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High-Tone Therapy for Polyneuropathy

Medium-frequency muscle stimulation represents an effective supplementary treatment option, free of side-effects, for patients with polyneuropathy.

Polyneuropathy can manifest in many ways and likewise have numerous causes: Oftentimes primary diseases, such as diabetes mellitus, alcohol abuse, kidney disease or infections, are to blame for the damage of peripheral nerves. The most common symptoms are paresthesia and sensitivity disorders, particularly in the extremities. In its advanced stage, polyneuropathy can lead to motor deficits, a heightened pressure sensitivity or trophic disorders.

For those affected this almost always means a considerable impairment of their quality of life. In addition to burning and cramp-like pains, there are muscle weakness, paralysis and sleep disorders. In many cases the patients' complaints are accompanied by depression.

By means of a development from Hans-Ulrich May, a German neurologist and psychiatrist, the spectrum of available therapies has been extended by a non-medicinal treatment option: medium-frequency muscle stimulation – also known as High-Tone Therapy or High-Tone Electrical Muscle Stimulation (HTEMS) – which is supposed to activate the metabolism and tissue circulation in a manner similar to intense physical activity.

In contrast to classical electrotherapy (transcutaneous electrical nerve stimulation, TENS), HTEMS works with medium-frequency, metal-compatible alternating current, whose frequency oscillates between ca. 4.000 Hz and 33.000 Hz and whose amplitude is simultaneously

modulated. As a rule, the electrodes are applied to the thighs, calves or soles of the feet. The dosage on the thighs should be chosen in such as a manner, as to produce tension in the muscles. Those receiving the treatment then experience nothing more than a pleasant tingling in the lower leg and foot area.

High-tone therapy was first investigated scientifically in 2005 in a pilot study conducted at the German Diabetes Centre in Düsseldorf. On three consecutive days, a total of 21 patients were treated with conventional TENS for 30 minutes, and a further 20 patients with the new procedure. The results differed significantly: Whereas 80 % of HTEMS-treated patients reported an improvement in their symptoms, only 33 % of the TENS group experienced any relief.

Since then – as presented in the table on page 4 – a number of further studies have been performed. Despite differences in study design and patient collectives, these investigations could confirm the effectiveness of this (so far) zero side-effect mode of therapy.

The largest study to date was performed in 2008 with 414 diabetic patients who underwent high-tone treatment at least four times weekly, for 30 minutes per session. Similarly, after four weeks, 88,4 % of the patients involved responded favourably to the treatment. All primary symptoms – tingling, burning, pains and numbness – could be reduced with regard to both their frequency and intensity. Moreover, patients were able to sleep better. The greatest novelty value provided by the study came in the evidence that, even three weeks after end of treatment, the symptom relief continued.

Meanwhile it could be shown that the high-tone treatment could lead to a number of additional positive effects: In one study, a group of overweight diabetic patients experienced a significant reduction in their body mass. Two further studies resulted in a reduction in HbA1c, whilst another reported an improvement in the microvascular endothelial cell function. Finally, a positive change in systemic immune parameters was observed.

Likewise, the latest investigation pointed to a new aspect: In a study with 28 diabetic patients, conducted in 2016, the researchers could additionally show – aside from the average symptom reduction from 8 to 6 according to the Neuropathy Symptom Score (NSS) – a reduction and an increased differentiation of hematopoietic stem cells which could favour tissue regeneration.

High-tone therapy treatment with a home-therapy device

Questions and answers regarding High-Tone therapy

What have been your experiences with high-tone therapy in PNP patients? In these patients, could High-Tone therapy also improve mobility and walking stability (gait safety)?

UNIV.-PROF. DR. RICHARD CREVENNA
Head of the University Clinic for Physical Medicine, Rehabilitation and Occupational Medicine, AKH/Medical University of Vienna

"The feedback from my patients with polyneuropathy of different aetiology with regards to high-tone therapy is largely very positive. Following an easy-to-understand introductory training, the independent home-therapy seems to be very easy in its application and especially effective against the agonising pain and dysesthesia – despite being somewhat time-consuming. The therapy itself is described by patients as pleasant and relaxing. Additionally, their pain-hampered quality of life and nightly sleep can be improved by the treatment.

The mobility and walking stability (gait safety) of the affected patients can, first and foremost, be improved by consistent active exercise and training the relevant basic motor properties. This presupposes a state free of pain or, at least, an alleviation of the existing complaints as well as good sleep. Both can be achieved with effective physical, analgesic and regenerative modalities such as high-tone therapy, which naturally underlines its value."

Can the use of high-tone therapy in patients with PNP lead to a reduction in the medicinal dosages of anticonvulsants?

