种疾病，也不能创造另一种疾病。

(3) Elimination: Removal of the photosensitizer from the patient should be of clinical utility. One may want to retreat a patient without re-administering the photosensitizer, so half-life may be of consequence.

(3) 清除：从患者体内清除光敏剂应具有临床效用。人们可能想要暂时退出治疗，而无需重新给予光敏剂，因此半衰期变得很重要。

(4) Selectivity/ targetability: A photosensitizer that goes where you want it to go and accumulates selectively in those tissues can be beneficial. This assumes that one understands the correct target for illumination and activation. Intracellular targets, such as mitochondrial membranes, will lead to intracellular programmed death by apoptosis. Cell membrane or extra cellular-based death via vessel collapse will lead to necrosis. Necrosis initiates the cytokine family of response with systemic consequences. Clearly, the target of destruction can be important and have clinical consequences. One may be able to exploit this to create PDT vaccines via encouraging systemic response or avoid this by highly selective apoptotic response. Additionally, one could conjugate the photosensitizer, for example, to carriers, monoclonal antibodies, radioactive source etc. to enhance specificity and destructive capability. However, these “advances” contain their own new side-effects.

(4) 选择性/靶向性：光敏剂可以达到您要求的任何部位，积聚在您选择好的那些组织中，这是大有裨益的。假定人们理解照射和激活的正确目标，即细胞内靶标，例如线粒体膜，将通过细胞凋亡诱导细胞内的计划性死亡。通过血管瓦解的细胞膜死亡或基于细胞的死亡将诱发坏死。坏死诱发细胞因子族的反应，带来周身响应。显然，破坏靶标可能很重要并具有临床后果疗效。人们可以通过刺激周身反应来利用它制造光动力疫苗，或者通过高度选择性的细胞凋亡反应来避免。另外，例如载体、单克隆抗体、放射源等可以结合光敏剂，以增强特异性和破坏性能力。然而，这些的“添加”包含了其自身的新副作用。

(5) Activation: Reliable activation by an appropriate wavelength of light is needed to prevent accidental treatment.

(5) 活化：需要通过适当波长的光进行可靠的活化以防止意外治疗。

(6) Sunlight precautions: As all photosensitizers go to skin, some degree of sunlight precautions are needed. Ideally, this would be measured in hours or days and not weeks or months.

(6) 日光预防措施：由于所有光敏剂都会进入皮肤，因此需要采取一定程度的日光预防措施。理想情况下，这种措施将持续数小时或数天，不必数周或数月那么长。

(7) Administration: Versatile by topical, swallowing, inhalation or IV, depending on the clinical situation. In any case, minimal administrative toxicity (i.e. hypotension, allergic reaction) and ease of administration are valuable characteristics.

(7) 给药：根据临床病症，通过局部、口服、吸入或静脉注射等多种形式给药。在任何病例中，最小限度的给药毒性（如低血压、过敏反应等），以舒适的给药剂量为特征。

(8) Indications: Will it be better to have very specific drugs for specific medical indications (i.e. a family of photosensitizers with specific indications) or one drug that works on most diseases?

(8) 适应症：特定药物针对特定医学适应症（如具有特定适应症的光敏剂族），还是一种药物对大多数疾病起作用，哪一种更好呢？

(9) Reliability: Even the best theoretical photosensitizer must get where you need it and activate when you need it, each and every time, or it is almost useless.

(9) 可靠性：即使是理论上最佳的光敏剂也必须到达您指定的部位，并在您需要时激活，每一种或每一次都一样，否则光敏剂就是无用的。

(10) Pain-free therapy: Since PDT is done as an outpatient procedure and does not usually need sedation, a photosensitizer inducing pain during and after therapy will not allow for successful outpatient PDT.

(10) 无痛治疗：因为光动力疗法是门诊的治疗措施，通常不需要镇静，因此在治疗期间和治疗后不允许光敏剂诱导疼痛，即使为了光动力成功的门诊疗法也不行。

(11) Outpatient therapy: Outpatient administration and therapy is patient-friendly. It is also cost-effective. As therapy costs play a greater role in insurance decisions, keeping PDT less costly than other modalities is important. Patients also prefer outpatient care over hospitalization.

(11) 门诊治疗：门诊给药和治疗对患者友好，也是具有成本效益的。因为治疗费用在保险决策中发挥更大作用，因此保持光动力疗法的成本低于其他疗法是极其重要的。患者也更喜欢门诊治疗而非住院治疗。

(12) Availability: The photosensitizer must be commercially available and able to be reconstituted by a local pharmacy rather than sub-specialty labs.

(12) 可用性：光敏剂必须是市场上可以买到的，并且能够由当地药房而非附属专业实验室再造。

(13) Cost: A prohibitively expensive drug will prevent its wide use.

(13) 成本：阻止或禁止广泛使用昂贵的药物。

(14) Safety: Ideally you want to be able to give this photosensitizer without significant worry and feel that when therapy is initiated, good clinical outcomes will occur. You do not want the photosensitizer to induce morbidity such as clots, stroke, heart attack etc.

(14) 安全性：理想上，您希望使用这种光敏剂时没有明显顾虑，在开始治疗时就会产生良好的临床效果。您不希望这种光敏剂诱发凝块、脑梗、心脏病等疾病。

(15) Biochemistry: Water-soluble photosensitizers easily travel the body. With chemical manipulation, non-soluble photosensitizers can be synthesized with appropriate carriers to allow for clinical use.

(15) 生物化学：水溶性光敏剂易于在体内流动。用化学治疗、不溶性光敏剂可以为临床治疗合成适当载体。

(16) Wavelength: Longer wavelengths of activation allow for deeper tissue penetration. Activation at 400 nm is measured at a millimetre light depth penetration; 630 nm gives about 10 mm depth. This assumes light penetrates similarly between normal and tumour tissue, which clinically it does not.

(16) 波长：激活波长越长需要穿透的组织深度越深。在 1 毫米光穿透深度下测量 400nm 的活化；630nm 需要穿透的组织深度约为 10mm。这种假设光在正常组织和肿瘤组织之间类似地穿透，临床上是肉眼不可见的。

(17) Integrative ability: An optimal photosensitizer will be able to be used in conjunction with other forms of treatment such as surgery, radiation and chemotherapy. A photosensitizer that prevents use of these modalities will not be clinically successful.

(17) 综合能力：最佳光敏剂能够与其他形式的疗法如手术、放射和化疗等配合使用。光敏剂还能预防使用那些临床上不成功的疗法。

(18) Forgiving: With limited dosimetry available, highly active photosensitizers may easily permit treatment overdosage. Less active photosensitizers may be more forgiving of excess illumination.

(18) 容忍度大：由于剂量有限，高活性光敏剂易于使治疗药物等过量。光敏剂的活性越低允许照射过度量越大。

(19) Transparency: The ideal photosensitizer would be easily and safely administered, target the appropriate structure, avoid normal tissues, activate

when needed until the structure in question is destroyed and then eliminate itself without causing permanent damage to the rest of the body. It would also tell you that you were successful and help you to achieve success if you were not.

(19) 透明度：理想的光敏剂可以轻松安全地施用，靶向适当的结构，避开正常组织，在需要时激活，直到所治疗的结构被破坏为止，然后自身消除而不会对身体的其他部位造成永久性损伤。如果您未成功治愈，它会告诉您，如果您被成功治愈，它会帮助您如愿以偿。

Photosensitizers in diagnostics (PDD):

诊断光敏剂：

Some photosensitizers have another feature that is relevant for clinical practice: The combination of photosensitizers and applied light can not only lead to photodynamic reactions but also lighten up tumours or other malignant tissue through fluorescence. Thereby, these areas are “marked” and subsequent treatments are simplified.

一些光敏剂具有与临床治疗相关的另一个特征：光敏剂和应用光的组合不仅可以诱导光动力学反应，还可以通过荧光减少肿瘤或其他恶性组织。因此，这些部位被“标记”并且后续治疗被简化。

This mechanism can also be used to assess the success of treatments if it is utilized post treatments.



如果在治疗后使用，该机制也可用于评估治愈的程度。

Fig. 3: PDD with Chlorin E-6 and blue laser

图 3: 配合二氢卟吩 E6 和蓝光诊断光敏剂

6.2.2 Types of photosensitizers

6.2.2 光敏剂类型

Photosensitizers can be categorized by direct chemical structure and come from several broad families. These are:

光敏剂可以通过直接化学结构分类，来自几个广义族。它们是：

- Photosensitizers with porphyrin-platform
- 含卟啉平台的光敏剂
- Photosensitizer with chlorophyll-platform
- 含叶绿素平台的光敏剂
- Dyes
- 染料
- Others
- 其他

They can be differentiated along the following factors:

可以通过以下因素区分：

- along their efficiency and affinity to the target tissue
- 对靶组织的功效和亲和力
- along their physiological and pharmaceutical effects
- 其生理和药理效应
- along the wavelength of light that is required to activate them
- 激活它们所需的光波长
- along their specific concentration of light absorbing molecules
- 其光吸收分子的特定浓度

6.2.2.1 Photosensitizer with porphyrin-platform

6.2.2.1 含卟啉平台的光敏剂

Examples for photosensitizers with porphyrin-platform are

含卟啉平台的光敏剂实例是

- Hematoporphryn Derivative (HpD)
- 血卟啉衍生物
- Benzoporphryn Derivative (BPD)
- 苯并卟啉衍生物
- Texaphyrine
- 德克萨卟啉

- 5-aminolevulinic acid (ALA)
- 5-氨基乙酰丙酸
- Chlorin E-6
- 二氢卟吩E6

5- Aminolevulinic Acid

5-氨基乙酰丙酸

5- Aminolevulinic Acid (ALA) is of particular importance for medical low-level-laser therapy. It occurs naturally and is a pro-drug. This means it only becomes an active drug through metabolism in the organism. It is thereby converted to protoporphyrin encymatical.

5-氨基乙酰丙酸对医学低强度光疗特别重要。它天然存在，是一种前体药物。这意味着它只能通过生物体内的新陈代谢成为活性药物。因此被转化为原卟啉环境。

The figure below shows the molecular structure of ALA.

下图显示了5-氨基乙酰丙酸的分子结构。

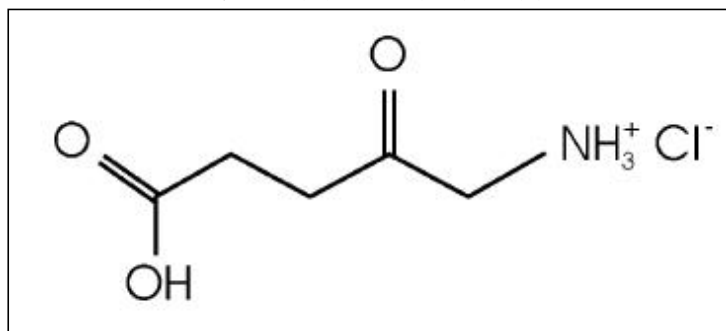


Fig. 4.: Molecular structure for ALA

图4: 5-氨基乙酰丙酸的分子结构

ALA absorbs light of a wavelength of approximately 630 nm; it is thus activated by red (laser-) light.

5-氨基乙酰丙酸吸收波长约为630nm的光;因此被红光激活。

In dermatology, photodynamic procedures in which 20 %- ALA is applied to the skin and afterwards activated with red light are well established already. Thereby, skin diseases like acne and even superficial skin cancer can be treated (see chapter 7 and 10). Though, tumour cells that are not located at the surface or close to the surface of the skin (> 1cm) cannot be treated efficiently with this procedure.

皮肤病科很成熟的光动力治疗中，20%的5-氨基乙酰丙酸应用于皮肤并随后用红光激活。因此，可以治疗痤疮甚至浅表性皮肤癌等皮肤病（见第7章和第10章）。但是，用这种方法不能有效地治疗不位于或不靠近皮肤表面（> 1cm）的肿瘤细胞。

Furthermore, ALA is used to treat actinic keratosis (20 % ALA), superficial bladder cancer (20 % ALA), head- and neck tumours (20 % ALA) and oral cavaty leukoplakia (10 % ALA).

此外，5-氨基乙酰丙酸还用于治疗光化性角化病（20%的5-氨基乙酰丙酸）、浅表性膀胱癌（20%的5-氨基乙酰丙酸）、头颈部肿瘤（20%的5-氨基乙酰丙酸）和口腔白斑（10%的5-氨基乙酰丙酸）。

If a decision whether to utilize ALA or not has to be made, it has to be considered that the procedure can be painful.

如果必须决定是否使用5-氨基乙酰丙酸，则必须考虑该疗法可能的疼痛。

Chlorin E-6

二氢卟吩E6

Chlorin E6 plays a crucial role in photodynamic tumour therapy. It is a naturally occurring molecular structure that can be extracted from green plants such as chlorella-alga. It is particularly attractive because it 1) has a very high absorption rate in the red light spectrum and 2) binds to tumour cells with extremely high selectivity so that practically no collateral damage results from the treatment. It furthermore has photo-physical features which are of advantage for PDT: For example, it has a long life-time in the triplet state (MedKoo).

二氢卟吩E6在光动力肿瘤治疗中起着至关重要的作用。是一种天然存在的分子结构，可以从绿色植物如小球藻中提取。特别有价值，因为1）在红光光谱中具有非常高的吸收率，2）以极高的选择性与肿瘤细胞结合，因此治疗几乎不诱导附带损害。它还具有光学物理特性，有利于光动力疗法：例如，长寿命和三重态（美杜古生物科学有限公司）。

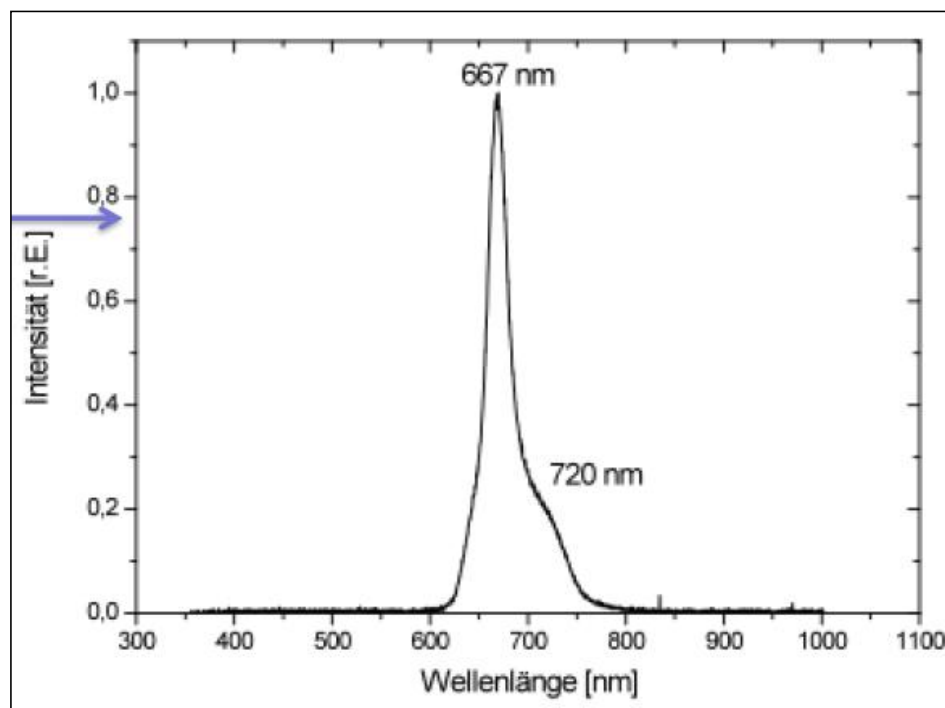


Fig. 5: Absorption spectrum of Chlorin E-6

图 5: 二氢卟吩 E6 的吸收光谱

Chlorin E6 is already FDA approved and easily accessible. Though, it is relatively cost- intensive.

二氢卟吩E6已获得食品及药物管理局批准且易于获取。但是，相对成本较高。

The figure below shows the molecular structure of Chlorin E6.

