Review Article

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The Effects of Auditory Stimulation with Pleasant and Unpleasant Sound on The Pain Threshold of Gingiva and Skin

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ABSTRACT

Introduction: *Music therapy is widely accepted to enhance well-being, reduce pain and distract patients from unpleasant symptoms in the clinical situation. It is known that pleasant music reduces pain, whereas unpleasant ones has no effects or tends to increase pain. However, the degrees of the pain perception modulated by these music remain unknown.*

Objective: *The aim of the study is to investigate the effects of auditory stimulation on the pain threshold of the forearm and mandibular gingiva using four different types of sound, two music as pleasant sound and scaler sound or alarm as unpleasant sound.*

Materials and Methods: *Twenty-five subjects were examined the pain threshold of the forearm and the mandibular gingiva using Pain Vision PS-2011N in listening to classical music, POPs, scaler sound and alarm through headphone. The pain threshold in each sound was compared with that in the silence condition.*

Results: *The changing rate of the pain threshold on the forearm compared with the condition without sound (100%) were 104.8 ± 4.3% (mean ± SE) in listening to classical music, 120.9 ± 6.6% in pops, 106.5 ± 4.3% in scalar sound, 106.9 ± 6.0% in alarm. The pain threshold of the forearm in pops was significantly higher than that in non-sound, classical music and scaler sound.*

The changing rate of the pain threshold on the gingiva compared with the condition without sound (100%) were 125.0 ± 12.9% in listening to classical music, 127.6 ± 9.1% in pops, 104.9 ± 6.4% in scalar sound, 102.0 ± 3.5% in alarm. The pain threshold on the gingiva while listening to music was significant higher value compared with that without sound.

Conclusion: *This study suggested that listening to pops increases the pain threshold on the gingiva or skin.*

Keywords

Pain threshold, Classical music, Pops, Scaler sound, Alarm.

Introduction

The pain is a very important sense in the clinical situation as a sensibility to tell the damaged organization. However, the sensibility might put physical activity at a disadvantage or make a depressed mental state because of the pain stress. When the pain continues for long time, the situation eventually enhances the disease associated psychological and physiological deterioration [1], which also impaired the quality of individual life [2].

On the other hand, many studies have demonstrated that the cognitive degree of pain is appreciably influenced by environment

or emotion, from such a reason, music therapy could be considered as a nonpharmacological method of reducing pain and anxiety [3-5]. Listening to music exerts direct physiologic effects through the autonomic nervous system and has a role in normalizing blood pressure [6,7]. Moreover, music effectively improves mood for medical patients to reduces anxiety and acute or chronic pain including cancer pain [8,9]. It is thought that the music reduces pains by the comfortable feeling induced from rhythm, sound and social enjoyment with people [10].

In previous report, the nociceptive reflex was largest in the content of unpleasant pictures, intermediate for neutral pictures and lowest for pleasant pictures, suggesting that positive emotions interfered with nociceptive processing at the level of the spinal cord [11]. And it was demonstrated that pleasant music reduced pain, whereas unpleasant ones had no effects or tended to increase pain [12]. The pain cognition would be influenced opposite effects by pleasant stimulation and unpleasant stimulation. However, the degree of pain modulated by emotional power and the neuro-physiological mechanisms still remain poorly understood.

Then in this study we investigated the pain threshold modulated by two kinds of pleasant sounds and two kinds of unpleasant sounds using the device which the pain threshold can be quantified.

Subjects and Methods

Subjects

The volunteers of 25 women (20-68 years old) at Tagami Dental Clinic participated in this study. They did not have a history of cardiovascular disorders, diabetes mellitus, psychotropic medication or analgesic, and were not pregnant. The present study was approved by the Ethics Committee of Matsumoto Dental University (No. 195). Informed consent was obtained from all participants. This study followed the Declaration of Helsinki on medical protocol and ethics.

Selection of sounds

We prepared four different types of sounds, which are two musical sounds, classical music (four seasons by Vivaldi) and Japanese pops without song (esperanza by Kana Nishino), ultrasonic-scalers sound (Morita Co., Ltd.) and the alarm tone of the alarm clock (Citizen). The scaler sound and the alarm tone were recorded beforehand and were presented.

Examination of pain threshold

The pain threshold was measured using Pain Vision PS-2011N (Nipro Co., Ltd.) that the intensity of electrical stimulation was gradually increase. A disposable electrode (EL-BAND, Nipro Co., Ltd.) for skin was pasted on the left forearm and the electric stimulation (pulse electric current 0.3msec 50Hz) from Pain Vision was delivered. When subjects recognized the pain on the forearm, they pushed the hand switch to stop the electrical stimulation. The intensity value was evaluated as the pain threshold when an electric stimulation was stopped.

About the gingival threshold, an electrode for the gingiva hold by each subject was attached on the gingiva of the left mandibular first and second molar and the pain threshold was measured such as the forearm. When the pain threshold in listening to sound was measured, a sound were started to play for 10 seconds before an electric stimulation was delivered, and the sound was immediately stopped when the pain threshold was evaluated.

