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TENS (80HZ-, 2HZ-, FM-, BURST- AND RANDOM MODE) INCREASES THE PRESSURE PAIN THRESHOLD IN A TIBIA MODEL

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Abstract

We investigated some TENS effects in an experimental model, based on advanced pressure pain threshold (PPT) measurement. 15 healthy persons received in randomized order TENS (30 min) with different mode characteristics: 80 Hz, 2 Hz, burst, frequency modulation (FM), random modulation and sham control. All forms of TENS increased the PPT significantly, while peak values were different: 80 Hz: +21,7%; FM: +18,3%; 2 Hz: +17,0%; burst: +13,9%; random: +12,3%; The contralateral side showed nearly the same effects at 80 Hz (+19,1%) as ipsilateral stimulation. A bilateral retroauricular stimulation was about half effective (+11,1%) compared to the local tibial TENS stimulation.

Introduction

Though TENS has been widely accepted for the treatment of nearly all forms of chronic pain within the last 20 years, there are many open questions concerning e.g. frequencies, waveforms, electrode positions, intensities and time factors . Convincing experimental models are rare, and most results of different authors are hardly comparable. We intended to investigate some TENS effects in one model, based on advanced pressure pain threshold (PPT) measurement.

Material and Methods

A self developed, automatic pressure pain device applicates a linear increasing pressure stimulus of 1 kp/s to the middle of the right tibia, started at signal and stopped by the test person at the first pain sensation (fig.1) . Measurements were repeated 5 times (median chosen as true value) every 5 minutes. Electrodes were positioned 5 cm proximal and distal of the tibial measurement point. 15 healthy persons received TENS (system TENStem, schwa-medico) within a 30 min period (individual amplitude; order: “strong, but comfortable”) with randomized applicated, different modes:

- 80 Hz mode (KI)
- 2 Hz mode (KI)
- burst mode (2/80 Hz)
- frequency modulation mode (FM; 2-128 Hz)
- random modulation mode (RM; 2-150 Hz)
- sham control (inactive TENS device)

The impulses of 80 Hz and 2 Hz mode are not single spikes, but short 3 kHz bursts (a special mode of TENStem system, mainly to make higher amplitudes more tolerable on the skin; so called Kreutner mode). In one experiment 80 Hz has been applicated on the contralateral tibia. In addition, bilateral retroauricular stimulation (80 Hz) was performed in the tibia model to get informations about nonsegmental contributions to analgetic effects. TENS intensity was turned to zero during PPT-measurements (1 min each period), so that the effective TENS application during the 30min treatment period was reduced to 24 min. Statistics: unpaired and paired t-test. Significance levels: $p< 0,05$(*); $p< 0,01$(**); $p< 0,001$(***). Since the basic mean values varied between the different groups, all values were normalized to the last basic value before TENS application.

Figure 1: Experimental setup

Results

All modes of TENS increased the PPT significantly, though slopes and peak values were more or less different (see fig. 2) :

80 Hz mode:	+1,09kp	+21,7%;	p<0,001	* * *
FM mode:	+ 0,82kp	+18,3%;	p=0,002	* *
2 Hz mode:	+0,75kp	+17,0%;	p=0,010	* *
burst mode:	+0,62kp	+13,9%;	p=0,003	* *
random mode:	+0,55kp	+12,3%;	p=0,006	* *
Sham controls:	<±0,12kp	< ±5%	p> 0,1	n.s.