PROF. DR. AUGUST HEIDLAND
Former Head of the Nephrological Department of the Medical University Clinic and of the Board of Trustees for Dialysis and Kidney Transplantation in Würzburg

"We conducted an in-depth investigation into the effect of High-Tone treatment on PNP in patients with kidney failure, requiring dialysis. It was shown that, in the majority of cases, the health status improved significantly. More than 70 % of the patients who underwent high-tone treatment during their dialysis sessions reported clearly reduced symptoms of pain, burning, tingling and numbness of the feet and, partially, of the lower limbs. Additionally, the sleep quality of our patients was enhanced. The well-being and the quality of life index had risen considerably. In individual cases several patients further reported an increased strength with an improved ability to climb stairs. With regard to the measurement of handgrip strength – a parameter of whole-body strength and of the life expectancy of kidney failure patients – a clear, positive trend could be identified.

In patients for whom the high-tone treatment was successful, the use of pain-relieving substances could be markedly reduced or, in part, completely discontinued. This is especially meaningful in the case of kidney failure, since at this stage of the disease the pharmacokinetics and –dynamics of various analgesics are clearly changed. Oftentimes, analgesics lead to pronounced uremic symptoms, such as fatigue, nausea, impaired vigilance and orthostatic hypotension. Kidney failure patients, in particular, are already required to take a multitude of medicines and consequently are reluctant to accept additional medications. For this very reason, a non-medicinal and effective treatment option such as High-Tone therapy presents a valuable supplement or alternative to the conventional spectrum of therapies."

Experiences with High-Tone therapy in the treatment and rehabilitation of oncological patients

High acceptance of the procedure

PRIM. DR. MARCO HASSLER
Medical Director of The Sonnberghof Centre

The Sonnberghof Centre specialises in the rehabilitation of people with tumour diseases. Annually, approximately 2.200 oncological patients receive in-patient treatment from a multi-disciplinary team of medical doctors, nursing staff, physio- and occupational therapists, psychologists, dieticians, sport scientists, masseurs and electrotherapists, as well as biomedical analysts. The therapeutic programme, usually spanning three weeks, first and foremost comprises activating and symptom-relieving therapies, psychological care, in addition to counselling and lifestyle training elements.

For the last three years, supplementing the pre-set extent of therapies, high-tone therapy has been implemented for the treatment of polyneuropathy. The prevalence of PNP, depending on tumour type and chemotherapy, can reach 40 %, where patients present with a symptom duration ranging between two months and three years.

High-tone therapy is highly appreciated by its users. The reasons are its easy handling and the possibility – after an introductory training by a medical-technical specialist or therapist – of the patient contributing to their own pain relief. Over and above this, those treated experience it as an 'add-on', i.e. something beyond the usual programme which they can implement in their free time, for instance in the evening while watching TV.

On average the treatments span 16 days, with acceptance of the device being extremely high. The handling by the patients themselves proves to be very easy. To date, there has been just one case in which a nurse had to lend a helping hand.

Although our primary thrust is to find out which patients respond well to the treatment, owing to the limited treatment duration, the attained successes are quite remarkable: Our experience has shown that particularly patients with a heightened pain sensitivity benefit from the treatment.

After a total of 287 applications, we are convinced of the efficacy of high-tone therapy and consider it an important instrument in in-patient oncological rehabilitation. One problem, however, is that this therapy does not (yet) receive consideration for achieving the full performance profile and is viewed as a voluntary, supplementary therapy, the costs of which our institution has to cover.

High-Tone therapy as a valuable therapeutic approach

PRIM. DR. DANIELA GATTRINGER
Board of the Institute for Physical Medicine and Rehabilitation, Holy Order Clinic in Linz, The Compassionate Sisters

The Holy Order Clinic in Linz, Compassionate Sisters, is regarded as the leading oncological hospital for Upper Austria. Due to this main emphasis, we treat a large number of patients with tumour diseases at the Institute for Physical Medicine and Rehabilitation. Our inter-professional team of medical doctors, physiotherapists, occupational therapists, masseurs and sport scientists annually conducts approximately 36.000 in-patient treatments. With regard to out-patient treatments, we record another 13.000 visits.

Polyneuropathy exists in the frequent side-effects of chemotherapy with platinum-containing medications, taxanes, vinca alkaloids, or treatment with immuno-modulating substances. These mainly manifest as sensitivity disorders, for example numbness or tingling, in addition to pain in the hands and feet. Oftentimes, they are accompanied by disorders of fine motor function or balance and coordination – even to the point of walking disorders. For the affected patients, this represents a strong restriction of their quality of life, often with severe psychological stress.

It is our aim, wherever possible, to prevent PNP complaints, or – should they arise – to treat these as soon as possible. Aside from training in sensory motor function and/or vibration, we have been routinely implementing high-tone therapy with very good successes since 2013. Across the board, our patients experience the treatment with the HiToP device as very pleasant, whereby side-effects are rarely reported.

We implement high-tone therapy in both the in- and out-patient settings. A treatment series normally comprises six to ten sessions, which we conduct in a relatively short period of time. When patients respond well, we often recommend a daily treatment with a home-device.