下图显示了二氢卟吩 E6的分子结构。

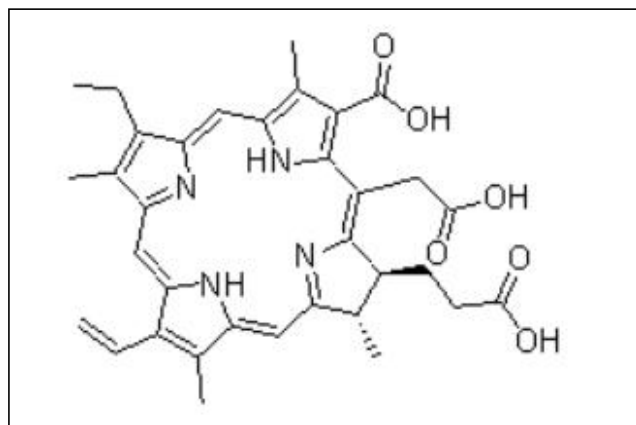


Fig. 6: Molecular structure of Chlorin E6.

图 6: 二氢卟吩 E6 的分子结构。

Within oncology, Chlorin E6 is used particularly successful in dermatology, urology, pulmonology and for the treatment of head or neck tumours. Outside oncology, it is also used in dermatology and urology as well as in dentistry and to treat wound infections (Haupt).

肿瘤学范围之内，二氢卟吩E6特别成功的用于皮肤病科、泌尿科、肺病科和头颈肿瘤的治疗中。肿瘤学范围之外，还用于皮肤病科、泌尿科、牙科和治疗伤口感染（豪普特制药）。

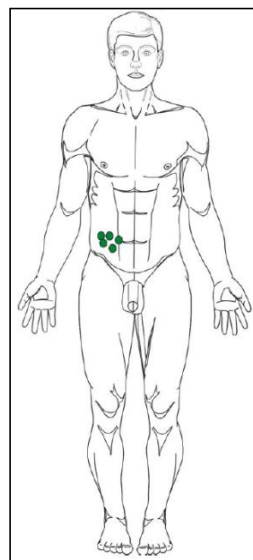
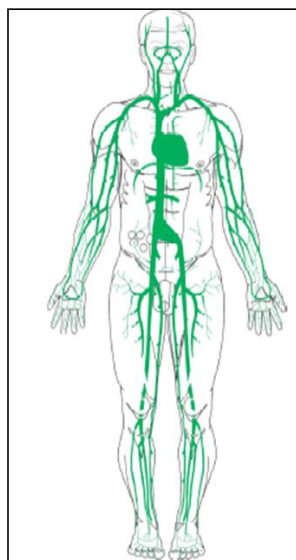
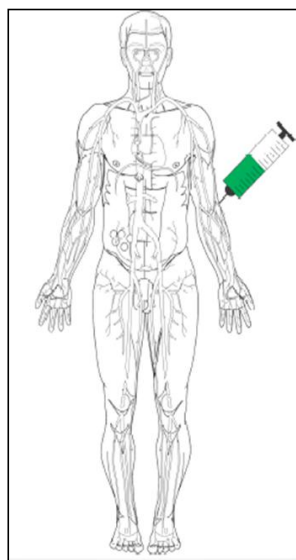


Fig. 7 - 9:

Accumulation process of Chlorin E6:

Selective accumulation at tumour tissue

after 3 - 4 hours.

图7-9: 二氢卟吩E6的累积过程: 3-4小时后在肿瘤组织上选择性积累。

6.2.2.2 Photosensitizers with chlorophyll-platform

6.2.2.2含叶绿素平台的光敏剂

Examples for Photosensitizers with chlorophyll- platform are:

含叶绿素平台的光敏剂的实例是：

- Chlorins
- 二氢卟吩
- Purpurins
- 红紫素
- Bacteriochlorins
- 菌绿素

6.2.2.3 Dyes

6.2.2.3染料

Examples for „dye- families” that can be used as photosensitizers are

可用作光敏剂的“染色族”的实例是

- Phthalocyanines
- 酞菁
- Naphthocyanines
- 萘酞菁

Interestingly, these dyes have molecular structures that are similar to those of porphyrins.

很有意义的是，这些染料的分子结构与卟啉相似。

Methylene Blue

亚甲蓝

Methylene Blue is of particular importance for medical low-level-laser therapy, especially for antimicrobial photodynamic therapy. For example, it is common knowledge already since the beginning of the 20th century that Methylene Blue is an anti-malarial drug. It not only has an anti-parasitic effect but also synergizes with malaria drugs such as Chloroquine or Endoperoxid. This combination even has its own abbreviation, namely BlueArt.

亚甲蓝对于医学低强度光疗尤其重要，特别是对于抗菌光动力疗法。例如，自20世纪初以来，亚甲蓝是一种常识性的抗疟疾药物。不仅具有抗寄生虫作用，而且还与氯喹或内过氧化物等疟疾药物协同作用。这种组合甚至有自己的缩写术语，即BlueArt。

It further has the potential to be employed in treatments of other microbial diseases such as tuberculosis or HIV.

还有可能用于治疗其他细菌引起的疾病，如结核病或艾滋病毒。

It has its absorption peak at approximately 660 nm (red light) and is a derivative of phenothiazine that is like Methylene Blue itself often utilized in microscopic diagnostics.

其吸收峰位于约660 nm处（红光），是吩噻嗪的衍生物，像亚甲蓝一样经常用于显微诊断。

Curcumin

姜黄素

Curcumin is also of special importance for low-level-laser therapy. It can be extracted from curcuma (curcuma longa) but can also be produced synthetically. It consists of three main components, the so-called curcuminoids:

姜黄素对低强度光疗也特别重要。可以从姜黄中提取，也可以人工合成。由三个主要成份组成，即所谓的类姜黄素：

- Curcumin I = Diferulolylmethane, appr. 77 % share
- 姜黄素I = 二苄基甲烷约占77%
- Curcumin II = Demethoxycurcumin, appr. 17 % share
- 姜黄素II = 去甲氧基姜黄素约占 17%
- Curcumin III = Bisdemethoxycurcumin, appr. 3 % share.
- 姜黄素III = 双脱甲氧基姜黄素约占3%。

The absorption maximum of curcumin is at 430 nm (blue light).

姜黄素的最大吸收值在430nm处（蓝光）。

It is phototoxic even in small quantities (e.g. for bacteria) and has furthermore pro-apoptotic, anti-inflammatory, immune-stimulating, radio-protective, chemo-protective, anti-tumoural, anti-metastatic, anti-angiogenetic, radio-sensitising and chemo-sensitising effects. Curcumin is thus a highly effective photosensitizer, especially for treatments of psoriasis, tumours, infections and other diseases.

即使是少量（例如对细菌）也具有光毒性，并且还具有促凋亡、抗炎、免疫刺激、放射防护、化学保护、抗肿瘤、抗转移、抗血管生成、放射增敏作用和化学致敏作用。因此，姜黄素是一种非常有效的光敏剂，特别是用于治疗牛皮癣、肿瘤、感染和其他疾病。

It is recognized as generally safe (GRAS) by the FDA. For humans, it is known that an intake of up to 2200 mg/ day is safe (see Arnhold).

姜黄素被食品及药物管理局认为是一般安全的。对于人类而言，已知摄入量高达2200毫克/天是安全的（参见Arnhold）。

6.2.2.4 Others

6.2.2.4其他

Among the group of other potential photosensitizers, Hypericin is of particular importance due to its high efficacy.

在其他潜在的光敏剂组中，金丝桃素由于高效率而特别重要。

Besides, a variety of chemotherapeutics has absorption spectra that facilitate their usage in photodynamic therapy.

此外，具有吸收光谱的各种化学治疗剂，有助于在光动力疗法中应用。

Hypericin

金丝桃素

Hypericin is a red Anthrachinon-Derivative and one of the main components of St. Johns wart from which it is extracted. In photodynamic therapy, it is used in tumour therapy, depression treatments and for treatments of viral and chronic bacterial infections.

金丝桃素是一种红色的蒽醌衍生物，也是圣约翰草提取物的主要成分之一。在光动力疗法中，用于肿瘤、抑郁症、病毒和慢性细菌感染的治疗。

It has its absorption maximum at approximately 589nm (yellow light).

最大吸收值在约589nm处（黄光）。

The figure below shows the molecular structure of Hypericin as well as the mechanism of its photo activation and the thereby induced effects.

下图显示了金丝桃素的分子结构、光活化机制及其由此诱导的效应。

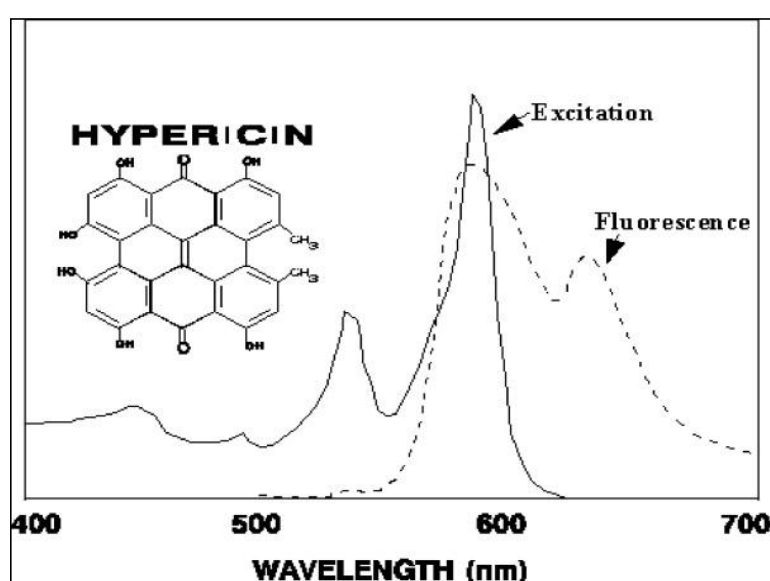


Fig. 10: Molecular structure and absorption spectrum of Hypericin

图10：金丝桃素的分子结构和吸收光谱

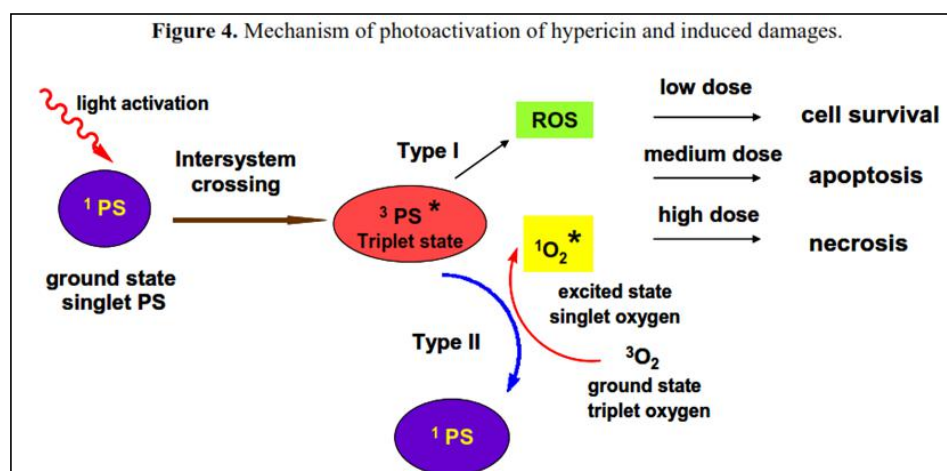


Fig. 11: Mechanism of photoactivation of hypericin and induced damages

图 11：金丝桃素的光活化机制和诱导的损伤

6.3. Interstitial and intravenous photodynamic tumour therapy:

Case studies

6.3. 间质和静脉内光动力肿瘤治疗：病例研究

The method of interstitial laser therapy in interventional oncology was first introduced in 2004 by Vogl et al. from the Faculty of Interventional Oncology of the University Frankfurt, Germany. In their study, the authors tried to overcome the problem of limited penetration depth by using fibre optic laser catheters that have been directly inserted in tumour tissue or metastases. With this method, they were able to document an effective and controlled necrosis and were convinced to be able to treat liver metastases as well. They further mentioned that one of the key advantages of the therapy is that it can be performed without almost any side-effects and pain. This leads to a great acceptance by patients. Another advantage is that the therapy can be conducted ambulant.

介入肿瘤学中的间质光疗法最早由德国法兰克福大学介入肿瘤学系的 Vogl 等人于 2004 年引入。在其研究中，作者试图通过使用直接插入肿瘤组织或转移灶的光纤导管来克服穿透深度有限的问题。通过这种方法，他们能够记录有效和受控的坏死，对治疗肝转移深信不疑。他们进一步提到，该疗法的一个主要优点是可以在几乎没有任何副作用和疼痛的条件下进行。使得患者很愿意接受。另一个优点是可以进行流动性治疗。

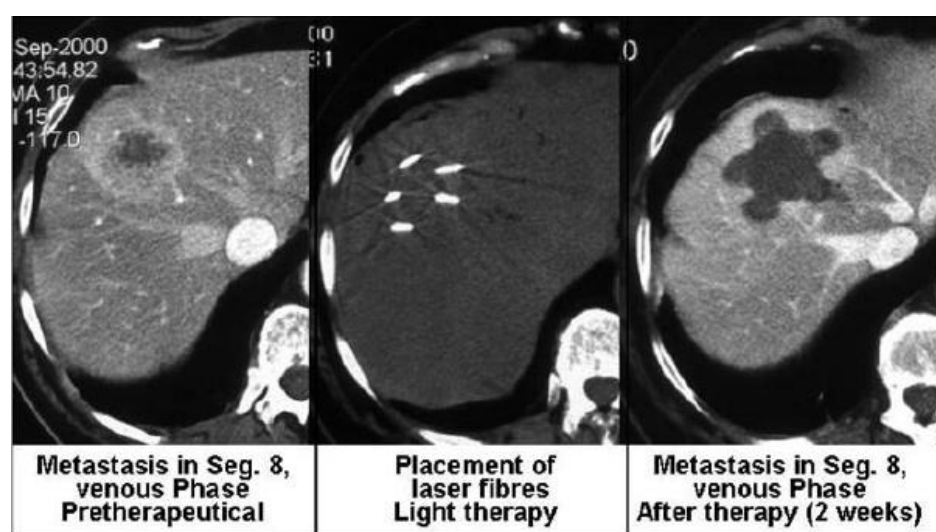


Fig. 12: Interstitial photodynamic therapy of liver metastases

图 12：肝转移的间质光动力疗法

The idea of treating cancer patients with intravenous laser irradiation („systemic PDT“) was first introduced by Kaplan et al. in 2008. They conducted a study with 76 patients with metastasized malignant melanoma which they treated with intravenously applied Chlorin E-6 and intravenous laser irradiation. 34 patients felt an improvement of their life quality, reduction of pain, less weakness and increased appetite. The lymph nodes of 16 patients disappeared completely and the dissemination of metastases of 25 other patients could be stopped for 6 - 12 months. Besides a general boost of the immune system, the authors further assumed that freely circulating tumour cells and tumour stem cells had been destroyed by the therapy. Lastly, the elimination of micro-organisms in the blood stream could prevent patients from contracting concomitant infections.

Kaplan 等人首次提出了用静脉内光照射（“周身光动力疗法”）治疗癌症患者的想法。他们对 76 名转移的恶性黑色素瘤患者进行了一项研究。用静脉注射二氢卟吩 E-6 配合静脉内光疗。34 名患者感觉生活质量得到提高、疼痛缓解、虚弱减少和食欲增加。16 名患者的淋巴结完全消失，其他 25 名患者的转移灶可停止 6-12 个月的转移。除了免疫系统普遍增强外，作者进一步认为治疗破坏了自由循环的肿瘤细胞和肿瘤干细胞。最后，消除血液中的细菌可以防止患者被伴行传染病所感染。

Thus, Weber took the results from Vogl and Kaplan together and developed a combination of “systemic PDT” via intravenously applied photosensitizers and subsequent intravenous irradiation as one component and interstitial PDT with fibre optic laser catheters and direct laser activation as the other component. In a first pilot study, he used this scheme to treat a patient with small intestine carcinoma and 4 liver metastases from May 2010 to May 2011. Before, the patient had received chemo therapy with different chemotherapeutics but the therapy did not lead to significant improvements and had severe side-effects. Also, the small intestine carcinoma had been removed operational in 2009 but 2 new liver metastases developed soon.