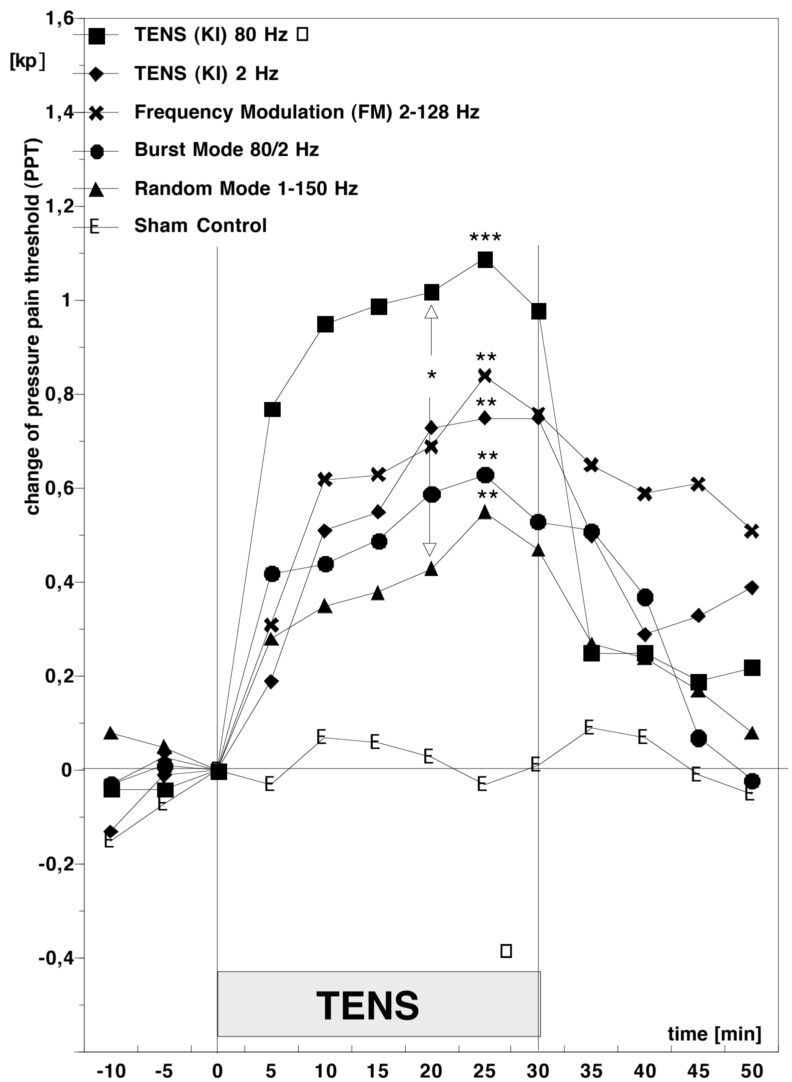

Fig.2: pressure pain threshold (PPT) during and after segmental treatment with different TENS-stimulations (duration: 30 min, intensity:"strong but comfortable", electrode size: 25 cm^2, n=15) KI=Kreutner mode (3kHz burst/impulse)

The TENS stimulation at contralateral tibia showed nearly the same effect at 80 Hz (+0,91kp; +19,1%; p<0,001) as ipsilateral stimulation (fig.3). The retroauricular stimulation was half effective (+0,56kp; +11,1%; p=0,02) compared to the local tibial stimulation. A bilateral two channel ear lobe stimulation in a further experiment (not demonstrated in fig. 3) showed about the same effect .

