Effects of transcutaneous electrical nerve stimulation on motor and sensorial nerves for diabetic polyneuropathy patients by use of electromyography

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List of abbreviations
DP, diabetic polyneuropathy
EMG, electromyography
ENMG, electroneuromyography
HRFM, high rate frequency modulation
TENS, transcutaneous electrical nerve stimulation

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Abstract

About 20–30% of diabetic patients are affected by DP. Transcutaneous electrical nerve stimulation (TENS) and electrical has been proposed as physical therapies. This study was aimed to investigate the effects of high rate frequency modulation (HRFM) with TENS treatment on patients which have diabetic polyneuropathy (DP).

Patients with type 2 diabetes and DP (n=14) both upper extremities were treated for 20 min daily for twenty consecutive days. The patients' values of glucose, amplitude and latency were measured by use of EMG at before TENS, after TENS and following term of TENS. Patients were similar in terms of baseline characteristics, such as age, duration of diabetes, neurological symptoms scores and neurological disability scores. Differences among glucose levels related to before TENS, after TENS and following term of TENS are found statistically significant ($p<0.05$). Differences for amplitude did not change statistically. Differences on latencies belong to motor and sensorial nerves were found statistically significant ($p<0.05$).

In conclusion, result of the study indicated that TENS treatment has been positive effect on diabetic polyneuropathy.

Keywords

Diabetes, pain, polyneuropathy, transcutaneous electrical nerve stimulation.

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Introduction

Diabetes is recognized as one of the leading causes of morbidity and mortality in the world. Type 2 diabetes occurs predominantly in adults over than 30 years old. This disease affects about 2.5-3% of the worlds population (American Diabetes Association, 1995). Peripheral neuropathy is the most common complication of type 2 diabetes mellitus and occurs in the distal extremities and typically affects the sensory, motor, and autonomic systems (Harris et al., 1993). In diabetic patients, chronic hyperglycemia can produce neuropathic changes that affect peripheral nerve function and produce extremity pain (Greene et al., 1990). Peripheral neuropathy is a common complication of diabetes, affecting nearly one of every three patients with type 2 diabetes mellitus and increasing in incidence with the duration of diabetes (Harris et al., 1993). Advanced neuropathic deficits underlie most food ulcers and amputations (Greene et al., 1990). Today diabetic neuropathy remains untreatable except by palliative measures. For symptomatic relief, various analgesics, anticonvulsants and tricyclic antidepressants have been tried with variable success (Max et al., 1992). New drugs (Martyn et al., 1987) and nonpharmacological therapies such as transcutaneous electrical nerve stimulation (TENS) (Kumar and Marshall, 1997; Armstrong et al., 1997), acupuncture (Abuaisha et al., 1998) and spinal cord stimulation (Tesfaye et al., 1996) are being explored to alleviate the pain and discomfort associated with peripheral neuropathy. TENS therapy can be suggested due to the beneficial effects of electrotherapy in alleviating pain associated with arthritis and rheumatological conditions (Neumann, 1993).

In the current study, we aimed to investigate exposing the effects of TENS therapy for diabetic polineuropathy patients on some nerves such as median sensorial, ulnar sensorial, median motor and ulnar motor in terms of amplitude and latency.

Subjects and Methods

Selection of Patients

Fourteen diabetes patients, which have applied to internal diseases polyclinic in Yuzuncu Yıl University, Medical Faculty, Research and Practice Hospital are receipt to this study. Seven of these patients were female and remaining patients were male. The average of their age was 51 ± 2.4 (the youngest: 33, the oldest: 60). Illness duration is changed between 4 and 16 years, estimated average is 8.8 years. 6 patients treated with crystalline insulin, 8 patients did not use insulin. All subjects were voluntarily for the study and gave informed with a written consent. The protocol of the study was approved by our local ethics committee.

Electrical Stimulation

Peripheral or central electrical stimulation of nerve system is used to control chronic pain which is exist for a long period (Tulgar, 1992). Neurostimulator apparatus, which indicatives a rapid stage for technologic improvements are very portable and popular. For local pain, TENS is adequate and favorable. TENS (HRFM; continuous pulses changed from 90 Hz to 55 Hz over 90 msec, 1.3 times a second) electrodes which are accommodate to the aching region perform electrical treatment signals. Also, these electrical signals are proved as neuropsychological security and efficiency. On functional electrical stimulation, the neurons which have lost its functionality are stimulated with electrical signals that are favorable to nerve system characteristics to become more functional.