因此，Weber 将 Vogl 和 Kaplan 的研究成果结合在一起，并通过静脉内应用光敏剂和随后的静脉内照射作为治疗的一部分，用光纤导管和直接光激活的间质光动力疗法作为另一部分，研发了“周身光动力疗法”的组合。在第一项初步研究中，从 2010 年 5 月至 2011 年 5 月 Weber 使用该方案治疗一例小肠癌患者和 4 例肝转移患者。之前，患者接受了不同药物的化疗，但治疗未见显著好转并伴有严重的副作用。此外，2009 年小肠癌已被手术切除，但很快进行到 2 处新的肝转移。



Fig. 13: Figure scheme

图 13：方案图

A first systemic PDT in May 2010 led to a surprising improvement of life quality and after a second treatment course in June 2010, both metastases were no longer visible in a July 2010 MRI. However, in December 2010 metastases reappeared and in January 2011 the patient was treated with 3 sessions of systemic PDT. But the metastases were still growing slowly.

2010年5月首次周身光动力治疗导致生活质量发生惊人的提高。2010年6月第二个疗程后，2010年7月核磁共振成像中不再可见转移灶。然而，2010年12月，转移再次出现，2011年1月，患者接受了3次周身性光动力治疗。但转移灶仍在缓慢进行。

In February 2011 the patient received a combination of systemic PDT with Chlorin E-6 and interstitial laser therapy of the metastases. For interstitial therapy, the skin was punctured with 4 needles and fibre optic catheters were inserted to a depth of about 2 cm in the direction of the metastases to overcome the significant laser energy reduction by the skin. The needles were not placed directly in the metastases. Red light at 50 mW was used for stimulation of the applied Chlorin with a power density of 10 W/cm² for 20 min. Two weeks after the therapy the metastases changed and showed evidence of becoming necrotic.

2011年2月，患者接受了周身光动力疗法配合二氢卟吩 E-6 和间质光疗的组合方案治疗转移瘤。对于间质治疗，用4支针进行皮肤针灸，且光纤导管沿转移方向插入约2cm的深度，以克服皮肤对光能的显著吸收。针未直接置于转移灶中。使用50兆瓦红光刺激施加的二氢卟吩，功率密度为10 W/cm²，持续20分钟。治疗两周后，转移灶发生变化并显示出坏死的迹象。

The combined treatment protocol of systemic and interstitial therapy led to an impressive recovery of the patient so that she could be successfully operated by partial liver resection in the University clinic of Goettingen with a big hope of final healing.

周身和间质疗法的组合治疗方案使患者康复速度惊人，因此在哥廷根大学诊所她的部分肝切除手术很成功，给最终治愈带来莫大的希望。

Weber concluded that the combination of a modern highly specific photosensitizer (Chlorin E-6) in combination with intravenous laser blood irradiation (systemic PDT) and interstitial laser PDT using a modern catheter technique seems to be the most promising approach to photodynamic therapy today and in the future.

Weber 总结说，现代高度特异性光敏剂（二氢卟吩 E-6）配合静脉内光血液照射（周身光动力疗法）和带现代导管技术的间质光动力疗法，似乎是目前和未来最有前景的光动力组合疗法。

Weber delivers further examples of cancer patients which have been treated with Chlorin E-6 PDT:

Weber 提供了用二氢卟吩 E-6 光动力治疗癌症患者的更多实例：

- 1 patient (75 years) with operational pancreas carcinoma and interrupted chemotherapy (gemzar) with recrudescence and peritoneal carcinose is in complete remission since one year after two interstitial

therapies with Chlorin E-6 and additive 1000 mg Xeloda/ day. Right now there are no sign of tumours, tumour markers normalized.

- 1 例胰腺癌患者（75 岁）做过手术和中断性化疗（健择）伴有复发症和腹膜癌。自从使用二氢卟吩 E-6 和添加剂 1000 mg 希罗达/天进行两次间质治疗后一年内完全缓解。目前没有肿瘤迹象，肿瘤指标正常。
- Another patient at a similar age (in treatment right now) shows a similar course.
- 另一例年龄相仿的患者（现在治疗中）显示类似的病程。
- Another patient (born 1956) developed a recrudescence one year after whipple, tumour markers Ca 19-9 at entry 880, one day after interstitial therapy app. 2400, 4 days later at 700 which indicates tumour decomposition.
- 还有 1 例患者（1956 年出生）在惠普尔手术后一年复发。肿瘤指标 Ca 19-9 开始 880，间质治疗后一天 2400，4 天后 700，表明肿瘤分解。
- A patient with newly diagnosed Mamma- Ca with a tumour size of almost 5 cm and axillary lymph nodes, no signs of tumour after 8 weeks.
- 最后 1 例新近诊断为乳腺癌的患者，肿瘤尺寸近 5 cm，腋窝淋巴结，此疗法 8 周后无肿瘤迹象。

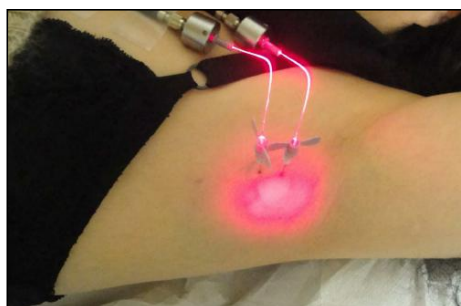


Fig. 14: Interstitial PDT of lymph metastases

图14：淋巴间质光动力疗法

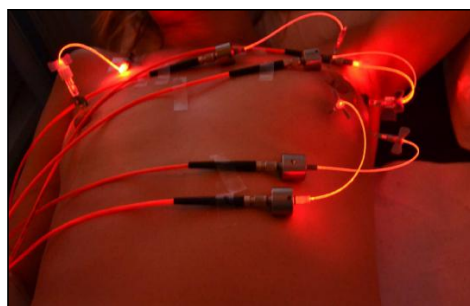


Fig. 15: Interstitial PDT of Mamma-Ca

图15：乳腺癌转移的间质光动力疗法

Despite these very promising results, photodynamic therapy should be regarded as a complementary approach to traditional chemo therapy, not as an alternative therapy. It can for example contribute to lessen the side-effects of chemo therapies. Additionally, many chemo therapeutics have an absorption spectrum that allows to use them as photosensitizers as well.

尽管有这些充满曙光的疗效，但光动力疗法应该被视为传统化疗的补充方法，而不是替代疗法。例如，它有助于减轻化学疗法的副作用。另外，许多化学治疗剂具有吸收光谱，可以用作光敏剂。

6.4 Topical photodynamic therapy

6.4 局部光动力疗法

The topical (external) photodynamic therapy is relevant in dermatology and ophthalmology.

与皮肤病科和眼科相关的局部（体外）光动力疗法。

In ophthalmology it is a standard therapy since a long time. It has been the only approved treatment method for certain kinds of vessel degeneration underneath the retina (choroidal neovascularisation) which can for example develop during an age-dependent form of macular degeneration (AMD) for a long time. In Germany, the benzoporphyrin derivative Verteporfin is approved for AMD-treatments. It absorbs light in the red light spectrum (peak at approx. 680 nm).

眼科中，因为持续时间长，被视为一种标准疗法。对于视网膜下某些类型的血管退化（如脉络膜新生血管化等），它是唯一认可的治疗方法，例如与年龄相关的长久病程的黄斑退化。在德国，批准苯并卟啉衍生物维替泊芬用于与年龄相关的黄斑退化的治疗。吸收红光光谱中的光（约 680 nm 可见）。

The particular advantage of PDT in this area of application is that treatment areas (below the retina) can be reached directly through the patient's pupil. Newly built vessels can be capped and seeing loss can thereby be prohibited. Photoreceptors of the retina and the pigment epithelium that is located below the retina are prevented from damage as well. Nowadays, several drugs that don't have to be activated with light (e.g. Avastin, Lucentis, Pegaptanib or Triamcinolone) are also commercially available for these indications and can be injected to the eye directly (intravitreal). Though, they are often used in combination with PDT as well.

光动力疗法在该应用领域中的独一无二的优点是通过患者的瞳孔直接到达治疗部位（视网膜下）。新建血管可以被封闭，因此可以防止视觉损失。也防止损坏视网膜的光感受器和位于视网膜下方的色素上皮细胞。如今，几种不必用光活化的药物（例如阿瓦斯丁、雷珠单抗、哌加他尼钠或曲安西龙）也可商购获得，并可直接注射到眼部的玻璃体内。当然，它们通常也配合光动力疗法使用。

In dermatology, PDT is well established to treat various kinds of skin cancer and its pre-stages. PDT is furthermore effective in the treatment of sclerodermy, acne vulgaris, psoriasis, different kinds of hyperkeratosis, virus induced vulgar warts and other chronic skin diseases. Approved drugs in this context are: 5-Aminolavulinic acid (5-ALA) and its methylester Methyl-5-amino-4-oxopentanoate (MAOP) (see chapters 6.2 and 7).

皮肤病科的光动力疗法已成熟用于治疗各种皮肤癌及其前期。光动力疗法还可有效治疗硬皮病、寻常痤疮、牛皮癣、各种亢奋角化病、病毒引起的恶性疣和其他慢性皮肤病。在这方面，批准的药物是：5-氨基乙酰丙酸及其甲酯甲基-5-氨基-4-氧代戊烷（见第 6.2 节和第 7 章）。

Selection of studies

研究精选

1) Methyl-aminolevulinate photodynamic therapy for the treatment of actinic keratosis and non-melanoma skin cancers: a retrospective analysis of response in 462 patients.

1) 甲基氨乙酰丙酸光动力治疗光化性角化病和非黑色素瘤皮肤癌：对 462 名患者的反应进行回顾性分析。

Authors: Fai D, Arpaia N, Romano I, Vestita M, Cassano N, Vena GA.

作者：Fai D, Arpaia N, Romano I, Vestita M, Cassano N, Vena GA。

Abstract

摘要

Aim:

目标：

Topical photodynamic therapy (PDT) with methyl-aminolevulinate (MAL) is widely used for the management of actinic keratosis (AK) and non-melanoma skin cancers (NMSCs). The authors report the results of a retrospective chart review showing the cumulative four-year experience with MAL-PDT in a hospital outpatient setting.

局部光动力疗法配合甲基氨乙酰丙酸广泛用于治疗光化性角化病和非黑色素瘤皮肤癌。作者报告了一项回顾性统计图表的审查结果，显示了在医院门诊中用光动力疗法配合甲基氨乙酰丙酸治疗疾病中累积的四年经验。

Methods:

方法：

The medical records selected concerned all patients who completed the MAL-PDT regimen (one single session for AK and two sessions one week apart for NMSCs) and who underwent post-treatment assessments over a follow-up period of at least 12 months.

选择的病历涉及完成光动力疗法配合甲基氨乙酰丙酸治疗方案的所有患者（每隔一周一个光化性角化病疗程和两个非黑色素瘤皮肤癌疗程），至少 12 个月的随访期间接受治疗后评估。

Results:

疗效：

Present case series included a total of 462 patients: 210 patients with AK, 228 subjects with 348 basal cell carcinomas (BCCs), 213 of nodular type (nBCC) and 135 of superficial type (sBCC), 17 patients with Bowen's disease and seven with squamous cell carcinoma. On the whole, following a single session, complete clearance of AK was achieved in 79% of patients at three months and in 68.1% at 12 months. As concerns BCCs, regardless of the clinical type, a complete response was observed in 71% of lesions at three months, with a rate of recurrence at 12 months of 15%. The risk of both initial treatment failure and recurrence was higher for nBCCs than sBCCs. Our results, even if

obtained in very few cases, indicate that Bowen's disease is very responsive to MAL-PDT, unlike microinvasive or invasive SCC. Treatment was generally well tolerated.

本病例系列共纳入 462 例患者：210 例光化性角化病患者；228 项测试针对 348 例基底细胞癌患者，包括 213 例结节型基底细胞癌患者和 135 例浅表型基底细胞癌患者；17 例鲍文病病患者，7 例鳞状细胞癌患者。总的来说，一个疗程后，79% 的患者在 3 个月时完全清除光化性角化病，68.1% 的患者在 12 个月时完全清除光化性角化病。关于基底细胞癌，无论临床类型如何，在 3 个月时 71% 的病灶中观察到完全反应，12 个月时复发率为 15%。结节型基底细胞癌初始治疗失败和复发的风险均高于浅表型基底细胞癌。我们的研究成果，即使是在很少的病例中，也表明鲍文病对光动力疗法配合甲基氨乙酰丙酸组合非常敏感，与微创或侵袭性浅表型基底细胞癌不同。治疗通常易于接受。

Conclusion:

结论：

Our experience confirms that MAL-PDT is a valid approach to patients with AK, BCC and Bowen's disease, with an acceptable tolerability profile and a very low risk of complications.

我们的经验证实，光动力疗法配合甲基氨乙酰丙酸组合是治疗光化性角化病、基底细胞癌和鲍文病患者的有效方法，具有可接受的耐受性和并发症的风险低。

2) Topical methyl-aminolevulinate photodynamic therapy using red light-emitting diode light for treatment of multiple actinic keratosis: A randomized, double-blind, placebo-controlled study.

2) 用发光二极管红光配合局部甲基氨乙酰丙酸光动力治疗多种光化性角化病：一项随机、双盲、安慰剂对照研究。

Pariser D1, Loss R, Jarratt M, Abramovits W, Spencer J, Geronemus R, Bailin P, Bruce S.

作者：Pariser D1, Loss R, Jarratt M, Abramovits W, Spencer J, Geronemus R, Bailin P, Bruce S.

Abstract

摘要

Background:

背景：

The use of light-emitting diode light offers practical advantages in photodynamic therapy (PDT) with topical methyl-aminolevulinate (MAL) for management of actinic keratosis (AK).

在光动力疗法中发光二极管光的使用提供了实用的优点，配合局部甲基氨乙酰丙酸治疗光化性角化病。

Objective:

目的：

We sought to evaluate the efficacy of MAL PDT using red light-emitting diode light.

我们试图使用发光二极管红光来评估甲基氨乙酰丙酸光动力疗法的功效。

Methods:

方法:

We conducted a multicenter, double-blind, randomized study. A total of 49 patients with 363 AK lesions had 16.8 % MAL cream applied under occlusion for 3 hours, and 47 patients with 360 AK lesions had vehicle cream similarly applied. The lesions were then illuminated (630 nm, light dose 37 J/cm²) with repeated treatment 1 week later. Complete lesion and patient (all lesions showing complete response) response rates were evaluated 3 months after last treatment.

我们进行了一项多中心、双盲、随机研究。共有 49 名患者，携带 363 个光化性角化病灶。在 3 小时封闭条件下施用 16.8% 甲基氨乙酰丙酸乳膏，携带 363 个光化性角化病灶的 47 名患者施用此种载体乳膏。然后照射病灶（630nm，光剂量 37J/cm²），1 周后重复治疗。最后一次治疗后 3 个月评估病灶和患者（显示所有病灶完全反应）的完全反应率。



Fig. 16: Treatment of actinic keratosis

图 16: 光化性角化病的治疗

Results:

疗效:

MAL PDT was superior ($P < .0001$) to vehicle PDT with respect to lesion complete response (86.2% vs 52.2%, odds ratio 6.9 [95% confidence interval

4.7-10.3]) and patient complete response (59.2% vs 14.9%, odds ratio 13.2 [95% confidence interval 4.1-43.1]).

甲基氨乙酰丙酸光动力疗法比单独的载体光动力疗法具有更出色的疗效 (P<.0001)，相对于病灶完全反应而言 (86.2%：52.2%，优势比 6.9 [95%置信区间 4.7-10.3])；相对于患者完全反应而言 (59.2%：14.9%，优势比 13.2 [95%置信区间 4.1-43.1])。

Limitations:

局限性:

The study population may not be representative of all patients with AK.

研究人群可能不代表所有的光化性角化病患者。

Conclusion:

结论:

MAL PDT using red light-emitting diode light is an appropriate treatment alternative for multiple AK lesions.