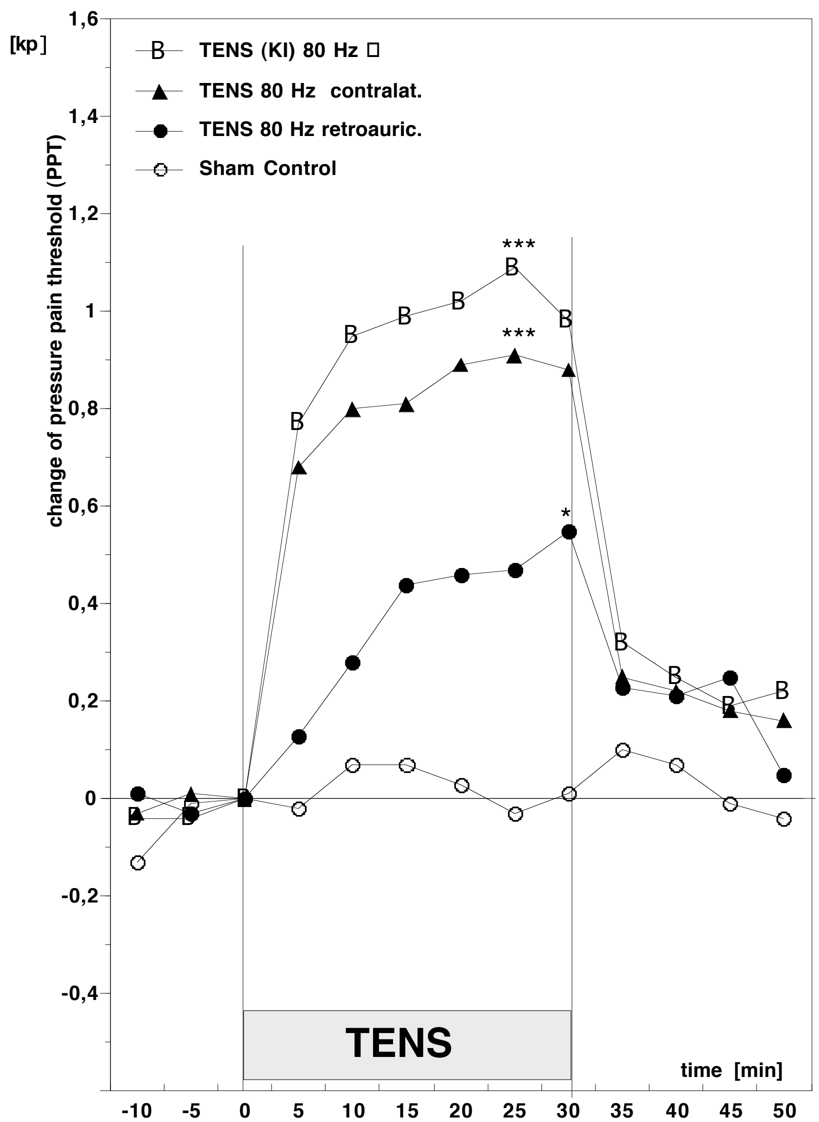

Fig.3: pressure pain threshold (PPT) during and after heterosegmental treatment with TENS 80 Hz (duration: 30 min, intensity:"strong but comfortable", electrode size: 25 cm^2, n=15) KI=Kreutner mode (3kHz burst/impulse)

Discussion

Most pain models used for TENS investigations are based on different forms of skin pain, generated by stimuli of heat, cold or electricity. Though some remarkable effects have been shown already before, the conclusion from experimental results to therapeutical usefulness is difficult, since skin pain is rather different from the chronic (e.g. musculosceletal) pain in patients. In some publications the clinical usefulness of TENS is even doubted at all. The demonstrated model has been chosen to get closer to a “true” pain, caused by increasing pressure similar to diagnostical palpation, and generating mainly a periostal pain in healthy volunteers. In further experiments we plan to involve patients with musculosceletal pain either.

The intention of this preliminary paper is mainly to demonstrate some interesting effects of different TENS modes, and to encourage others to quantify and differentiate specific effects by similar methods. Following observations are noticable:

1) TENS application elevates the (pressure) pain threshold roughly by 20% within 30 min. The effects decrease within 30 min after offset with a remarkable delay. 80 Hz revealed the highest analgetic effect, closely followed by 2 Hz and FM. Burst and random mode TENS were less effective in this model. While differences between the other modes can just be taken as tendencies, those between 80 Hz and random mode are significant ($p<0,05$). Random modes are often recommended to prevent adaptation effects of the ZNS. The observed reduced efficiency might be interpretated as the action of a hypothetical “random input suppression system” of the ZNS. It will be of interest, if similar differences can be observed in further studies. If so, random modes may not be recommended in the future. Similar aspects may be discussed for burst modes.

2) TENS is effective on the ipsi- and contralateral side as well, at least on the same segmental level. This result fits quite well with many recommendations and clinical observations, e.g. in Trigeminus neuralgia or phantom limb pain therapy. It shows also, that direct influence of the peripheral nociceptor by electricity may not be of importance, if any. Evidently spinal and supraspinal gate control mechanisms are playing the leading role in TENS effects, in contrast to the classical electrotherapy with high electricity currents, e.g. by galvanotherapy (3).

3) TENS stimulation in greater distance from the segmental level (ear region) ist still effective, but less than segmental stimulation. This may be related to a heterosegmental and supraspinal involvement of TENS induced gate control mechanisms. Such effects might be useful in the treatment of widespread pain, or pain with no clear segmental relation.

In conclusion, TENS has been confirmed in our experiments as a mild physical analgetic. Unlike to others (in 1; 2) we found the pain threshold reactions to be rather unspecific, concerning different types of modes and locations. This may be one explanation for the very heterogenic scene of devices and therapeutical recommendations, which can be observed in the literature. Further investigations will be required to separate the most effective from the less effective parameters.

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