High-tone therapy is also an integral component of our unique (in the whole of Austria) out-patient oncological rehabilitation programme. The patients complete a 6-week, multimodal therapy programme, based on their individual problems and needs. Likewise in this case, after conclusion of the oncological therapy, the long-lasting, chemotherapy-induced PNP complaints frequently lead to patients seeking treatment for their pain. Also in this rehabilitation setting, high-tone therapy represents a valuable therapeutic approach.

Important studies on high-tone therapy – an overview

STUDY	RESULTS
I. Spanidis et al. External muscle stimulation differentiates circulating hematopoietic stem cells in diabetes patients. Diabetologie und Stoffwechsel 2016; 11 – FV29	Patients: 28 Symptom reduction from 8 to 6 according to the Neuropathy Symptom Score (NSS), respectively, from 5,5 to 5 according to the Neuropathy Disability Score (NDS). Reduction and increased differentiation of hematopoietic stem cells.
L. Di Micco et al. Muscle Stimulation in elderly patients with CKD and sarcopenia. G Ital Nefrol 2015; 32(5)	Patients: 6 HTEMS and 6 placebo Increase in volume of urine by 22 % and creatinine by 40 % under HTEMS. Rise in NOx-values and improvement of microcirculation.
B. Di Iorio et al. High-Tone external Muscle Stimulation in patients with acute kidney injury (AKI): beneficial effects on NO metabolism, asymmetric dimethylarginine, and endothelin-1. Clinical Nephrology 2014; 82(5)	Patients: 17 HTEMS and 17 without HTEMS Rapid rise in NOx-values and higher drop of the ET-1-values in the HTEMS group. Plasma ADMA value significantly higher after 14 days.
A. Klassen et al. High-Tone External Muscle Stimulation in End-Stage Renal Disease: Effects on Quality of Life in Patients with Peripheral Neuropathy. Clinical Nephrology 2013: 79(Suppl.1)	Patients: 25 The quality of life of kidney failure patients with PNP could be clearly improved by high-tone therapy.
B. Strempska et al. The Effects of High-tone External Muscle Stimulation on Symptoms and Electrophysiological Parameters of Uremic Peripheral Neuropathy. Clinical Nephrology 2013; 79(Suppl.1)	28 Patients undergoing hemodialysis 64 % report a general improvement of their well-being after HTEMS, 57 % experience less pronounced cold feet. The subjectively experienced improvement of the uremic peripheral neuropathy corresponds to an improvement in objective, electrophysiological parameters.
K. Kempf et al. High-frequency External Muscle Stimulation in the Relief of Symptomatic Diabetic Neuropathy. Diabetes, Stoffwechsel und Herz 2010; 19(5)	Patients: 414 88,4 % Therapy responders, reduction of intensity and frequency of tingling, burning, pain and numbness as well as of sleep impairment. Evidence of symptom relief even 3 weeks after end of therapy.
P. Humpert et al. External Electric Muscle Stimulation Improves Burning Sensations and Sleeping Disturbances in Patients with Type 2 Diabetes and Symptomatic Neuropathy. Pain Medicine 2009; 10(2)	Patients: 92 Improvement in symptoms in 73 % (paresthesia, pain, burning, numbness, sleep disorders).
A. Klassen et al. High-Tone External Muscle Stimulation in End-Stage Renal Disease: Effects on Symptomatic Diabetic and Uremic Peripheral Neuropathy. Journal of Renal Nutrition 2008; 18(1)	Patients: 40 Significant improvement of tingling, burning, pain, numbness. Improvement of sleep disorders in 73 %.
B. Rose et al. Beneficial Effects of External Muscle Stimulation on Glycaemic Control in Patients with Type 2 Diabetes. Experimental and Clinical Endocrinology & Diabetes 2008; 116(10)	Patients: 16 Improvement of metabolic and immunological parameters (IL-6 and IL-18).
M. Humpert et al. High-tone therapy for the treatment of painful neuropathy in type 2 diabetics improves the microvascular endothelial cell function. Poster presentation, Conference of the German Diabetes Society 2006	Patients: 27 Subjective improvement of symptoms in 57 %. Improvement of microvascular endothelial cell function.
L. Reichstein et al. Effective treatment of symptomatic diabetic polyneuropathy by high-frequency external muscle stimulation. Diabetologia 2005; 48(5)	Patients: 20 HTEMS und 21 TENS Improvement of symptoms in 80 % with HTEMS vs. 33 % with TENS with non-painful diabetic PNP: 100 % HTEMS vs. 44 % TENS.
M. Lankisch et al. New possibilities for the treatment of type 2 diabetes by external electrical muscle stimulation. Poster presentation, Autumn Conference of the Study Group of Registered Diabetologists 2005	Patients: 16 Significant reduction in body mass (107,2 vs. 105,5 kg; $p<0,05$) and a reduced HbA1c (7,5 vs. 7,1%; $p=0,08$). The average weight loss amounted to 1,4 kg; BMI sank by 0,6 kg/m2 and HbA1c by 0,6 %.