使用发光二极管红光的甲基氨乙酰丙酸光动力疗法是治疗多种光化性角化病的适合方案。

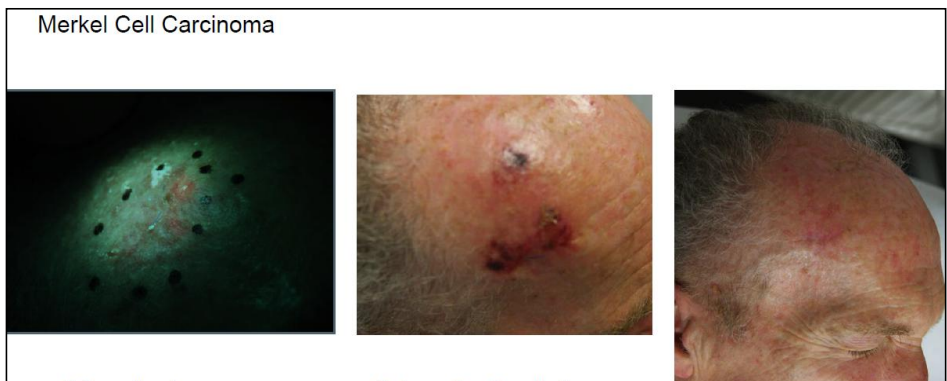


Fig. 17:
Healing
process of a
Merkel
Carcinoma
图 17: 梅克尔

癌的愈合过程

**Fig. 18: Healing process
after topical PDT**

**图 18: 局部光动力疗法后
的愈合过程**



Fig. 19: Healing process after topical PDT

图 19: 局部光动力疗法后的愈合过程



Fig. 20:

Treatment success basal carcinoma

图 20: 成功治疗基底癌

Fig. 21:



Treatment success acne vulgaris

图 21: 成功治疗寻常痤疮

6.5 Anti- microbial photodynamic therapy

6.5 抗菌光动力疗法

Against the background of increasing pathogen resistances against antibiotics, the anti- microbial photodynamic therapy is just about to move back to the spotlight. Its efficacy to kill microbial pathogens is though known since more than a hundred years. Technically, it is conducted analogous to the Photodynamic Tumour Therapy (see chapter 6.1). For each disease, specific

photosensitizers have to be identified. Afterwards, they have to be activated by local or systemic (intravenous) light application of appropriate wavelength.

根据病原体对抗生素抗性增加的背景，抗菌光动力疗法恰恰令病原体消除抗性成为该疗法的亮点。尽管病原体已发现有一百多年的历史，但其灭菌功效卓著。从技术上讲，这类似于光动力肿瘤治疗（见第 6.1 节）。对于每种疾病，必须识别特定的光敏剂。之后，通过适当波长的局部或周身（静脉内）光照射激活光敏剂。

In this context, pathogen-specific photosensitizers for all major infectious diseases have been known for years. The previous negligence of the therapy has to main reasons:

在这种情况下，多年来已获得了许多用于所有主要传染病的病原体特异性的光敏剂。以往治疗的疏忽主要有以下几个原因：

On the one hand, the first breakthroughs in research in the 1940s were achieved simultaneously to the development of the first commercially available antibiotics (e.g. Penicillin). In reaction to that, research funds for aPDT had been reduced radically. Since a couple of years, this trend is reversed as aPDT becomes more interesting again in times of increasing pathogen resistances against antibiotics. In this context, a broad range of studies shows that aPDT is equally effective against multi-resistant pathogens than it is against non-multi-resistant pathogens. As all evidence suggests, pathogens will neither be able to develop resistances to aPDT in the future.

一方面，20 世纪 40 年代首次突破性的研究同时研发了第一种市售抗生素（即青霉素）。作为对此的反应，抗生素光动力疗法的研究发现大幅减少。几年后，这一趋势发生逆转。因为当病原体对抗生素的抗性增加时，抗生素光动力疗法再次变得越来越有趣。在这方面，广泛的研究表明，抗生素光动力疗法对抗多重耐药性病原体，与对抗非多重耐药性病原体，具有相同的效果。所有证据表明，病原体将来都不会对抗生素光动力疗法产生抗药性。

On the other hand, physicians weren't able "to take aPDT out of the laboratory" until recently. The limiting factor had been the disability of science to activate the photosensitizers within the body with light of appropriate wavelength. Nowadays, new technological developments facilitate interstitial and systemic (intravenous) laser applications (see e.g. chapter 5) which are the key to aPDT today.

另一方面，直到最近，医生才能“从实验室中移出抗生素光动力治疗”。这一限制因素是科学的不利条件，用适当波长的光激活人体内的光敏剂。如今，新型技术的发展促进了间质和周身（静脉内）光应用（参见例如第 5 章），这是当今抗生素光动力疗法的关键。

The further development and subsequent implementation in medical practice is the core task of the ISLA Research Group which was founded in 2013. Its focus currently lies on the development of treatment options for infectious diseases such as Malaria and Tuberculosis but the group also works on HIV, hepatitis and lyme disease. Right now, the development of pathogen-specific and efficient photosensitizers as well as the conduction of first pilot studies are on the agenda (spring 2014).

医疗实践的进一步发展和随后的付诸实践是 ISLA 研究小组的核心任务，该小组成立于 2013 年。其重点目前在于开发疟疾和结核病等传染病的治疗方案，但该小组也致力于艾滋病毒、肝炎和莱姆病的治疗。目前，病原体特异性和高效光敏剂的研发以及首次初步研究的开展已列入议事日程（2014 年春季）。

One photosensitizer that has already proven to be an effective drug is Hypericin. It has anti-bacterial and anti-viral effects and is used successfully to treat lyme disease and other viral infections.

已经证明金丝桃素是一种光敏剂和一种有效药物。它具有抗菌和抗病毒作用，可成功用于治疗莱姆病和其他病毒感染。

Literature

文献

- Arnhold, Jürgen: Fokale Therapie des Prostata Cha
- Arnhold, Jürgen: 前列腺癌的病灶治疗
- Busse, Ann- Kathrin: Effekte von Hypericin auf humane renale Karzinomzellen in vitro
- Busse, Ann- Kathrin: 体外金丝桃素对人肾癌细胞的疗效
- Medkoo: <http://www.medkoo.com/bio-reagents/ChlorinE6.htm>
- Haupt, Manfred: Photodynamic Therapy with Chlorin E6 Trisodium Salt
- Haupt, Manfred: 配合二氢卟吩 E6 三钠盐的光动力疗法
- Weber, Michael: Systemic photodynamic therapy
- Weber, Michael: 周身光动力疗法
- Kaplan et al: Systemic Photodynamic Therapy in the Combined Therapy of Patients with Malignant Neoplasms with Metastases; Book of Abstracts, int. Laser conference Helsinki 2008
- Kaplan 等人: 恶性肿瘤患者的组合治疗中周身光动力疗法; 《摘要集》, 赫尔辛基间质光会议, 2008 年

- T. J. Vogl, K. Eichler, K. Engelmann, M. G. Mack, R. Straub, S. Zangos: Interstitielle Photodynamische Lasertherapie zur Behandlung von Lebermetastasen: Erste Ergebnisse einer in vivo Phase I-Studie; Fortschr Röntgenstr 2003; 175:682-687, Georg Thieme Verlag Stuttgart
- 非英文
- Weber, M.: Intravenöse und interstitielle Lasertherapie: Eine neue Option in der Onkologie.
- Weber, M., 静脉和间质光疗：肿瘤科的新型疗法
- D. Fai, N. Arpaia, I. Romano, M. Vestita, N. Cassano, G. A. Vena: Methyl-aminolevulinate photodynamic therapy for the treatment of actinic keratosis. In: Giornale Italiano di Dermatologia e Venereologia. Bd. 144, Nr. 3, 2009, ISSN 0392-0488, S. 281-285, PMID 19528909.
- D. Fai, N. Arpaia, I. Romano, M. Vestita, N. Cassano, G. A. Vena: 甲基氨乙酰丙酸光动力治疗光化性角化病。《皮肤病科和性病科》意大利期刊。144 卷，3 期，2009 年，ISSN 0392-0488，S. 281-285 页，PMID 19528909。
- Lasse R. Braathen, Rolf-Markus Szeimies, Nicole Basset-Seguin, Robert Bissonnette, Peter Foley, David Pariser, Rik Roelandts, Ann-Marie Wennberg, Colin A. Morton: Guidelines on the use of photodynamic therapy for nonmelanoma skin cancer: An international consensus. In: Journal of the American Academy of Dermatology. Bd. 56, Nr. 1, 2007, ISSN 0190-9622, S. 125-143, doi:10.1016/j.jaad.2006.06.006.
- Lasse R. Braathen, Rolf-Markus Szeimies, Nicole Basset-Seguin, Robert Bissonnette, Peter Foley, David Pariser, Rik Roelandts, Ann-Marie Wennberg, Colin A. Morton: 用光动力治疗非黑色素瘤皮肤癌指南：国际共识。《美国皮肤病学会》期刊。56 卷，1 期，2007 年，ISSN 0190-9622，S.125-143 页，doi: 10.1016 / j.jaad.2006. 06.006。
- Marieke H. Roozeboom, MD, Martine A. Aardoom, Patty J. Nelemans, MD, PhD, Monique R.T.M. Thissen, MD, PhD, Nicole W.J. Kelleners-Smeets, MD, PhD, Danielle I.M. Kuijpers, MD, PhD, Klara Mosterd, MD, PhD (2013): Fractionated 5-aminolevulinic acid photodynamic therapy after partial debulking versus surgical excision for nodular basal cell carcinoma: A randomized controlled trial with at least 5-year follow-up. In: Journal of the American Academy of Dermatology Volume 69, Issue 2, Pages 280-287, August 2013
- Marieke H. Roozeboom, 医学博士 Martine A. Aardoom, Patty J. Nelemans, 医学博士 Monique R.T.M. Thissen, 医学博士 Nicole WJ Kelleners-Smeets, 医学博士 Danielle IM Kuijpers, 医学博士 Klara Mosterd (2013 年)：对手术切除结节性基底细胞癌的部分主体后，分次 5-氨基乙酰丙酸光动力疗法：随机对照试验，随访至少 5 年。《美国皮肤病学会》期刊，第 69 卷，第 2 期，第 280-287 页，2013 年 8 月
- David Pariser, MD, Robert Loss, MD, Michael Jarratt, MD, William Abramovits, MD, James Spencer, MD, Roy Geronemus, MD, Philip Bailin, MD, Suzanne Bruce, MD: Topical methyl-aminolevulinate photodynamic therapy using red

light-emitting diode light for treatment of multiple actinic keratosis: A randomized, double-blind, placebo-controlled study. In: Journal of the American Academy of Dermatology, Volume 59, Issue 4 , Pages 569-576, October 2008

- David Pariser 医学博士, Robert Loss 医学博士, Michael Jarratt 医学博士, William Abramovits 医学博士, James Spencer 医学博士, Roy Geronemus 医学博士, Philip Bailin 医学博士, Suzanne Bruce 医学博士: 用发光二极管红光的局部氨基乙酰丙酸光动力治疗多种光化性角化病: 一项随机、双盲、安慰剂对照研究。《美国皮肤病学会》期刊, 第 59 卷, 第 4 期, 第 569-576 页, 2008 年 10 月

Chapter 7: Biological laser therapy in dermatology

第 7 章: 皮肤病科的生物光疗

In dermatology, laser therapy is used for the treatment of eczema, neurodermatitis, psoriasis, chronic wounds, acne, herpes or gingivitis. In this context, blue laser light is very important due to its strong anti-bacterial and anti-inflammatory effects.

在皮肤病科, 光疗法用于治疗湿疹、神经性皮炎、牛皮癣、慢性伤口愈合、痤疮、疱疹或牙龈炎。在这种情况下, 蓝光由于其强大的抗菌和抗炎作用而显得极其重要。

In clinical applications, all available laser wavelengths are combined in a special applicator to facilitate the respective wavelength-specific effects on the skin.

临床应用中, 所有可用光波长都组合在一个专用涂药器中, 以促进皮肤上各自波长的特异性疗效。

7.1 Effects of different laser light on the skin

7.1 不同光对皮肤的疗效

- Blue acts bactericidal, improves the microcirculation (release of NO) and stimulates the respiratory chain on the level of NADH-dehydrogenase
- 蓝光可起到杀菌作用, 改善微循环 (释放一氧化氮), 并在烟酰胺腺嘌呤二核苷酸-脱氢酶水平上刺激呼吸链

- Green activates membrane potential of cells (Na/K- ATPase) and mitochondria
- 绿光激活细胞（钠/钾-三磷酸腺苷酶）和线粒体的膜电位
- Red improves healing, binds to cytochrom-c-oxidase in the respiratory chain, builds up of cells and leads to immunological effects
- 红光加速愈合，与呼吸链中的细胞色素-c-氧化酶结合，生成细胞并诱导免疫疗效
- Infrared cross-links the hyaluronic acid and binds to cytochrom-c-oxidase
- 红外光交联透明质酸，并与细胞色素-c-氧化酶结合

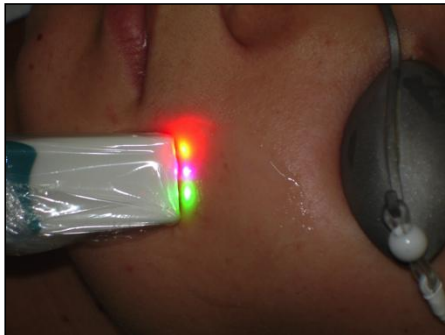


Fig. 1: Dermatologic treatment with a combination of red, infrared, green and blue lasers

图 1：红光、红外光、绿光和蓝光组合的皮肤病治疗

7.2 Laser therapy for treatment of acne

7.2 光疗法治疗痤疮

The well-known and proven effects of (laser) light on acne are based on the stimulation of bacterial porphyrins and the subsequent destruction of propioni bacteria by active oxygen radicals.

光对痤疮的疗效已证实且众所周知的是基于细菌卟啉的刺激和随后通过活性氧自由基破坏丙酸血症细菌。

Side effects such as skin aging or promotion of skin cancer (compared to UV irradiation) do not appear.

未见皮肤老化或促进皮肤癌变等副作用（与紫外光照射相比）。

"[Blue] Light gets at the core of what causes acne eruptions: P. acnes, the bacterial responsible for causing acne inflammation, pumps out tiny molecules called porphyrins. When those porphyrins are exposed to certain wavelengths of light, they produce free radicals that kill the bacteria. Without P. acnes around to cause inflammation, acne clears up." American Academy of Dermatology

“[蓝]光在诱导痤疮发作中位于核心：痤疮丙酸杆菌诱导痤疮炎症，泵出称为卟啉的微小分子。当某些波长的光照射这些卟啉时，它们会产生自由基，杀死细菌。没有痤疮丙酸杆菌引起炎症，痤疮就会消失”。《美国皮肤病学会》

Blue/red light treatment

蓝/红光治疗

It was found that some of the visible violet light, present in sunlight, in the range 405-420 nm activates a porphyrin (Coproporphyrin III) in *Propionibacterium acnes* which damages and ultimately kills the bacteria by releasing singlet oxygen. A total of 320J/cm² of light within this range renders the bacteria non viable. This part of the spectrum is just outside the ultraviolet and produces little if any tanning or sunburn. Application of the light for 3 consecutive days has been shown to reduce the bacteria in the pores by 99.9%. Since there are few porphyrins naturally found in the skin, the treatment is believed safe except in patients with porphyria.

发现存在于阳光下405-420nm范围内的一些可见紫光激活痤疮丙酸杆菌中的卟啉（粪卟啉III），其通过释放单线态氧而损害并最终杀死细菌。在该范围内共320焦耳/平方厘米的光就使细菌不能存活。这部分光谱就在紫外光之外，几乎不会晒黑或晒伤皮肤。已经证明连续3天施用该光可降低毛孔中99.9%的细菌。由于皮肤中天然存在的卟啉很少，因此除了卟啉症患者外，治疗被认为是安全的。

Treatment is often accompanied with application of red light which has been shown to activate ATP in human skin cells (essentially a photobiomodulation effect), and seems to improve response rates. Overall improvements of on average 76% for 80% of patients occurs over 3 months; most studies show that it performs better than Benzoyl peroxide but treatment is far better tolerated.

通常治疗伴随着红光照射，已经证实红光激活人皮肤细胞中的三磷酸腺苷（主要是光生物调节作用），似乎提高了反应率。总体而言，时间超过3个月后80%的患者平均改善率为76%；大多数研究表明其疗效优于过氧化苯甲酰，而且患者更易于接受。

How Effective Is Blue Light Therapy?