Physical effect of neurostimulation; remove or diminish pain, increase blood cycle, decrease muscle atrophy, diminish edema and effusion, and diminish in muscle spasm. The contraindications are rare skin allergy against TENS electrodes and shah vessel sinuses on patients carrying pace maker implants and pregnant women.

Blood Samples Collection and Preparation

Before and after TENS treatment and following term of TENS, in the morning form each patient with an empty stomach were collected 5 ml blood and in this blood sample glycemia was measured.

The application of TENS treatment Method

To determine MDA and glycemia levels, blood samples were collected from each patient 24 hours before beginning of TENS treatment. Each patient were applied TENS treatment as séance once a day during 20 days trial period. It was used 4 pairs of self-jealous electrodes. To increase the electrode's conductivity, after shutting off equipments, the finger tap was wet to alter polarity via little water before and middle the treatments. 2 pairs of these electrodes were parallel settled on median nerves in the anterior part of wrists by 2 cm intervals. Each séance took 20 minutes and polarity was changed to minimize the effect of unwanted electrolysis. For this reason, negative and positive polarities were applied by 10 minutes, stimulation mode 200 μs periodical, 1.3 times quickly impulse (90 Hz) per second, high rate frequency modulation (HRFM) which is slowed down (55 Hz) for

a short period (90 ms) (Neumann, 1993; Bonnefont-Rousselod et al., 2004). To avoid the effect of electrical shock, before changing polarity, TENS system were turned off. After that, the position of electrodes was reversed and by turning on the system, current value was increased over again from 0 to treatment levels. In the following minutes of the treatment, the patients were asked how the feeling of current level. According to the answers, if current values were not sensible, it was increased. It was decreased, if current values disturbed the patients.

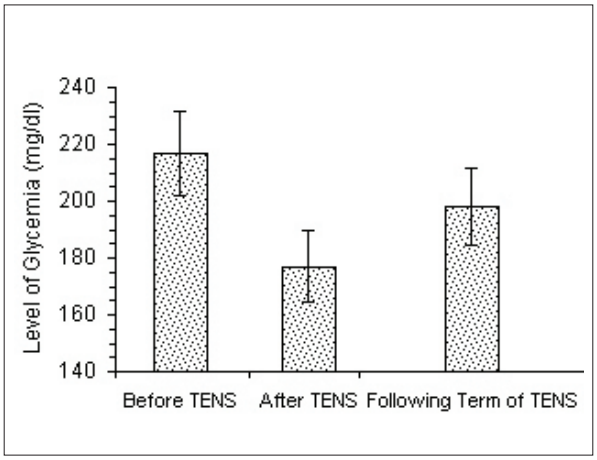

Figure 1. Change of serum glucose levels in diabetic patients before, after and following term of TENS-treatment.

Electromyography (EMG)

EMG, which is almost easily reached and cheap, and especially neuron impulse studies are frequently used deputy examination methods. These methods can answer some questions such as distribution, intensity, symmetry of peripheral neuropathy and whether primary axon demyelinizations are exist. It can denote on which level (dominant distribution at proximal or distal) peripheral neurons are under demyelinization. When existence of weak demyelinization is generally observed in early periods, axonal casualties gain priority with improving diabetes period, for diabetic patients. Furthermore, it can

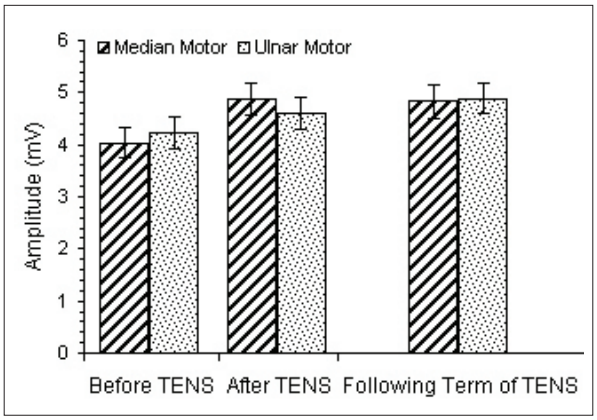

Figure 2. Change of amplitudes in diabetic patients before, after and following term of TENS-treatment for ulnar and median motor nerves.

