Analysis of High-Frequency Transcutaneous Electrical Nerve Stimulation-induced Sensory Threshold from the Elderly People for Healthy Life

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Abstract

It is generally known that transcutaneous electrical nerve stimulation (TENS) decreases the threshold of pain and release of catecholamine by mechanical and chemical stimulation. However, there have been no studies to find the change in the sensory threshold and time-dependent stimulus by TENS on the body regions. The present study was to examine the difference of sensory threshold by electrical stimulation at low back and scapulodorsal and knee joint regions in the elderly people. The sensory threshold was significantly increased in the lower back compared with the shoulder and knee joint regions. The sensory threshold tended to increase in the older age group, increasing particularly in subjects in their 80s. The change of the sensory threshold was significantly associated with a time-dependent manner, increasing after stimulation from 5, 10, and 15 min compared with 0 min for all ages. Furthermore, the sensory threshold in response to the application of TENS revealed a time-dependent response, with the sensory threshold tending to increase with age, in particular, in the lower back region. Therefore, these results at least partially suggest that the change of sensory threshold is associated with age, and that needed of the development of senile specialized physical therapy for healthy life.

Keywords: Sensory threshold, Transcutaneous electrical nerve stimulation, Elderly people

Introduction

In the area of physiotherapy, noninvasive electrotherapy applied to decrease pain is known to induce a marked response¹,². Pain inhibition via high-frequency, low-intensity TENS based on gate control theory is commonly used in physical therapy³,⁴. Some previous studies have shown that TENS inhibited pain from various causes and controlled metabolites associated with the pain⁵,⁶. It is well known that TENS suppresses the release of catecholamines and increases the threshold of pain caused by heat or cold stimulation and chemical substances⁷,⁸. However, few studies have examined the change in the threshold following the application of TENS and the presence and the extent of the stimulation-induced “adaptation phenomenon.” Systematic research is required to address this issue because it is important to control the treatment intensity by the subjective sensation of the patient during the application of electrical stimulation⁹,¹⁰. In addition, it is important to maintain the pain-reduction effect to prevent the adaptation phenomenon induced in response to TENS¹⁰. The pain and the displeasure caused by electronic stimulation results in excitation of the sympathetic nerve and can give rise to the activation of mitogen-activated protein kinases (MAPKs) or an activation of pain-related proteins such as the p38 mitogen-activated protein kinase (p38 MAPK) or the stress activated protein kinase/c-Jun N-terminal kinase (SAPK/JNK)¹¹-¹³. Most importantly, these negative consequences will lead to a vicious circle, which can result in the loss of the ultimate goal of physical therapy: the healing and the recovery of the patient. Few studies have analyzed the change in the sensory threshold and the time-dependent stimulus by TENS on the body. They have focused on geriatric patients aged over 60 years. The purpose of this study was to contribute to the development of physical therapy and health science through a comparative analysis of the sensory threshold of the lower back and the shoulder and knee joint region in men and women aged over 60.
years and the change in the sensory threshold following the application of TENS induced time-dependence in age.

Results

Change in the Sensory Threshold in Response to the Application of TENS to the Body Parts

The change of the stimulation-induced sensory threshold following the application of TENS to the lower back and the shoulder and knee joint regions in the subjects over 60 years are as follows: The results of the analysis of the stimulation-induced sensory threshold of the body parts without regard to age and sex are shown in Figure 1. As shown in Figure 1A, there was a significant correlation between the sensory threshold of the shoulder (21.0 ± 1.2 mA) and knee joint (23.3 ± 1.0 mA) regions lower than in the back region (36.5 ± 5.2 mA). The results of the analysis of the sensory threshold according to age showed a statistically significant difference in the sensory threshold of the lower back region (60s; 29.7 ± 2.0 mA, 70s; 31.7 ± 2.0 mA, 80s; 46.6 ± 5.3 mA). The difference was less than that in the shoulder (60s; 19.4 ± 1.1 mA, 70s; 20.3 ± 2.6 mA, 80s; 23.4 ± 2.6 mA) and the knee joint (60s; 21.7 ± 2.0 mA, 70s; 22.9 ± 2.1 mA, 80s; 25.2 ± 2.5 mA) regions. In particular, the sensory threshold in the lower back region showed a marked increase in subjects in their 80s compared with those in their 60s and 70s (Figure 1B). In the case of the lower back region, the sensory thresholds of the women and men were 28.2 ± 1.2 mA and 9.0 ± 1.8 mA in 60s, 30.9 ± 1.5 mA and 32.6 ± 1.4 mA in 70s, 45.9 ± 4.6 mA and 40.9 ± 1.2 mA in 80s, respectively. Thus, the sensory threshold increased with advancing age (Figure 1C). In addition, the sensory threshold of the women in the shoulder region was significantly increased in subjects in their 70s (20.9 ± 1.7 mA) and 80s (22.9 ± 2.5 mA) compared with those in their 60s (19.7 ± 1.4 mA) (Figure 1D). The pattern of an increase in the sensory threshold with advancing age, but this was not statistically significant.

Change in the Time Dependence of the Sensory Threshold in Response to the Application of TENS to the Lower Back and Shoulder and Knee Joint Regions for Subjects over 60 Years

The change in the TENS-induced time-dependent sensory threshold in response to the application of TENS to the lower back and the shoulder and knee joint regions for subjects over 60 years is shown in Figure 1.