蓝光治疗的效果如何？

Recently, the Journal of Neuroscience reported that this specific bandwidth of light is up to five times more effective than other wavelengths at causing this neurochemical shift. A joint National Institute of Health (NIH) study with Thomas Jefferson University was also conducted to determine the antidepressant response of blue light therapy. This study demonstrated recovery and remission rates equal to or higher than similar studies with standard bright light therapy.

最近，《神经科学》期刊报道，这种特定的光带宽提高到五倍，疗效好于其他波长，因为诱导神经化学物质转移。美国国立卫生研究院与托马斯杰斐逊大学的联合研究旨在确定蓝光治疗抗抑郁的反应。该研究表明恢复和缓解率等于或高于使用标准强光疗法的类似研究。

Acne therapy with combined laser therapy (red, infrared, green and blue): Pilot study, Lauenfoerde/ Germany (2008):

组合光（红光、红外光、绿光和蓝光）治疗痤疮：初步研究，德国劳恩福德（2008年）：

An impressive improvement in 5 patients with severe acne could be observed within 3 weeks of treatment: 治疗 3 周内观察到 5 例重度痤疮患者的显著改善：



Fig. 2: Acne before therapy

图 2：治疗前痤疮



Fig. 3: Acne after therapy (3 weeks later)

图 3：治疗后痤疮（3 周后）



Fig. 4: Acne before therapy

图 4：治疗前痤疮



Fig. 5: Acne after therapy (3 weeks later)

图 5：治疗后痤疮（3 周后）

Photodynamic therapy in dermatology

皮肤病科的光动力疗法

Newest research indicates that photodynamic therapy seems to be even more effective in treatment of dermatological conditions (i.e. with 5-ALA crème) compared to laser therapy alone. This is important especially for treatments of different types of skin cancer and its pre-stages (actinic keratosis, basalioma) (see chapter 6).

最新研究表明，与单一光的疗法相比，该光动力疗法似乎治疗皮肤病症状（诸如使用 5-氨基乙酰丙酸膏）更有效。这对于不同类型的皮肤癌及其前期（诸如光化性角化病、基底细胞瘤）的治疗尤为重要（见第 6 章）。

7.3 Cosmetic laser therapy

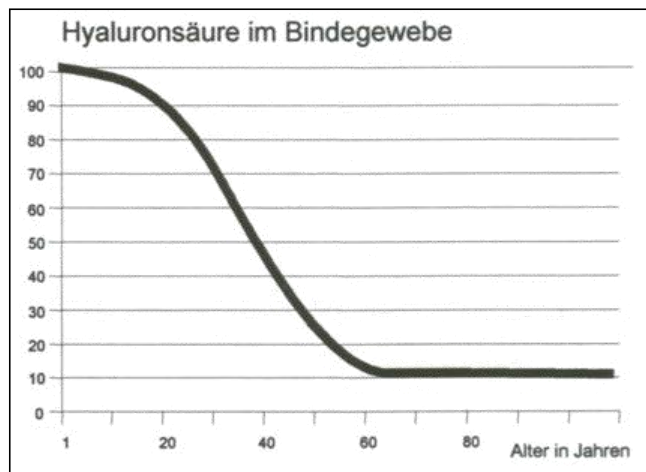
7.3 美容光疗

The combination of the different laser wavelengths (red, infrared, green and blue lasers) with special “beauty” crèmes (based on hyaluronan) leads to an optimal renewing of the skin and connecting tissue. These highly effective crèmes are mixtures of hyaluronic acid incorporated in liposomes. In this preparation the hyaluronic acid is able to penetrate the different layers of the skin. Finally, the laser irradiation accumulates and stores the content of the hyaluronan in the skin and connecting tissue.

不同光波长（红光、红外光、绿光和蓝光）组合与专用“美容”乳霜（基于透明质酸）诱导最佳地皮肤再生和结缔组织。这些高效的乳膏是掺入脂质体中的透明质酸的混合物。在该制剂中，透明质酸能够渗透皮肤的不同层。最后，光照射累积并储存透明质酸在皮肤和结缔组织中的含量。

<http://www.isla-laser.org/wp-content/uploads/kosmetische-lasertherapie.jpg> This therapy is used for vitalisation and regeneration of skin and wrinkles, for cell metabolism regeneration and for purification of the connecting tissue with

increase of energy transport processes.



<http://www.isla-laser.org/wp-content/uploads/kosmetische-lasertherapie.jpg> 该疗法用于皮肤和皱纹的活化和再生，伴随运输过程能量的增加，细胞新陈代谢再生和结缔组织净化。

Fig. 6: Reduction of natural amount of hyaluronan in the skin due to increased aging

图 6：由于老化加快，皮肤中天然透明质酸的量减少

Hyaluronan is a natural component of the connecting tissue. It improves production of collagen and elastin and is responsible for binding water in the connecting tissue. The amount of hyaluronan is mostly important for the elasticity of the skin and the connecting tissue. In the age of 40, the amount is reduced by 50 % in comparison to new born babies.

透明质酸是结缔组织的天然成分。增加胶原蛋白和弹性蛋白的生成，负责锁住结缔组织中的水分。透明质酸的量对于皮肤和结缔组织的弹性最重要。40岁时，与新生婴儿相比，透明质酸的量减少了50%。

In the age of 60, it is already reduced to only 10 % of the original amount.

60 岁时，透明质酸的量减少到原始量的 10%。

The hyaluronan-laser method („cold laser lifting“)

透明质酸-光法（“冷光改善”）

The procedure combines the two currently most successful methods for skin rejuvenation: Hyaluronan and laser therapy. Only the combination of these two components is leading to significant and sustainable effects, such as healthy, fresh and youthful skin as well as a vitalized attitude to life.

该疗法结合了目前最成功的两种皮肤再生法：透明质酸和光疗。只有这两个部分组合才能诱导显著和可持续的疗效，例如健康、嫩肤和年轻的肌肤，以及对生活充满活力的态度。

The special hyaluronan crème is micronized in the production process to an extent facilitating its application into the skin with deep penetration into basal cell tissue.

专用的透明质酸乳膏在生产过程中被微粉化，在一定程度上促进其在皮肤中的应用，深入渗透到基底细胞组织中。

Afterwards, laser irradiation leads to cross-linking and storage of hyaluronan in the skin by development of its original and natural (long-chained) form.

之后，光照射，以其原始和天然（长链）的发育形式，导致透明质酸在皮肤中的交联和储存。

This method is highly innovative as it passes the central limitation of connecting externally produced hyaluronan to the human tissue.

该方法具有高度创新性，因为将体外产生的透明质酸通过中心边界缔结到人体组织。

Component 1: Hyaluronan

组分1：透明质酸

- Hyaluronan (or hyaluronic acid) is a glycosaminoglycan distributed widely throughout connective epithelial and neural tissues
- 透明质酸（或玻璃酸）是一种广泛分布于结缔组织上皮和神经组织的糖胺聚糖
- It is one of the chief components of the extra cellular matrix and protects joints by increasing the viscosity of the fluid and by improving elasticity of cartilage between bones
- 是细胞外基质的主要成分之一，通过增加液体粘度和改善骨骼间软骨弹性来保护关节
- Hyaluronan also contributes to tissue hydrodynamics (1 gr. can absorb as much as 6 l of water), movement and proliferation of cells, and participates in a number of cell surface receptor interactions
- 透明质酸还有助于组织流体动力学（1克可吸收多达6升水）、细胞运动和增殖，并参与许多细胞表面受体间的相互作用
- In cosmetics, Hyaluronan is a common skin care ingredient (due to its moisturizing effects)
- 在化妆品中，透明质酸是一种常见的护肤成分（由于其保湿效果）
- FDA has approved hyaluronan in 2003 for injections (for filling soft tissue defects such as facial wrinkles)

- 食品及药物管理局于 2003 年批准了透明质酸用于注射（填充面部皱纹等软组织缺陷）
- Natural hyaluronan content in the human skin is reduced significantly with increased aging
- 随着逐渐衰老，人体皮肤中的天然透明质酸含量显著降低
- Hyaluronan is important for regulation of cellular growth processes, wound-healing, defence against pathogens, cell protection, transport of nutrients and transport of degradation products
- 透明质酸对于调节细胞生长过程、伤口愈合、防御病原体、细胞保护、营养物质和降解产物的运输非常重要
- Unfortunately, hyaluronan has a short half life of about 20.3 hours
- 不幸的是，透明质酸的半衰期短，约为 20.3 小时
- Thus, clinical effects normally disappear a few days after treatment
- 因此，临床疗效通常在治疗后几天内消失
- If hyaluronan can be converted into its long-chained form within the tissue, life period is increased tremendously
- 如果透明质酸可以在组织内转换成自身的长链形式，则生命周期会大幅度延长

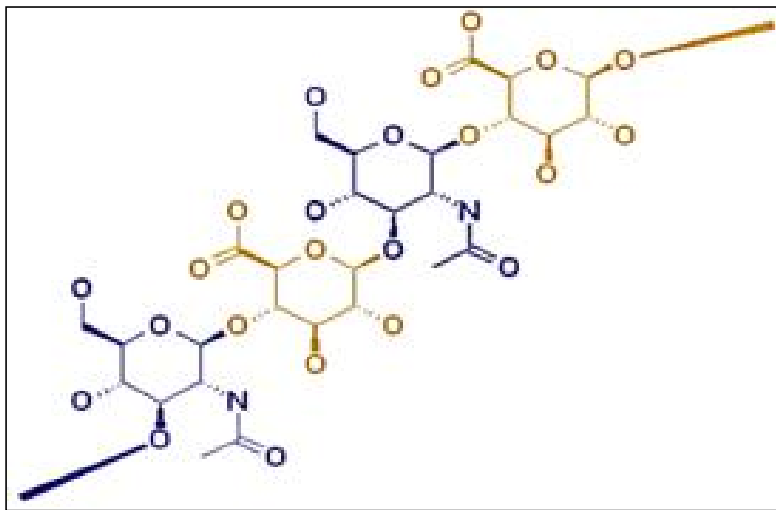


Fig. 7: Molecular structure of hyaluronan

图 7: 透明质酸的分子结构

Component 2: The low-level-laser
组分 2: 低强度光

As explained before, the hyaluronan crème won't be able to develop its effects within the tissue without an additional cross-linking mechanism. This is finally achieved by local laser irradiation (especially by infrared light), converting the hyaluronan into its original long-chained form and thereby storing it sustainably within the skin and connecting tissue.

如前所述，透明质酸乳膏不能在没有其他交联机制的情况下在组织内发挥其作用。这最终通过局部光照射（尤其是通过红外光）实现，将透明质酸转化为其原始的长链形式，从而将其可持续地储存在皮肤和结缔组织内。

After this combination procedure, the artificially produced hyaluronan functions in the tissue in the same way as organism's self-produced hyaluronan.

该组合治疗之后，人造透明质酸以与生物体自身产生的透明质酸相同的方式在组织中起作用。

Subsequently, volume and elasticity of the skin is improved significantly.
随后，皮肤的细胞量和弹性显著改善。

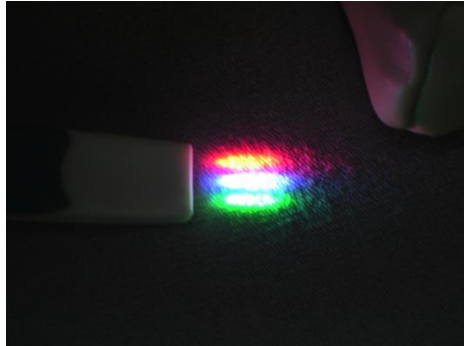


Fig. 8: Applicator with red, infrared, green and blue lasers

图 8：配备红光、红外光、绿光和蓝光的涂药器

Practical application

实际应用

Application of the new hyaluronan crème:

新鲜的透明质酸乳膏的应用：

The new and highly effective weberneedle® beauty crème is a special mixture of hyaluronic acid incorporated in liposomes. In this preparation, the hyaluronic acid is able to penetrate different layers of the skin and connecting tissue.

新型高效韦伯针®美容乳膏是一种专用的透明质酸混合物，含有脂质体。在该制剂中，透明质酸能够穿透皮肤的不同层与细胞组织缔结。



Fig. 9: Application of special hyaluronan crème.

图 9：专用透明质酸乳膏的应用。

The single non cross-linked hyaluronic acid:

单相非交联透明质酸：

In the age of 40 years the concentration of hyaluronic acid in the skin is already reduced to about 50 %, at the age of 60 even to 90 %. Thereby the elasticity of the skin is highly reduced. The skin is becoming dry and wrinkled. Thus, it is most important to accumulate and store the hyaluronan within the skin and connecting tissue. This can be done successfully by infrared laser irradiation.

40岁时，皮肤中透明质酸的浓度已经降低约50%，60岁甚至降低90%。从而大大降低了皮肤的弹性。皮肤变干和起皱纹。因此，最重要的是在皮肤内和结缔组织中积聚并储存透明质酸。可以通过红外光照射成功实现。

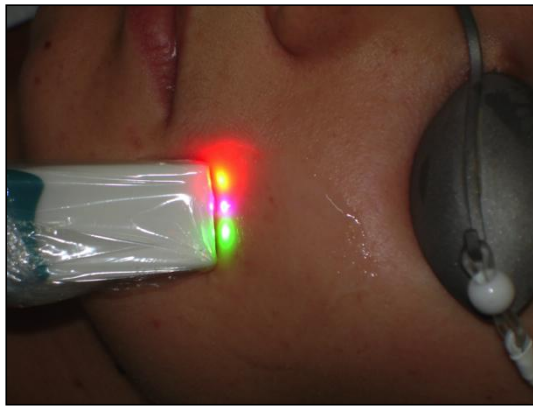


Fig. 10: Laser irradiation of the skin after application of special crème.

图 10：使用专用乳霜后光照射皮肤。

Effects of different lasers in cosmetic laser therapy

不同光在美容光疗中的作用

1. **Red laser:** Increase of cell activity and microcirculation, stimulation of the immune system.
1. **红光：** 增强细胞活性、改善微循环、刺激免疫系统。
2. **Infrared laser:** Increase of ATP production, cross-linking of hyaluronan within the skin
2. **红外光：** 增加三磷酸腺苷的生成和透明质酸在皮肤内的交联
3. **Green laser:** Binding of moisture within the skin, stimulation of mitochondria
3. **绿光：** 锁住皮肤内的水分，刺激线粒体
4. **Blue laser:** Anti-bacterial effects on impure skin, increase of circulation and tissue nutrition.
4. **蓝光：** 净化皮肤、抗菌、改善循环和增加组织营养。

General effects

一般疗效

- Vitalisation and regeneration of skin and wrinkles with additional biological effects of the different laser sources

- 皮肤和皱纹的活化与再生，配合不同光源的其他生物效应
- Cell metabolism regeneration, refreshing effect on the skin (increased degree of moisture)
- 细胞新陈代谢与再生，嫩肤的作用（增加保湿程度）
- Purification of the connecting tissue with increase of energy transport processes
- 通过增加能量传输过程来净化结缔组织
- After first treatment: considerable effects of freshness and rejuvenation
- 第一次治疗后：嫩肤和恢复活力的疗效相当显著
- After 10 treatments: verifiable sustainable effects
- 10 次治疗后：验证持久的疗效

Conclusion

结论

The combined laser therapy will lead to a cross-linking of the hyaluronan molecules (photopolymerisation). In this cross-linked structure, the hyaluronan has the same functions as body's original hyaluronan.

组合光疗会诱导透明质酸分子的交联（光聚合）。这种交联结构中，透明质酸具有与人体原始透明质酸相同的功能。

Mostly important for the optimal treatment success is the combination of all different lasers with the application of non cross-linked hyaluronan incorporated in liposomes.

