THERAPEUTIC EFFICACY OF TAMMEF (Therapeutic Application of Musically Modulated Electromagnetic Field) SYSTEM IN CARPAL TUNNEL SYNDROME.

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Abstract.

The carpal tunnel syndrome (CTS) is an entrapment neuropathy due to the median nerve compression within the carpal canal.
The therapy includes more treatments, therefore we would verify the possible therapeutic efficacy of a musically modulated electromagnetic field called TAMMEF (Therapeutic Application of Musically Modulated Electromagnetic Field) System.
We included 120 women, aged from 30 to 60 years, affected by idiopathic CTS, diagnosed by clinical, laboratory findings and electromyography, submitted to 2 cycles, distanced 3 months one to another, each composed by 15 daily applications, lasting 30 minutes.
The evaluation of paresthesias and of the pain with analogic scale was carried out daily, instead electromyography at the time 0 and at the end of therapy.
The clinical parameters progressively decreased and quite regressed in 114 of the 120 patients at the end of the treatment; electromyography showed improved in 109 patients, unchanged in 9 and worsened in 2.
Our results seem to prove that TAMMEF System has a therapeutic activity in CTS, probably due to an antiedema action at level of carpal canal and to an observed variation of plasmatic level of cyclic adenosine monophosphate (AMPc), oxygen free radicals and prostaglandin E2.

Introduction

The carpal tunnel syndrome (CTS) is the most well-known and common entrapment neuropathy, due to the median nerve compression within the carpal canal (1). With the word CTS we refer to a whole of signs and symptoms represented by acroparesthesias of the upper limb, mainly nocturnal, with characteristic distribution and irradiation, associated or not to motor deficit of the thumb and to atrophy of the thenar eminence. CTS develops in three stages, in relation with the extent of nerve injury: irritative (sensory deficit), sensory-motor and paretic form (2).
The therapy includes more treatments, according to the gravity of the disease: immobilization of the wrist, analgesic anti-inflammatory drugs, physical therapy, infiltrations with corticosteroids, surgical operation (3,4).
Among instrumental physical therapy, the magnetotherapy with extremely low frequency electromagnetic field (ELF) has been introduced in the treatment of various painful syndromes (5,6). The effects of the various types of low frequency electromagnetic fields used in clinical practice depend on their codes (frequency, intensity, waveform, the number of impulses per train and the interval between one train and another). The electromotor forces induced at a given point of a biological system act on the electric charges present which respond, causing functional modifications in the cellular microenvironment (7-9).
The overall biophysical effect can be appreciated only by observation, since the level of complexity of the system does not allow one to predict what mechanisms of action will predominate. However, it is possible to compare the effects of a certain field with those of an all-inclusive reference field whose parameters continually change in time so that all possible codes can occur in a single application.
Our group has already shown the efficacy and tolerability of the extremely low frequency (ELF) field in patients affected by osteoporosis (10), rheumatoid arthritis (11) and osteoarthritis (12). Recently to evaluate the utility of applying the widest possible magnetic field, we introduced the new TAMMEF (Therapeutic Application of a Musically Modulated Electromagnetic Field) System. The field is obtained from recorded musical passages; thus its parameters (frequency, intensity, waveform) are modified in time, randomly varying within the respective ranges (12).The aim of this study is to evaluate the efficacy of the TAMMEF system in the treatment of idiopathic carpal tunnel syndrome.

Materials and Methods

We adopted an all-inclusive electromagnetic field, called TAMMEF System, a field whose parameters are modified in time and randomly vary within the respective range, so that in a single application (usually 30 minutes) all possible codes can occur. For this purpose, it is possible to use a pair of electromagnets controlled, through an amplifier, by a suitably programmed computer. However, it is even simpler to control the electromagnet by means of signals recorded on magnetic tape, using an audio tape player instead of the computer. For example, the playback of musical passages can be a simple, easy solution for the proposed task

An audiotape player sends the relative monochannel-microphone signal to two low frequency amplifiers A and B, both with adjustable gain. The current from amplifier A, modulated according to the recorded signal, feeds two electromagnets with iron-silicon cores joined subsequently by a ferromagnetic arc. The anatomical region to be treated is placed between the opposing faces (3x4 cm) of the polar expansions. The current from amplifier B feeds a loudspeaker that plays the pilot musical passage. The music can also be heard through headphones, with automatic exclusion of the loudspeaker. The gain of amplifier A is regulated so that when the audiotape contains a sinusoidal signal with frequency of 100 Hz, the electromagnetic field is equal to the ELF field usually used (about 3 gauss midway between the poles when this distance is 30 cm). This set-up is then left unchanged whatever the contents of the audiotape used subsequently. The patient is allowed to regulate the gain of amplifier B, with the volume preferred, whether the music is being transmitted over a loudspeaker or into a headset.