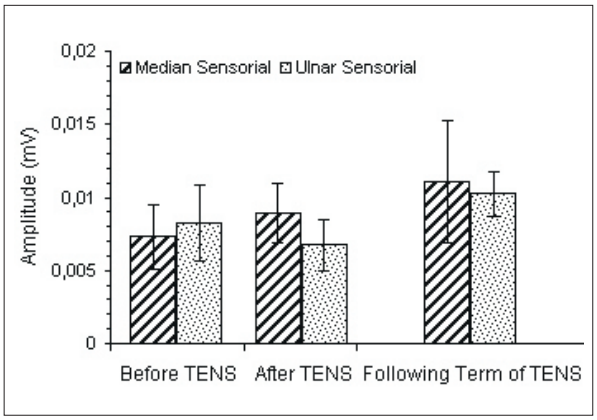

Figure 3. Change of amplitudes in diabetic patients before, after and following term of TENS-treatment for ulnar and median sensorial nerves.

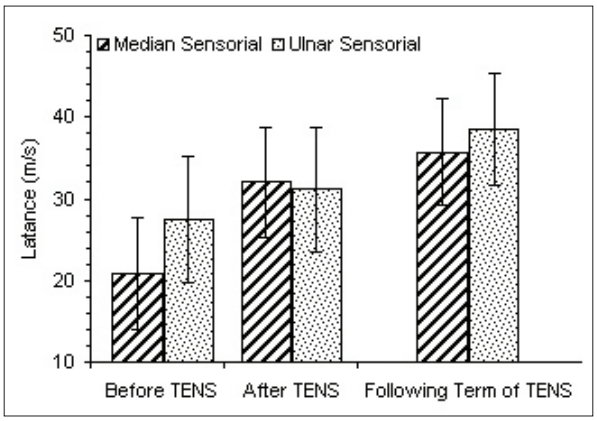

Figure 4. Change of latances in diabetic patients before, after and following term of TENS-treatment for ulnar and median sensorial nerves.

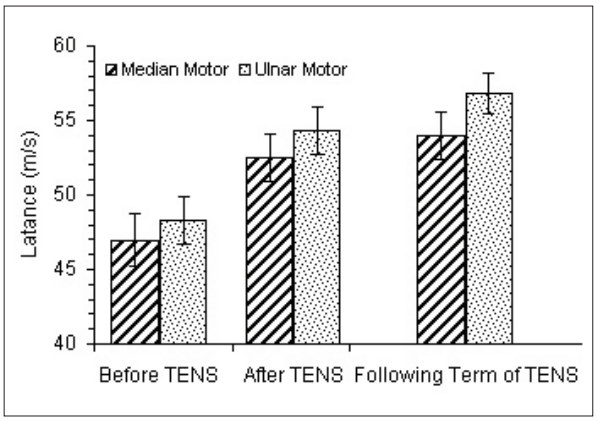

Figure 5. Change of latances in diabetic patients before, after and following term of TENS-treatment for ulnar and median motor nerves.

be stimulant to investigate other etiologies when existence of findings that is not matches ordinary electrophysiological aspects. In this study, amplitude and latency records were obtained on median sensorial, ulnar sensorial, median motor and ulnar motor nerves by use of concentric injection electrodes on peripheral neurons related to before and after TENS therapy and following term of TENS from diabetic polyneuropathy patients.

Statistical Analyses

All statistical analyses were performed using SPSS-PC software. Groups for glycemia parameter were analyzed by one-way ANOVA because it has normal distribution and groups have equal variance. Duncan test performed on glycemia as a post hoc test to compare means. Amplitude and latency parameters were analyzed by non-parametric Kruskall-Wallis test because of non-normality.