实现最佳的成功治疗，最重要的是所有不同光的组合，配合脂质体中掺入非交联透明质酸的应用。

Treatment examples cosmetic laser therapy

美容光疗的治疗实例



of crow's fat

图 12：眼角脂肪的治疗

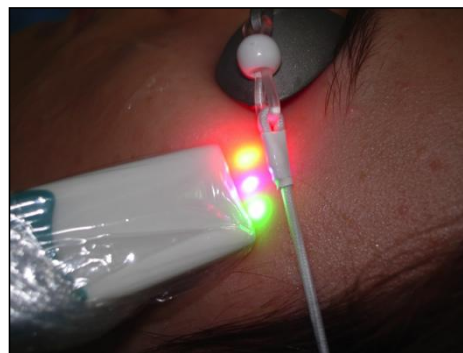


Fig. 11:
Labial
treatment

图 11:
唇部治疗

Fig.
12:
Treatment



Fig. 13: Treatment of nasolabial fold

图 13: 鼻唇沟的治疗

Literature

文献

- Ablon G.: Combination 830-nm and 633-nm Light-Emitting Diode Phototherapy Shows Promise in the Treatment of Recalcitrant Psoriasis: Preliminary Findings.
- Ablon G.: 830-nm 和 633-nm 发光二极管光组合治疗顽固性银屑病的展望: 初步研究成果。
- Goldberg DJ, Russell BA.: Combination blue (415 nm) and red (633 nm) LED phototherapy in the treatment of mild to severe acne vulgaris.
- Goldberg DJ, Russell BA.: 蓝光 (415 nm) 和红光 (633 nm) 发光二极管光组合治疗轻度至重度寻常痤疮。
- Aziz-Jalali MH, Tabaie SM, Djavidi GE.: Comparison of Red and Infrared Low-level Laser Therapy in the Treatment of Acne Vulgaris.

- Aziz-Jalali MH, Tabaie SM, Djavid GE.: 红光和红外光低强度光治疗寻常痤疮的比较。
- Sommer AP, Zhu D.: Green tea and red light-a powerful duo in skin rejuvenation.
- Sommer AP, Zhu D.: 绿茶和红光-强效嫩肤二重奏。
- Sadick NS.: A study to determine the efficacy of a novel handheld light-emitting diode device in the treatment of photoaged skin.
- Sadick NS.: 一项研究,旨在确定新型手持式发光二极管设备在光老化皮肤治疗中的功效。
- Lee SY, Park KH, Choi JW, Kwon JK, Lee DR, Shin MS, Lee JS, You CE, Park MY.: A prospective, randomized, placebo-controlled, double-blinded, and split-face clinical study on LED phototherapy for skin rejuvenation: clinical, profilometric, histologic, ultrastructural, and biochemical evaluations and comparison of three different treatment settings.
- Lee SY, Park KH, Choi JW, Kwon JK, Lee DR, Shin MS, Lee JS, You CE, Park MY.: 发光二极管光疗用于皮肤再生的前瞻性的随机、安慰剂对照、双盲和面部不同部位的临床研究: 门诊、轮廓科、组织科、超微结构和生物化学评估以及三种不同治疗背景的比较。
- Morton CA¹, Scholefield RD, Whitehurst C, Birch J.: An open study to determine the efficacy of blue light in the treatment of mild to moderate acne.
- Morton CA¹, Scholefield RD, Whitehurst C, Birch J.: 一项开放式研究,旨在确定蓝光治疗轻度至中度痤疮的疗效。
- Sami NA¹, Attia AT, Badawi AM.: Phototherapy in the treatment of acne vulgaris.
- Sami NA¹, Attia AT, Badawi AM.: 治疗寻常痤疮的光疗法。
- Lee SY¹, You CE, Park MY.: Blue and red light combination LED phototherapy for acne vulgaris in patients with skin phototype IV.
- Lee SY¹, You CE, Park MY.: 发光二极管蓝光和红光组合治疗皮肤光反应 IV 型患者的寻常痤疮。
- Sadick N.: A study to determine the effect of combination blue (415 nm) and near-infrared (830 nm) light-emitting diode (LED) therapy for moderate acne vulgaris.
- Sadick N.: 一项研究,以确定发光二极管蓝光(415 nm)和近红外光(830 nm)组合治疗中度寻常痤疮的疗效。
- Avci P¹, Gupta A, Sadasivam M, Vecchio D, Pam Z, Pam N, Hamblin MR.: Low-level laser (light) therapy (LLLT) in skin: stimulating, healing, restoring.
- Avci P¹, Gupta A, Sadasivam M, Vecchio D, Pam Z, Pam N, Hamblin MR.: 低强度光疗皮肤: 刺激、愈合、恢复。
- Neiburger EJ.: Rapid healing of gingival incisions by the helium-neon diode laser.
- Neiburger EJ.: 氦-氖二极管光快速愈合牙龈切口。

- Lyons RF, Abergel RP, White RA, Dwyer RM, Castel JC, Uitto J.: Biostimulation of wound healing in vivo by a helium-neon laser.
- Lyons RF, Abergel RP, White RA, Dwyer RM, Castel JC, Uitto J.: 氦-氖光体内生物刺激以愈合伤口。

Chapter 8: Weight loss and low-level-laser therapy

第 8 章：减肥和低强度光疗

The market for non- invasive measures of weight loss/ fat reduction is one of the fastest growing markets in aesthetic medicine. More and more costumers value the advantages of such procedures towards surgical interventions because convalescence times are shorter and significantly fewer side effects like pain or swelling occur.

减肥/减脂的无创测量市场是美容医学中发展最快的市场之一。越来越多的消费者视这种治疗的优势在于手术干预，因为康复时间短，疼痛或肿胀等副作用明显减少。

Against this background, the low-level-laser therapy presents itself as a successful non- invasive weight loss procedure. A broad range of studies shows that the girth of targeted body regions – e.g. hips, waits and upper arms – could be substantially and steadily reduced by low level laser

therapies. The therapy is thereby painless and passes off without any side-effects.

在这种背景下，低强度光疗本身就是一种成功的无创减肥治疗。广泛的研究表明，人体靶向部位的周长，例如臀部、腰部和上臂等，通过低强度光疗可以大幅度 and 稳定地减肥。而且此种治疗是无痛的，没有任何副作用。

Selected studies

精选研究

1) Nestor et al. examined the potential of low-level-laser therapy as a method for reducing upper arm circumference. They conducted a randomized double-blind study whereby healthy subjects (N=40) with a body mass index of 20 to 35 kg/m received three 20-minute low-level-laser therapies (N=20) or sham treatments (N=20) each week for two weeks.

1) Nestor 等人，研究了低强度光疗作为减少上臂围方法的可能性。他们进行了一项随机双盲研究，健康受试者（N = 40），身高体重指数为 20-35 kg/m，接受三次 20 分钟低强度光疗（N = 20）或假治疗（N = 20）每周一次，共两周。

Upper arm circumference was measured after three and six treatments and two weeks post-treatment. Primary success criterion was the proportion of subjects achieving a combined reduction in arm circumference of ≥ 1.25 cm measured at three equally spaced points in between the elbows and the shoulder. Secondary outcomes included total measurement change at each time point and subjective satisfaction ratings.

第三次和六次治疗后以及疗程后两周测量上臂围。主要成功标准是受试者获得的比例为，在肘部和肩部之间的三个等间距点测量的手臂围总体减少 ≥ 1.25 cm。次要成果包括每个时间点的总体测量变化和主观满意度评分。

After six treatments, the low-level laser therapy group showed a combined reduction in arm circumference of 3.7 cm versus 0.2 cm in the sham treatment group ($p < 0.0001$). Significantly more subjects in the low-level-laser therapy group (N=12; 60 %) achieved ≥ 1.5 cm total decrease in upper arm circumference versus sham-treated subjects (N=0; 0 %) ($p < 0.0005$). Low-level-laser therapy treatment resulted in a combined reduction in arm circumference of 2.2 cm after three treatments and 3.7 cm after six treatments (for each, $p < 0.0001$) indicating a progressive and cumulative treatment effect. Body mass index remained unchanged for all subjects. A significantly greater number of subjects in the low-level-laser therapy treatment group were satisfied with their results ($p < 0.05$), believed their upper arm appearance improved ($p < 0.0005$) and indicated the results exceeded expectations ($p < 0.05$). The treatments were painless and no adverse events were reported.

六次治疗后，低强度光疗组显示手臂围总体减少 3.7 cm 而假治疗组手臂围总体减少 0.2 cm ($p < 0.0001$)。低强度光疗组 (N = 12; 60%) 中受试者的上臂围比假治疗受试者总体显著减少 ≥ 1.5 cm (N = 0; 0%) ($p < 0.0005$)。低强度光疗导致三次治疗后手臂围总体减少 2.2cm，六次治疗后（每次 $p < 0.0001$ ）总体减少 3.7cm，表明有进行性累积的疗效。所有受试者的身高体重指数保持不变。低强度光疗组中的受试者显然获得了更多的总体减少数值，他们对疗效感到满意 (p

<0.05), 认为他们的上臂外观变美 ($p < 0.0005$) 并且表明疗效超出预期 ($p < 0.05$)。治疗无痛, 未报告不良事件。

They authors conclude that the non-invasive low-level-laser therapy is safe, painless and effective in reducing upper arm circumference and is associated with a high degree of subject satisfaction.

作者得出结论, 无创低强度光疗在减少上臂围的过程中是安全、无痛和有效的, 并且相关受试者满意度高。

2) Nestor et al. followed up on their initial study in order to examine the long-term efficacy of low-level-laser therapy on reducing upper arm circumference. In a multicenter trial, a total number of 62 probands received either three 20- minute low-level-laser therapies ($N=31$) or a placebo treatment ($N=31$) each week for two weeks. The effect was first measured after three treatments, then again after six treatments, then again two weeks post- treatment. To measure the long-term efficacy, follow up measurements were conducted five to ten months after the treatments. The results show that 58 % of the probands achieved study success criteria, defined as a combined reduction in arm circumference of 1.25 cm measured at 3 equally spaced points between the elbow and shoulder. In comparison, only 3 % of the probands of the placebo group achieved this success. The average combined change in arm circumference for the laser treatment group was 2.01 cm after 3 LLLT treatments and 3.70 cm after 6 treatments, compared to 0.11 and 0.31 cm for the placebo group. The long-term efficacy for a subgroup of 33 probands was at average measured after 7,6 months. The group that had actually received a laser treatment had at that point still lost 3.25 cm arm circumference, the placebo group only 0.15 cm.

2) Nestor 等人, 随后进行初步研究, 以检查低强度光疗对减少上臂围的长期疗效。在一项多中心试验中, 总共 62 名先证者, 每周接受三次 20 分钟低强度光疗 ($N = 31$) 或安慰剂治疗 ($N = 31$), 持续两周。首先三次治疗后测量疗效, 然后六次治疗后再次测量以及在整个疗程结束后两周再次测量疗效。为了测量长期的疗效, 在整个疗程完成后 5 至 10 个月进行随访测量。结果显示, 58% 的先证者达到了研究成功标准(定义是在肘部和肩部之间的 3 个等间距点测量的上臂围总体减少 1.25 cm)。相比之下, 安慰剂组中只有 3% 的先证者达到了这一成功标准。在三和六次低强度光疗后, 光疗组的上臂围平均总体减少为 2.01cm 和 3.70cm。而安慰剂组在三和六次治疗后上臂围平均总体减少为 0.11 和 0.31cm。在 6 和 7 个月, 对 33 名先证者亚组的长期疗效进行了平均测量。实际接受光疗的组在此时上臂围平均总体仍然减少了 3.25 cm, 安慰剂组只减少了 0.15 cm。The results therefore show that LLLT has long-term, if not permanent, effects on fat reduction and body contouring. Furthermore, blinded subjective assessments revealed significantly greater satisfaction of the laser treated group. No side-effects occurred.

因此, 结果表明低强度光疗对减肥和瘦身具有长期或永久性疗效。此外, 盲法主观评估显示光疗组的满意度显著提高。没有副作用。

3) In another study, Caruso- Davis et al. could show that low-level-laser therapy as a non-invasive body countering method could lead to a cumulative girth loss of 2,15 cm after eight 30- minute treatments over four weeks.

3) 在另一项研究中, Caruso-Davis 等人证明, 在 4 周内八次 30 分钟治疗后, 作为无创人体对抗法的低强度光疗可诱导累积周长减少 2.15 cm。

In the same study, the authors also examined which of the following mechanisms that are induced by irradiation are actually responsible for the measured results: (1) Laser activation of the complement cascade, (2) laser-induced adipocyte death, or (3) laser-induced increased triglyceride release or lipolysis from adipocytes. Therefore, human adipose-derived stem cells were plated and differentiated to form adipocytes. In the first experiment, results showed that serum complement lysed fat cells in both irradiated and non-irradiated adipocytes. It was thus shown that LLLT does not activate the complement cascade to induce fat loss from adipocytes. In another experiment, the research team found that irradiation with LLLT does not kill adipocytes, as in both irradiated and non-irradiated groups, the adipocytes maintained intact metabolic functions and the number of viable cells, as measured by the propidium iodide assay, remained the same. Furthermore, calcein levels, a dye injected into both groups, were lower in the laser-treated group, suggesting reduction of cell-trapped calcein due to leakage. Finally, results of the last experiment showed that irradiation with LLLT increased triglyceride release, but not lipolysis from adipocytes.

在同一项研究中, 作者还考察到以下各项光照射诱导的机制, 实际上对测量结果均产生了疗效: (1) 光激活补体级联, (2) 光诱导脂肪细胞死亡, 或 (3) 光诱导脂肪细胞增加甘油三酯释放或脂肪分解。因此, 将人脂肪源干细胞接种并分化以形成脂肪细胞。在第一项实验中, 结果显示, 在照射和未照射的脂肪细胞中, 血清补体溶解脂肪细胞。因此可见, 低强度光疗未激活补体级联以诱导脂肪从脂肪细胞中减少。在另一项实验中, 研究小组发现用低强度光照射未杀死脂肪细胞, 因为在照射和未照射组中, 脂肪细胞保持完整的代谢功能, 且通过碘化丙啶测定法测量的活细胞数仍然相同。此外, 注射到两组中的染料钙黄绿素水平在光疗组中较低, 表明由于渗漏导致细胞捕获的钙黄绿素减少。最后一次实验的结果显示低强度光照射增加了甘油三酯释放, 但未增加脂肪细胞的脂肪分解。

The results from these three in-vitro experiments verify the theory that LLLT creates pores in adipocytes through which fat leaks into the interstitial space without inducing cell lysis and further confirms the ability of low-level-laser therapy to influence fat loss.

这三个体外实验的结果验证了这项理论, 低强度光疗在脂肪细胞中产生微孔, 脂肪通过该孔渗入细胞间隙, 不诱导细胞裂解, 并进一步证实了低强度光疗具有很好的减肥疗效。

4) Further studies (Neira et al., Jackson et al.) showed that the usage of low-level-laser therapy can be of advantage if liposuction measures are undertaken. It was examined that bigger volume of fat could be extracted if patients received low-level-laser therapies in addition to their liposuction.

4) 进一步研究 (Neira 等人和 Jackson 等人) 表明, 如果采取吸脂措施, 低强度光疗很有利。据检查, 如果患者除吸脂外还接受低强度光疗, 可以抽出更大量的脂肪。

For all these studies it has to be considered that results are based on the usage of four low-level-lasers. Nowadays it is possible to simultaneously employ up to 12 lasers, in near future even 16. Accordingly, even better results can be expected in the future.

必须考虑所有这些研究, 其结果是基于四种低强度光的使用。如今, 有可能同时使用多达 12 种光, 在不久的将来甚至 16 种光。因此, 可以预期未来的疗效会更好。

Furthermore, all studies have been conducted with external low level laser therapies. With appropriate equipment, it is also possible to conduct interstitial LLTs. This is another factor that raises hope for even better results in the future.

此外, 所有研究都采用体外低强度光疗进行。使用适当的设备, 也可以进行间质低强度光疗。这是另一项因素, 为未来更好的疗效燃起希望之火。

Treatments are usually conducted with red lasers of wavelengths between 635 nm and 680 nm.

通常用波长在 635nm 和 680nm 之间的红光进行治疗。

Future studies shall on the one hand contribute to identify ideal treatment protocols and on the other hand shed further light on the cellular and systemic mechanisms that underlie the measured results.