The evaluation of paresthesias and of the pain with analogic scale (13) was carried out daily, instead electromyography (14) at the time 0 and at the end of therapy.

Electromyography was performed by Medelec Synergy Electromyograph and included nerve conduction studies. A bipolar stimulating electrode was used and the response was recorded through surface electrodes (Ag/Cl) using a belly tendon montage. The duration of the stimulus was 0,5 ms. The study included motor conduction velocity, distal motor latency, compound muscle action potential amplitude of the median (M3: middle finger-wrist, M4: ring finger-wrist) and ulnar (U4: ring finger-wrist) nerves, in line with AAEM (American Association of Electrodiagnostic Medicine) recommendations (15). The distal motor latency has been measured to one fixed distance of 7 cm.

We included 120 women, aged from 30 to 60 years, affected by idiopathic CTS of slight-medium entity, diagnosedbyclinical,laboratorytestsandelectromyography.

The examined patients have never had any infiltrative steroidal therapy or surgical decompression of the median nerve, moreover they stopped analgesic anti-inflammatory drugs in the two weeks before the beginning of the study.

Each patient has been submitted to 2 cycles, distanced 3 months one to another, each composed by 15 daily applications, lasting 30 minutes. It has been used the new TAMMEF System an all-inclusive reference field whose parameters continually change in time so that all possible codes can occur in a single application.

Three months after the end of treatments we evaluated clinical parameters and a second electromyographic examination.

The interval between the 2 cycles and the execution of a second cycle had these aims:

1) testing the length of the possible therapeutic effect of the magnetotherapy
2) evaluating the possible relapse of the syndrome due to the treatment suspension
3) estimating the utility or not of repeated cycles.

Results

The clinical parameters, in particular the subjective pain and the diurnal and/or nocturnal paresthesias, improved in the course of the treatment with electromagnetic fields. In fact, from the eighth application, sign and symptoms progressively decreased and quite regressed in 99 (82%) of the 120 patients at the end of the first cycle. At the end of second cycle other 15(12%) patients showed the same improvement and just 6 (5%) patients resulted unchanged.
Pain and paresthesias, stimulated by the Tinel and Phanel tests, followed the same increase of the subjective parameters.
At the control, three months later, the improvement of pain and paresthesias kept constant also in 111 (92,5%) patients. Only 3 (2,5%) subjects showed a relapse of the symptoms at the 90^{th} day from the end of therapy, while in the other 6 (5%) patients, who did not respond to treatment, the symptoms were unchanged. The electromyography showed improved in 114 (95%) patients, unchanged in 4 (3,5%) and worsened in 2 (1,5%).

Discussion and conclusions

Our results seem to prove that TAMMEF System has a therapeutic activity in CTS. In fact all the patients treated completed the therapeutic cycle and manifested a significant improvement of the clinical and electromyographic picture. The electromagnetic fields had produced a so-called “tail effect", continuing after the suspension of therapy, as if the biophysical action interfered with the pathogenetic mechanisms of the disease, probably by inhibition of the inflammatory process or due to an antiedema action of the electromagnetic fields at level of carpal canal and to an observed variation of plasmatic level of cyclic adenosine monophosphate (AMPc), oxygen free radicals and prostaglandin E2 (7,11).
We believe that the different efficacy of the TAMMEF System in CTS is due to the stage of the disease. In fact we suppose that magnetic fields can be effective in the early phases, in which inflammation is prevalent and degenerative processes of the axon is not jet started.
Moreover the therapeutic effect seems persistent and continuous after the treatment suspension. Therefore we think it useful to carry out the two cycles with the possibility of an extension of the therapy in the following years.
Our results confirm the safety, the efficacy and the tolerability of low frequency magnetic fields as previously reported (10-12, 17), also support the hypothesis that the effects of magnetic fields with parameters that change in time, like those produced by the music-piloted TAMMEF System, are equivalent to the effects of the ELF field (12,16).

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