Procedure

This study was performed in a room of the dental clinic, free from other noises, and the temperature was maintained at 23℃. The participants were installed in a comfortable chair and put on headphone with opening eyes.

After a 5-minute rest, the pain threshold on the forearm without sound was measured three times with an interval of one minute. After a 2-minute rest, the pain threshold of the forearm in listening to sound was measured 3 times every one minute. And then, after a 5-minute rest, the pain threshold of the gingiva on left mandibular without sound was measured three times. After a 2-minuts rest, their pain threshold of the gingiva were measured in listening to sound three times every one minute. As the measurement was performed one sound in a day, one subject needed four days for four sounds (Figure 1).

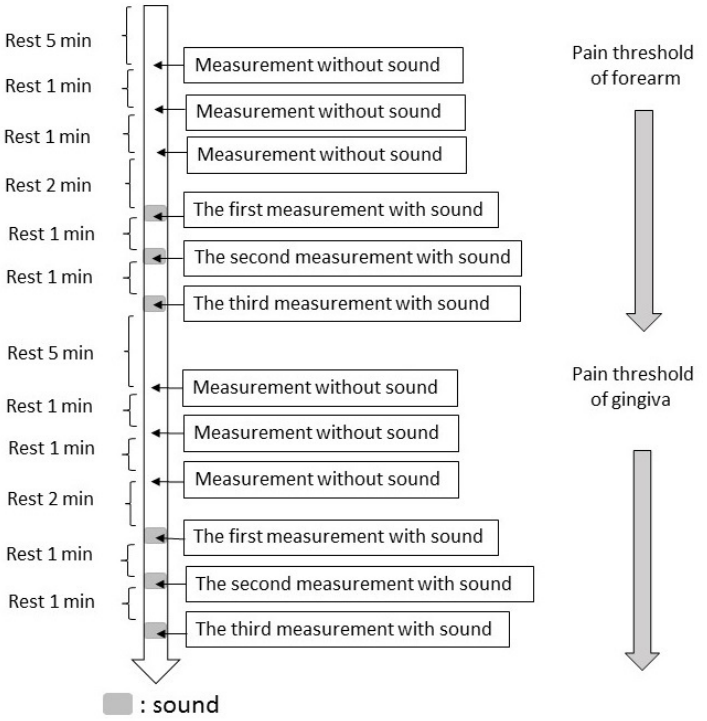

Figure 1: The procedure of pain threshold on the forearm and the gingiva without sound or with sounds in a day.

Statistical analysis

Wilcoxon singed-rank test was used as the comparison between the pain threshold of gingiva and forearm without sound. Pearson's correlation was used as the correlation between the pain threshold of gingiva and forearm without sound. The rate of the pain threshold modulated by each sound was compered by one-way ANOVA and follow-up comparisons were conducted with Dunnett T3. All

statistical analysis was processed using SPSS ver.23 (IBM) and statistical significance was accepted when P-values were <0.05.

Results

The mean ± standard error (mean ± SE) of the pain threshold without sound on the gingiva was 28.7 ± 3.9μA, and the forearm was 45.4 ± 6.7μA. There was a significance between the pain threshold of forearm and gingiva (P<0.0001) (Figure 2). And the moderate positive correlation was observed between the pain threshold of gingiva and forearm in all subjects (correlation coefficient; r = 0.579) (Figure 3).

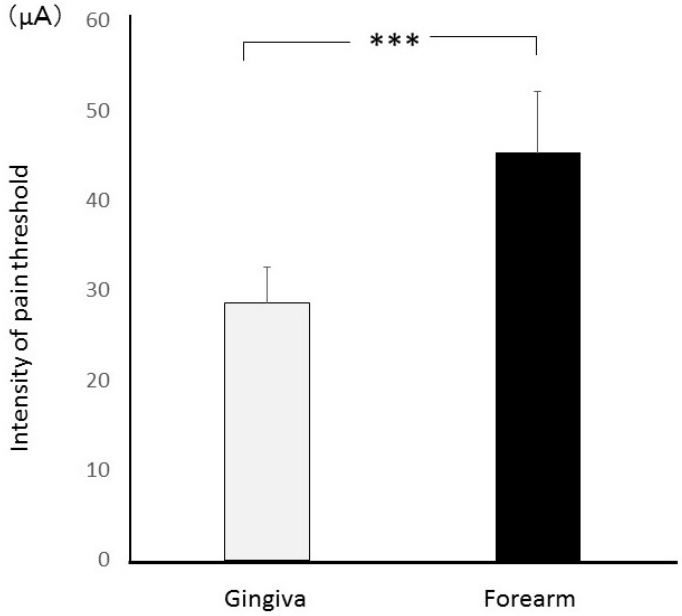

Figure 2: The comparison between the pain threshold of the forearm and the gingiva without sound. Each vertical bar represents the mean ± SE. ***p < 0.0001.