未来的研究应该一方面有助于确定理想的治疗方案, 另一方面光可以进一步照射作为测量疗效基础的细胞机制和各系统机制。

Literature

文献

- Caruso-Davis MK, Guillot TS, Podichetty VK, et al. Efficacy of low-level laser therapy for body contouring and spot fat reduction. *Obes Surg.* 2011;21:722-729
- Caruso-Davis MK, Guillot TS, Podichetty VK 等人, 低强度光疗对瘦身和定位减肥的功效。《肥胖症外科》期刊 2011 年; 21 卷: 722-729 页
- Jackson RF, Dedo DD, Roche GC, et al. Low-level laser therapy as a non-invasive approach for body contouring: A randomized, controlled study. *Lasers Surg Med.* 2009;41:799-809
- Jackson RF, Dedo DD, Roche GC 等人, 作为无创瘦身法的低强度光疗: 一项随机对照研究。《光外科》2009 年; 41 卷: 799-809 页
- Neira R, Solarte E, Reyes MA, et al. Low level assisted lipoplasty: A new technique: In proceedings of the World Congress on Liposuction, October 13-15, 2000, Dearborn, Michigan

- Neira R, Solarte E, Reyes MA 等人, 低强度光疗辅助瘦身: 一项新技术: 2000 年 10 月 13 日至 15 日世界吸脂瘦身大会的会议录, 密歇根州迪尔伯恩
- Nestor MS, Zarraga MB, Park H. Effect of 635nm low-level laser therapy on upper arm circumference reduction: A double-blind, randomized, sham-controlled trial.
- Nestor MS, Zarraga MB, Park H., 635nm 低强度光疗对上臂围塑形的疗效: 一项双盲、随机、假对照试验。
- J Clin Aesthet Dermatol. 2012;5:42-48.
- 《临床美容皮肤科》期刊 2012 年; 5 卷: 42-48 页。
- Nestor MS et al.: Body Contouring Using 635-nm Low Level Laser Therapy. In: Seminars in Cutaneous Medicine and Surgery.1085-5629/13
- Nestor MS 等人: 用 635-nm 低强度光疗瘦身。《皮肤病科与外科研讨会》, 1085-5629 卷 / 13 期
- 40. Nestor MS, Zarraga MB, Park H, et al. Efficacy of low-level laser therapy for upper arm circumference reduction: Final results of a multicenter double-blind, randomized, sham-controlled trial with long-term follow-up. Dermatol Surg. (in press)
- 40.Nestor MS, Zarraga MB, Park H 等人, 低强度光疗对上臂围塑形的疗效: 多中心双盲、随机、假对照试验的最终成果以及长期随访。《皮肤外科学》(出版)

Chapter 9: Stem cell therapy and low- level- laser therapy

第 9 章: 干细胞疗法和低强度光疗

9.1 Basic knowledge stem cells

9.1 干细胞基础知识

Stem cells are undifferentiated biological cells that can differentiate into specialized cells and can divide (through mitosis) to produce more stem cells. They are found in multicellular organisms.

干细胞是未分化的生物细胞, 可以分化成特化细胞或分裂(通过有丝分裂)成更多的干细胞。它们存在于多细胞生物中。

In mammals, there are two broad types of stem cells: embryonic stem cells, which are isolated from the inner cell mass of blastocysts, and adult stem cells, which are found in various tissues. In adult organisms, stem cells and progenitor cells act as a repair system for the body, replenishing adult tissues. In a developing embryo, stem cells can differentiate into all the specialized cells—ectoderm, endoderm and mesoderm- but also maintain the normal turnover of regenerative organs, such as blood, skin, or intestinal tissues.

哺乳动物中，广泛存在两种类型的干细胞：胚胎干细胞，其从囊胚的内细胞团中分离；成体干细胞，其存在于各种组织中。在成体生物中，干细胞和祖细胞充当身体的修复系统，补充成体组织。发育的胚胎中，干细胞可以分化成所有特化细胞 - 外胚层、内胚层和中胚层 - 也可以维持再生器官的正常更新，例如血液、皮肤或肠组织等。

There are three accessible sources of autologous adult stem cells in humans:
人类有三种可获得的自体成体干细胞来源：

1. Bone marrow, which requires extraction by harvesting, that is, drilling into bone (typically the femur or iliac crest),
1.骨髓，需要通过采集进行抽取，譬如钻入骨骼（通常是股骨或髂嵴），
2. Adipose tissue (lipid cells), which requires extraction by liposuction, and
2.脂肪组织（脂质细胞），需要通过吸脂术抽取，和
3. Blood, which requires extraction through apheresis, wherein blood is drawn from the donor (similar to a blood donation), and passed through a machine that extracts the stem cells and returns other portions of the blood to the donor.
3.血液，需要通过血液分离术抽取，譬如，血液从供体抽取（类似于献血），并通过机器提取干细胞并将血液的其他部分返回给供体。

Stem cells can also be taken from umbilical cord blood just after birth. Of all stem cell types, autologous harvesting involves the least risk. By definition, autologous cells are obtained from one's own body, just as one may bank his or her own blood for elective surgical procedures.

干细胞也可以从刚出生后的脐带血中抽出。在所有干细胞类型中，自体采集的风险最小。根据定义，自体细胞是从自己的身体获得的，就像人们可以为选择外科手术而储存自己的血液一样。

Adult stem cells are frequently used in medical therapies, for example in bone marrow transplantation. Stem cells can now be artificially grown and transformed (differentiated) into specialized cell types with characteristics consistent with cells of various tissues such as muscles or nerves.

成体干细胞经常用于医学治疗，例如用于骨髓移植。干细胞现在可以人工培养并转化（分化）成特定的细胞类型，其特征与各种组织如肌肉或神经组织的细胞一致。

In this context, Stem cell therapy is defined as the use of stem cells to treat or prevent a disease or condition.

由此可见，干细胞疗法被定义为使用干细胞来治疗或预防疾病或病症。

9.2 History of stem cell research

9.2 干细胞研究的历史

Though there was some evidence of stem cells or ‘special cells’ able to produce other cells as early as the late 1800s, the history of stem cell therapy begins in 1961 with the first published study (published by Dr. James Till and Ernest McCulloch) that accidentally identified cells that are able to renew indefinitely for a variety of uses. The existence of stem cells was thereby proved.

虽然早在 19 世纪末就有一些干细胞或“特定细胞”能够产生其他细胞的证据，但干细胞治疗的历史始于 1961 年，首次发表的研究（James Till 博士和 Ernest McCulloch 博士）偶然发现能够无限期更新用于各种用途的细胞。由此证明了干细胞的存在。

It then took some time until the next important step was taken. In 1996, the first cloning of a mammal took place: Dolly the sheep was born.

然后过了一段时间采取了下一个重要步骤。1996 年，第一次克隆哺乳动物：羊多莉诞生了。

In 1998, University of Wisconsin scientist James Thomson was able to isolate human embryonic stem cells and thereby showed their potential to rejuvenate and to specialize into tissues. This discovery also initiated the ethical debate on human embryonic stem cell research because his team derived the stem cells through a process that destroyed human embryos.

1998 年，威斯康星大学的科学家 James Thomson 能够分离出人类胚胎干细胞，进而显示出它们恢复活力和专门化组织的潜力。这一发现也开启了关于人类胚胎干细胞研究的伦理争议，因为他的研究团队通过破坏人类胚胎的过程来获得干细胞。

In 2000, retinal stem cells were identified in mice.

2000 年，从小鼠体内发现视网膜干细胞。

In 2001, the first collaborative stem cell research network - the Stem Cell Network - was formed in Canada. Furthermore, dermal stem cells were identified in adult skin tissue.

2001 年，第一个干细胞合作研究网络 - 干细胞网 - 在加拿大成立。此外，在成人表皮组织中发现了真皮干细胞。

In 2002, the first complete purification from mice of multi-potent marrow stem cells capable as single injected cells of extended marrow regeneration was achieved in vivo. Also, the International Society for Stem Cell Research

was formed and the International Stem Cell Forum (ISCF) was created to encourage international collaboration with the overall aim of promoting global good practices and accelerating progress in biomedical science.

2002 年，在 小鼠体内实现了多能骨髓干细胞第一次完全纯化，能够作为扩大骨髓再生的单程造血细胞。此外，国际干细胞研究学会成立，国际干细胞论坛创建是为了鼓励国际合作，总体目标是促进全球良好实践和加速生物医学的进步。

In 2003, cancer stem cells could be isolated in human brain tumours and rare human breast cancer stem cells were identified.

2003 年，癌症干细胞可以从人脑肿瘤中分离出来，并识别出罕见的人乳腺癌干细胞。

In 2004, the first derivation of dopaminergic cells from human embryonic stem cells was isolated and raised new hope for Parkinson's disease treatment (USA). Furthermore, the International Consortium of Stem Cell Networks (ICSCN) was initiated, which aims to unify international efforts to make stem cell therapy a reality for a broad range of debilitating diseases.

2004 年，人类胚胎干细胞中首次衍生的多巴胺能细胞被分离，为帕金森病治疗燃起了希望之火（美国）。此外，国际干细胞网络联盟启动，旨在国际一致努力，使干细胞疗法实现广大衰弱性疾病痊愈的梦想。

In 2005, the first evidence for human bone cancer stem cells was provided. James Till and Ernest McCulloch won the Lasker Prize for their experiments that first identified stem cells and set the stage for all current research on adult and embryonic stem cells.

2005 年，提供了人类骨癌干细胞的第一例证据。James Till 和 Ernest McCulloch 荣获拉斯克奖，因其实验首次发现干细胞并为目前所有成人和胚胎干细胞的研究奠定了基础。

In 2006, normal mammary stem cells could be demonstrated in adult mice. Also, the first induced pluripotent stem cells (iPS) could be generated by reprogramming adult mouse skin cells. The altered iPS cells have characteristics similar to embryonic stem cells (Japan)

2006 年，正常的乳腺干细胞可以在成年小鼠上得到证实。此外，通过成年小鼠表皮细胞的重编程产生出首例诱导的多能干细胞。改变的诱导的多能干细胞具有与胚胎干细胞相似的特征（日本）

In 2007, Mario Capecchi, Martin Evans and Oliver Smithies won the Nobel Prize for Physiology for Medicine for discoveries enabling germline gene modification in mice. Besides, the first physical identification and localization of mammalian intestinal stem cells was achieved. Moreover, first evidence for human colon cancer stem cells adduced.

2007 年，Mario Capecchi, Martin Evans 和 Oliver Smithies 荣获了诺贝尔医学奖，因为其发现了在小鼠体内能够进行种系基因修正。此外，首次实现了哺乳动物肠干细胞的生理标记和定位。此外，引证人类结肠癌干细胞的第一例证据。

In 2008, Sam Weiss was awarded the Gairdner Prize for the discovery of neural stem cells.

2008 年，Sam Weiss 因发现神经干细胞而被授予盖尔德纳奖。

In 2009, John Gurdon and Shinya Yamanaka won the Lasker Prize for their discoveries in nuclear reprogramming. Yamanaka is also awarded the Gairdner Prize. Moreover, iPS cells with minimal residual genomic alteration could be created.

2009 年, John Gurdon 和 Shinya Yamanaka 因发现细胞核重编程而荣获拉斯克奖。Yamanaka 还获得了盖尔德纳奖。因为生成了最小残留基因组改变的诱导多能干细胞。

In 2010, adult cells could be reprogrammed directly to neurons, cardiac muscle and blood cells for the first time. Besides, iPS cells were created by transfection of mRNA and a first clinical trial of human embryonic-derived stem cells for treatment of spinal cord injury was conducted.

2010 年, 成人细胞首次直接重新编程为神经元、心肌和血细胞。此外, 通过信使核糖核酸的基因转染产生诱导多能干细胞, 并完成了用人胚胎源干细胞治疗脊髓损伤的首例临床试验。

In 2011, multipotent human blood stem cells capable of forming all cells in the blood system could be isolated.

2011 年, 在血液系统中多能人血干细胞能形成所有种类的细胞。

In 2012, John Gurdon and Shinya Yamanaka won the Nobel Prize in Physiology or Medicine for the discovery that mature cells can be reprogrammed to become pluripotent. Aside from that, chinese scientists from the Guangzhou Institutes of Biomedicine and Health have converted cells found in urine into pluripotent stem cells that can be used to create neurons and brain cells. The researchers say the find holds huge potential for the rapid testing and development of new treatments for neuro-degenerative disorders.

2012 年, John Gurdon 和 Shinya Yamanaka 荣获了诺贝尔生理学 and 医学奖, 因为他们发现了成熟细胞可以重新编程成为多能干细胞。除此之外, 广州生物医药与健康研究院的中国科学家将尿液中的细胞转化为多能干细胞, 用于制造神经元和脑细胞。研究人员表示, 对快速试验和研发用于神经退行性疾病的新疗法, 该发现拥有巨大的潜力。

In 2013, scientists recovered stem cells from cloned human embryos, a longstanding goal that could lead to new treatments for such illnesses as Parkinson's disease and diabetes, using somatic nuclear transfer, or SCNT. Also, scientists in Japan said they had grown human liver tissue from stem cells in a first that holds promise for alleviating the critical shortage of donor organs.

2013 年, 科学家们用克隆的人类胚胎病愈了干细胞, 这是一项长期目标, 通过躯体细胞核移植为帕金森病和糖尿病等疾病带来新疗法。此外, 日本科学家表示, 他们首次用干细胞培养出人类肝脏组织, 这有望缓解供体器官的严重短缺。

9.3 Criteria for clinical applications of stem cells

9.3 干细胞临床应用的标准

Both for embryonic and adult stem cells, the following criteria need to be respected with regard to clinical applications of stem cells:

对于胚胎干细胞和成体干细胞，干细胞的临床应用需要遵守以下标准：

Proliferation: Stem cells need to be reproducible in adequate quantity.

增殖：干细胞需要具有足够的可繁殖性。

Differentiability: Stem cells need to have the potential to differentiate in the respectively required type of cell.

可辨性：干细胞需要具有在各自所需的细胞类型中分化的潜力。

Purity: The differentiation process needs to be controllable: cells of one and the same kind have to be producible.

纯度：分化过程应该可控：必须生成同一种类的细胞。

Pinpoint integratability: The cell/ tissue replacements must be transplantable to the target part of the body.

精确定位：细胞/组织替代物必须可移植到身体的靶向部位。

Immunity of tumour development: It has to be assured that transplants don't grow in an uncontrolled manner and thus induce tumour growth.

肿瘤生长的免疫力：必须确保移植物以可控方式发育，以免诱导肿瘤生长。

Long term therapeutic effectiveness: The transplants need to prove their functionality and therapeutic effect in the long term.

长期疗效：移植物需要长期验证其功能和疗效。

Immune compatibility: The transplants must be compatible to the immune system of the acceptor.

免疫相容性：移植物必须与受体的免疫系统相容。

9.4 The role of Low- Level- Laser Therapy

9.4 低强度光疗的作用

Against this background, the connection between stem cell therapy and low level laser therapy stems from the potential of the latter to stimulate various parts of cells.

在此背景下，干细胞疗法与低强度光疗之间的联系源于后者刺激各部分细胞的潜力。

Current studies that have been conducted on mice and rats indicate that low-level-laser therapy can contribute to improve the proliferation, differentiability and survival chances of stem cells. These results cannot be transferred to humans without reservations because differentiation mechanisms in embryonic mice stem cells are guided by different growth factors than differentiation mechanisms in human stem cells. They are nevertheless very promising and caused the formation of several research institutes that work on the cut surface of stem cell therapy and low-level-laser therapy.

目前对小鼠和大鼠进行的研究表明，低强度光疗有助于改善干细胞的增殖、分化和存活机会。这些效应不能毫无保留地转移给人类，因为小鼠胚胎干细胞中的分化机制由不同的生长因子诱导，而非人干细胞中的分化机制。因为前途无量，所以成立了几个研究机构，致力于干细胞治疗和低强度光疗的剖析与应用。

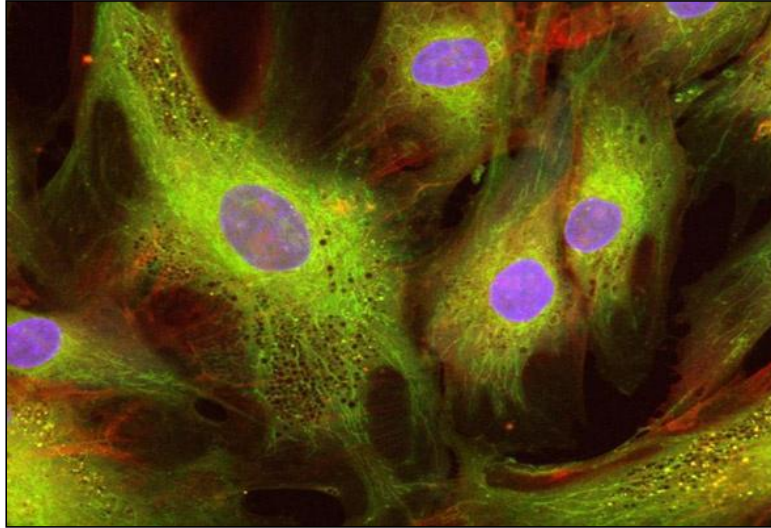


Fig. 1: Stem cells

图 1：干细胞

9.5 Selection of studies

9.5 研究精选

1) A study from Barboza et al. (Barboza et al.: 2014) could prove that low-level laser irradiation stimulated the proliferation of mouse mesenchymal stem cells without causing nuclear alterations.