Results

The effects of TENS treatment on the diabetic polyneuropathy are shown in Figure 1. Glucose levels of diabetic patients were compared on groups that are before TENS, after TENS and following term of TENS (n=14). It is very usual for the high level of the glucose to be found in the diabetes compared to the following term. After the TENS done for 20 days, it was observed that the glucose level was decreased (from 217±14.8 to 175±12.5 mg/dl as average ± SE) as statistically significant ($p<0.05$) between before and after TENS treatment. At the end of the fallowing term of TENS the average glycemia level increased to the value of 198±4.2 again (Figure 1).

For interested patients, changes of amplitudes of median sensorial, ulnar sensorial, median motor, and ulnar motor nerves which is obtained by ENMG (electroneuromyography) and related to before TENS, after TENS and following term of TENS are not found statistically significant ($p>0.05$). These are given in Figure 2 and Figure 3. Although it is not statistically significant, amplitude values were increased. Latencies of median and ulnar sensorial nerves that is obtained by ENMG at before TENS, after TENS and following term of TENS of diabetic polyneuropathy patients are not found statistically significant ($p>0.05$). It is plotted in Figure 4 to show changes on groups. Latencies of median and ulnar motor are found statistically significant ($p<0.05$), given in Figure 5. When statistical difference between before TENS and following term of TENS are significant, after TENS is observed as statistical transition group for median motor. When latency of ulnar motor is evaluated, statistical significances are found between before and after TENS and before TENS and following term of TENS. But, statistical significance cannot be found between after TENS and following term of TENS.

Discussion

For diabetic polyneuropathy patients, combine findings of axonal degeneration are typical for diabetic neuropathy and most of the other neuropathies showing only axonal degeneration are untypical when serious decrease of latency on sensorial and motor nerves. If these findings were accurately determined in clinic and presented together other electrodiagnostic abnormalities which is mostly diabetes mellitus, diagnosis are exposed more reliably. Only diabetic neuropathy type which is hard to determine by measurement is that showing loss of sense on distal as primer (Vinik, 2004). This neuropathy mostly influences slim fibers; however it is frequently coincided with electro-diagnostic abnormalities related to sensorial and motor fibers (Mima, 2004).

Diabetic polyneuropathy, which is a common disease, is frequently encountered with different forms (American Diabetes Association, 1995). It generally indicates slow and sly development and it is experienced on long period diabetic patients. Decreasing of the vibration sense is the most evident indication for these events (Young et al., 1993).

Sensorial compound muscle action potential amplitudes of two sided median nerves were low and distal motor latencies were long in ENMG examination before TENS for interested patients. Compound muscle action potential amplitudes of two sided ulnar nerves were low beginning from segments of inferior caput ulna. Motor latencies were slow especially more evident on segments of inferior caput ulna and posterior caput ulna. While sensorial responses of left median nerves were not obtained, it is obtained that sensorial action potential amplitudes belong to right median nerves and two-sided ulnar were low, and sensorial peak latencies were long.

It was exposed that TENS constitutes changes on sensorial and motor systems by previous studies (Watkins , 1984) Apfel et al., 2001). In these studies, effects of TENS therapy on neural activity in the mod of HRFM on diabetic patients were comprehensively and systematically exposed (Watkins , 1984) Apfel et al., 2001). Under these determinations, diabetes mellitus is a syndrome of metabolism disorder that attracts attention by hyperglycemia caused by absolute deficiency of insulin or reduction of biological activity of insulin (Harris et al., 1993). Result of the damage of myelin layer caused by this syndrome can occasion to decrease of action potentials' amplitudes and extend the latencies.

Probably, degeneration of myelin layer caused to increase of membrane capacity and this increase of membrane resistance can cause to decrease latances of median sensorial, ulnar sensorial, median motor, and ulnar motor nerves. Degeneration of myelinization of sensorial and motor nerves which is related to diabetes before therapy for interested patients can cause to low amplitudes and slow latance of these nerves.

In conclusion, TENS therapy is out of the alternative therapy and became a standard therapy method. Result of this study, it is thought that TENS therapy can improve the latency in the periods of after TENS and following term of TENS by decrease of membrane capacitance and membrane resistance, and regenerated demyelinization of nerve's myelin layer.

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