1) Barboza 等人的一项研究（Barboza 等人：2014 年）证明低强度光照射刺激小鼠间充质干细胞的增殖而不诱导细胞核改变。

The research team thereby used the following methods: Mesenchymal stem cells derived from bone marrow and adipose tissue were submitted to two applications (T0 and T48 hours) of low-level laser irradiation (660nm; doses of 0.5 and 1.0J/cm²). The trypan blue assay was used to evaluate cell viability, and growth curves were used to analyze proliferation at zero, 24, 48, and 72 hours. Nuclear alterations were evaluated by staining with DAPI (4'-6-diamidino-2-phenylindole) at 72 hours.

因此研究小组使用了以下方法：来自骨髓和脂肪组织的间充质干细胞用低强度光照射（660nm，剂量 0.5 和 1.0J/cm²）两次（T0 和 T48 小时）。用台盼蓝试验评估细胞活力，用生长曲线分析在 0、24、48 和 72 小时的增殖。在 72 小时用 DAPI（4'-6-二脒基-2-苯基吲哚）染色来评估细胞核变化。

The results were: Bone marrow-derived mesenchymal stem cells responded to laser therapy in a dose-dependent manner. Higher cell growth was observed when the cells were irradiated with a dose of 1.0J/cm², especially after 24 hours ($p < 0.01$). Adipose-derived mesenchymal stem cells responded better to a dose of 1.0J/cm², but higher cell proliferation was observed after 48 hours ($p < 0.05$) and 72 hours ($p < 0.01$). Neither nuclear alterations nor a significant change in cell viability was detected in the studied groups.

结果是：骨髓源的间充质干细胞以剂量依赖性方式对光疗起反应。当用 1.0J/cm² 剂量照射细胞时，可见更快的细胞生长，特别是 24 小时后（ $p < 0.01$ ）。脂肪源的间充质干细胞对 1.0J/cm² 剂量反应更好，而且在 48 小时（ $p < 0.05$ ）和 72 小时（ $p < 0.01$ ）后可见更快的细胞增殖。在研究组中未测试到细胞核改变或细胞活力的显著变化。

They conclude that the biostimulation of mesenchymal stem cells using laser therapy might thus be an important tool for regenerative therapy and tissue engineering.

他们得出结论，用光疗法对间充质干细胞进行生物刺激可能成为再生疗法和组织工程的重要工具。

2) Choi et al. (2013) investigated the feasibility of using an adipose-derived mesenchymal stem cell (ASC)-seeded acellular dermal matrix (ADM) along with low-level laser therapy (LLLT) to repair bone defect in athymic nude mice.

2) Choi 等人（2013 年）研究了用脂肪源间充质干细胞-接种的脱细胞真皮基质，配合低强度光疗修复无胸腺裸鼠的骨缺损的可行性。

Critical-sized calvarial defects were treated either with ADM, ADM/LLLT, ADM/ASCs, or ADM/ASCs/LLLT. In micro-computed tomography scans, the ADM/ASCs and the ADM/ASCs/LLLT groups showed remarkable bone formation after 14 days. Additionally, bone regeneration in the ADM/ASCs/LLLT group was obvious at 28 days, but in the ADM/ASCs group at 56 days. Bone mineral density and bone tissue volume in the ADM/ASCs/LLLT group significantly increased after 7 days, but in the ADM/ASCs group after 14 days. Histological analysis revealed that the defects were repaired in the ADM/ASCs and the ADM/ASCs/LLLT group, while the defects in the ADM and the ADM/LLLT groups exhibited few bone islands at 28 and 56 days. The successful seeding of ASCs onto ADM was confirmed, and LLLT enhanced the proliferation and the survival of ASCs at 14 days.

用脱细胞真皮基质（ADM）、脱细胞真皮基质/低强度光疗（ADM/LLLT）、脱细胞真皮基质/脂肪源间充质干细胞（ADM/ASCs）或脱细胞真皮基质/脂肪源间充质干细胞/低强度光疗（ADM/ASCs/LLLT）用于治疗重度颅骨缺损。微型计算机断层扫描中，ADM/ASCs 组和 ADM/ASCs/LLLT 组，在 14 天后显示出非凡的骨形成。此外，ADM/ASCs/LLLT 组的骨再生在第 28 天十分明显，但 ADM/ASCs 组中在 56 天才十分明显。ADM/ASCs/LLLT 组的骨密度和骨组织容量在 7 天后显著增加，但 ADM/ASCs 组在 14 天后才显著增加。组织学分析显示，ADM/ASCs

组和 ADM/ASCs/LLLT 组均能修复缺损，而 ADM 组和 ADM/LLLT 组的缺损在第 28 天和第 56 天罕见骨岛。证实了在第 14 天脂肪源间充质干细胞成功接种到脱细胞真皮基质上，低强度光疗增强了脂肪源间充质干细胞的增殖和存活。

The results indicate that ASC-seeded grafts promote bone regeneration, and the application of LLLT on ASC-seeded ADM results in rapid bone formation. The implantation of an ASC-seeded ADM combined with LLLT may thus be used effectively for bone regeneration.

结果表明，脂肪源间充质干细胞接种的移植物促进骨再生，低强度光疗照射脂肪源间充质干细胞接种的脱细胞真皮基质，诱导骨快速形成。因此，脂肪源间充质干细胞接种的脱细胞真皮基质的移植，配合低强度光疗，对骨再生很有效。

3) In another recent study, Tuby et al. (2013) investigated the hypothesis that photo- biostimulation by low-energy laser therapy (LLLT) applied to the bone marrow (BM) of myocardial infarcted rats may attenuate the scarring processes that follow myocardial infarction (MI). Wistar rats underwent experimental MI. LLLT (Ga-Al-As diode laser) was applied to the BM of the exposed tibia at different time intervals post-MI (4 hrs, 48 hrs and 5 days). Sham-operated infarcted rats served as control. Infarct size was significantly reduced (55%) in the laser-treated rats as compared to the control non-treated rats, at 2 weeks post-MI. A significant 3-fold increase was observed in the density of desmin immunopositive stained cells 14 days post-MI in the infarcted area of the laser-treated rats as compared to the non-laser-treated controls. The electron microscopy from the control infarcted rat hearts revealed a typical interphase area between the intact myocardium and the infarcted area, with conspicuous fibroblasts with collagen deposition dispersed among them. In rats that were laser treated (to BM), the interphase zone demonstrated cells with different intracellular structures. There was also a significant increase in the percentage of c-kit positive cells and macrophages in the circulating blood of the laser treated rats as compared to control non treated ones. In the majority of the cells clusters of myofibrils anchored to well-developed Z-lines and structures resembling the morphological characteristics of mature intact cardiomyocytes were evident.

3) 在最近的另一项研究中，Tuby 等人（2013 年）研究了这样的假设，低功率光疗对心肌梗塞大鼠的骨髓进行光生物刺激，以削弱心肌梗死后的瘢痕形成。威斯塔大鼠接受了实验性的心肌梗死。低强度光疗（砷化镓铝二极管光）以不同时间间隔（4 小时、48 小时和 5 天）照射胫骨的骨髓。假手术的心肌梗死大鼠作为对照。心肌梗塞后 2 周，与未治疗的对照大鼠相比，光疗大鼠的梗塞面积显著减少（55%）。与未经光疗的对照组相比，在光疗大鼠的梗塞面积中，心肌梗塞后 14 天可见结蛋白免疫阳性染色细胞的密度显著增加了 3 倍。电子显微镜显示对照梗塞大鼠心脏的完整心肌和梗塞区域之间典型细胞间期区域，其中分散有胶原沉积的显著成纤维细胞。在光疗（对骨髓）的大鼠中，细胞间期区域显示具有不同细胞内结构的细胞。与对照未治疗的大鼠相比，光疗大鼠的循环血液中干细胞因子阳性细胞和巨噬细胞的百分比也显著增加。在大多数细胞中可见，肌原纤维

簇锚定于发育良好的 Z-细胞系，并且结构类似于成熟的完整心肌细胞的形态特征。

In conclusion, LLLT to the BM of rats post- MI induces cardiogenesis mainly at the borders of the infarcted area in the heart.

总之，对心肌梗死后大鼠的骨髓进行低强度光疗，主要在心脏梗塞区域的边界诱导心脏发育。

4) Already in 2004, Gasparyan et al. found out that the long term effects of low-level-laser therapy can involve treatment mechanisms connected with activation of stem cells.

4) 早在 2004 年，Gasparyan 等人研究发现，低强度光疗的长期疗效可能涉及与干细胞活化相关的治疗机制。

In their study, migration of stem cells was tested under the influence of laser light alone as well as in case of combined influence of light and stromal cell-derived factor-1a (SDF-1a). This cytokine plays a role in lymphocyte trafficking, hematopoietic progenitor cell and stem cell homing.

在研究中，测试到干细胞的迁移仅在光的影响下以及在光和基质细胞源因子-1a 组合的影响下进行。该细胞因子在淋巴细胞运输、造血祖细胞和干细胞归巢中起作用。

To investigate the light influence on stem cells, they analyzed factor-dependent cell-Patersen (FDCP)-mix multipotent progenitor cells.

为了研究光对干细胞的影响，他们分析了因子依赖性细胞-帕特森-混合多能祖细胞。

Migration of the stem cell line was tested using Transwell system (Corning, NY) under influence of red diode laser (659.6 nm, 19.5 mW) or infrared diode laser (958 nm, 36 mW) during 15 min at continuous wave, as well as in case of applying 150 ng/ml SDF-1a.

在二极管红光（659.6nm，19.5mW）或二极管红外光（958nm，36mW）照射和施用 150ng/ml 基质细胞源因子-1a 的情况下，使用 Transwell 系统（纽约科宁），在 15 分钟连续波内测试干细胞系的迁移。

Group 1 cells were a group of negative control, group 2 cells received only red light irradiation, while group 3 cells had IR light irradiation. Group 4 cells were treated with 150 ng/ml SDF-1a. Group 5 cells were irradiated with red laser light in addition to 150 ng/ml SDF-1a, and group 6 cells by IR light and 150 ng/ml SDF-1a.

第 1 组细胞为阴性对照组，第 2 组细胞仅接受红光照射，第 3 组细胞接受红外光照射。第 4 组细胞用 150ng/ml 基质细胞源因子-1a 治疗。第 5 组细胞除了 150ng/ml 基质细胞源因子-1a 治疗外，还用红光照射。第 6 组细胞用红外光照射和 150ng/ml 基质细胞源因子-1a 治疗。

The count of migrated cells was $1496,5 \pm 409$ (100%) in case of negative control. Red and IR laser light increased migration activity of stem cells up to 1892 ± 283 (126%) and $2255,5 \pm 510$ (151%) accordingly. Influence of SDF-1a was more significant, than effects of light irradiation alone $3365,5 \pm 489$ (225%). Combined effects of light irradiation and SDF-1a were significantly stronger

5813±1199 (388%) and for SDF-1a and red laser light, and 6391.5±540 (427%) for SDF-1a and IR laser light irradiation.

在阴性对照的情况下，迁移细胞计数为 1496.5±409 (100%)。红光和红外光使干细胞的迁移活性分别增加至 1892±283 (126%) 和 2255.5±510 (151%)。150ng/ml 基质细胞源因子-1a 的影响比单独光照射显著，迁移细胞计数为 3365.5±489 (225%)。对于红光或红外光照射和基质细胞源因子-1a 的组合效应显著增加，迁移细胞计数分别为 5813±1199 (388%) 和 6391.5±540 (427%)。

The study results proved that laser light irradiation can activate stem cell migration in vitro. The results are more reliable in the case of combined application of light and SDF-1a. The authors concluded that these results are giving ground to consider that stem cell reactions on light irradiation can be one of the factors of light therapy.

研究结果证明，光照射可以激活体外干细胞迁移。光和基质细胞源因子-1a 的组合，疗效更可靠。作者得出结论是，这些成果使人们有理由相信光照射下的干细胞反应是光疗的效应之一。

9.6 Practical application of stem cells and laser therapy

9.6 干细胞和光疗的实际应用

The stem cells used in clinical practice are usually extracted from fat tissue. Due to ethical issues, embryonic stem cells are not used.

临床实践中使用的干细胞通常从脂肪组织中抽取。由于伦理问题，不使用胚胎干细胞。

Practical procedures consist of four main steps: At first, mesenchymal stem cells are extracted from the fat tissue of the patient. They are then taken to a special lab in which they are treated and proliferated. After this 2- week phase the reinjection of the stem cells takes place. Right after that, they are irradiated with laser light to improve their survival chances and their potential to proliferate further.

实际治疗主要包括四个步骤：首先，从患者的脂肪组织中抽取间充质干细胞。然后放置到专用培养器中被治疗和增殖。2 周后，这些干细胞以再注射的形式归巢。在此之后，用光照射以提高这些干细胞的生存机会和进一步增殖的潜力。

In summary, low-level-laser therapy can play an important role in future stem cell therapy. Though, the field is relatively young and a lot of basic research has to be conducted.

总之，低强度光疗在未来的干细胞疗法中会发挥重要的作用。尽管该领域相对年轻，必须进行大量的基础研究。



Literature

文献

- Barboza, C.A./ Ginani, F./ Soares, D.M./ Henriques, A.C./ Freitas, R. (2014): Low-level laser irradiation induces in vitro proliferation of mesenchymal stem cells. In: Einstein (Sao Paulo) 2014 Mar;12(1):75-81.
- Barboza, C.A., Ginani, F., Soares, D.M., D.M./ Henriques, A.C./ Freitas, R. (2014 年): 低强度光照射诱导间充质干细胞的体外增殖。《爱因斯坦》(圣保罗) 2014 年 3 月; 12 卷 (1 期): 75-81 页。
- Choi K1, Kang BJ, Kim H, Lee S, Bae S, Kweon OK, Kim WH. (2013): Low-level laser therapy promotes the osteogenic potential of adipose-derived mesenchymal stem cells seeded on an acellular dermal matrix. In: J Biomed Mater Res B Appl Biomater. 2013 Aug;101(6):919-28. doi: 10.1002/jbm.b.32897. Epub 2013 Mar 26.
- Choi K1, Kang BJ, Kim H, Lee S, Bae S, Kweon OK, Kim WH (2013 年): 低强度光疗促进脂质源间充质干细胞接种在脱细胞真皮基质上的成骨潜能。材料研究与生物技术应用, 《生物医学》期刊 2013 年 8 月; 101 卷 (6 期): 919-28 页。 doi: 10.1002 / jbm.b.32897。 电子版 Epub 2013 年 3 月 26 日。
- Gasparyan L.V., Brill G.E., Makela A.M.: INFLUENCE OF LOW LEVEL LASER RADIATION ON MIGRATION OF STEM CELLS. <http://www.emred.fi/research.html#LaserMigrStemCells>
- Gasparyan L.V., Brill G.E., Makela A.M.: 低强度光照射对干细胞迁移的影响。 <http://www.emred.fi/research.html#LaserMigrStemCells>
- Tuby, H./ Yaakobi, T./ Maltz, L./ Delarea, Y./ Oron, U. (2013): Effect of autologous mesenchymal stem cells induced by low level laser

therapy on cardiogenesis in the infarcted area following myocardial infarctions in rats. In: J. Biomedical Science and Engineering, 2013, 6, 24-31.

- Tuby, H., Yaakobi, T., Maltz, L., Delarea, Y., Oron, U. (2013 年): 低强度光疗诱导的大鼠自体间充质干细胞对心肌梗塞后梗死区域心脏发育的影响。《生物医学工程》期刊 2013 年,6 卷,24-31 页。