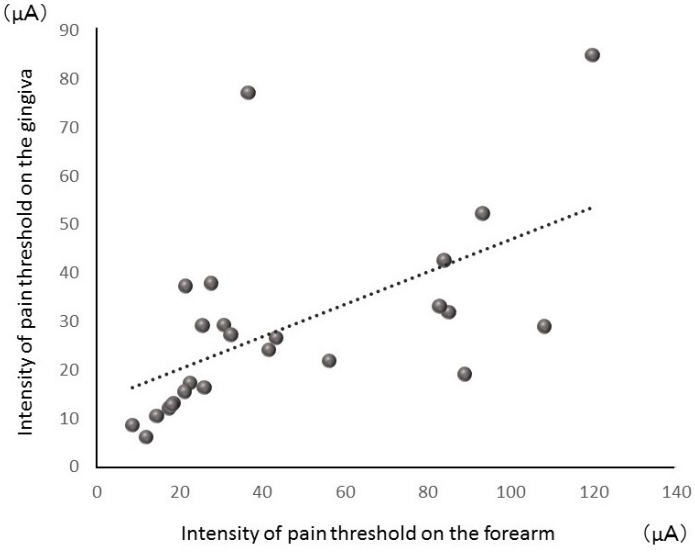

Figure 3: The positive correlation between the pain threshold of the forearm and the gingiva without sound. Correlation coefficient r = 0.579.

The changing rate of the pain threshold on the forearm compared with the pain threshold without sound (100%) were 104.8 ± 4.3% in listening to classical music, 120.9 ± 6.6% in pops, 106.5 ± 4.3% in scaler sound, 106.9 ± 6.0% in alarm. The value of the pain threshold in pops was significantly higher than that in no sound, classical music and scaler sound (no sound: p<0.0001, classical music: p<0.005, scaler: P<0.05) (Figure 4).

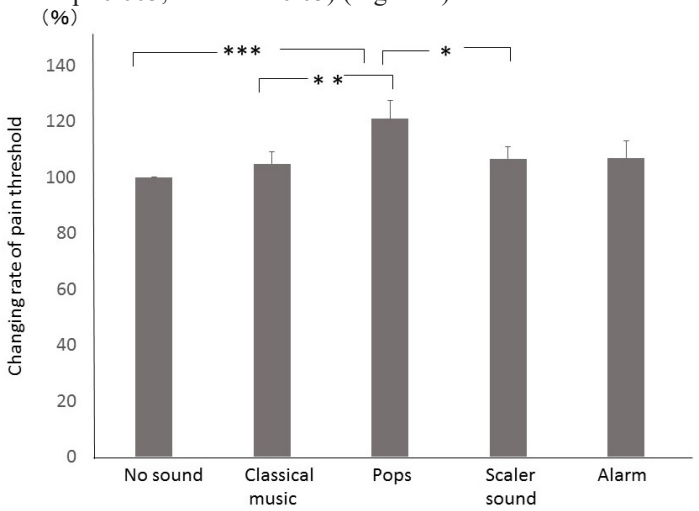

Figure 4: The changing rate of the pain threshold on the forearm in listening to each sound compared with that without sound.
Each vertical bar represents the mean ± SE.
***p < 0.0001, **p < 0.005, *p < 0.05.

The changing rate of the pain threshold on the gingiva compared with the condition without sound (100%) were 125.0 ± 12.9% in listening to classical music, 127.6 ± 9.1% in pops, 104.9 ± 6.4% in scalar sound, 102.0 ± 3.5% in alarm. The value of the pain threshold in classical music and pops was significantly higher than a state without sound (classical music: p<0.05, pops: P<0.0001). That in classical music was significantly higher than that in alarm (p<0.05), and that in pops was significantly higher than that in scaler sound (p<0.005) and alarm (p<0.0001) (Figure 5).

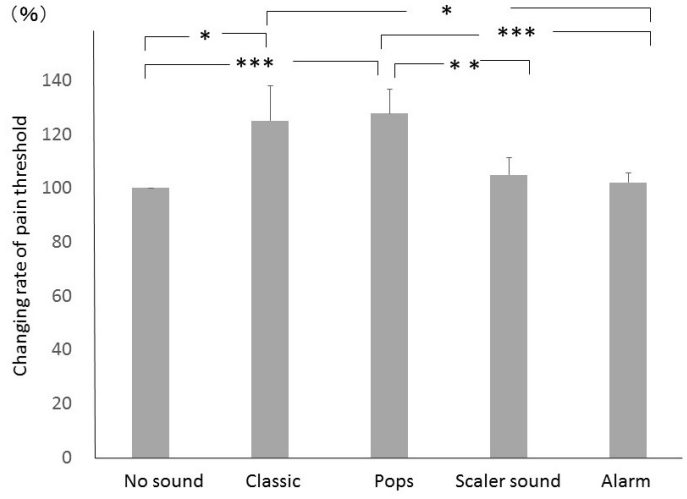

Figure 5: The changing rate of the pain threshold on the gingiva in listening to each sound compared with that without sound. Each vertical bar represents the mean ± SE. ***p < 0.0001, **p < 0.005, *p < 0.05.

Discussion

Pain Vision which we used in this study is the device that can objectively evaluate the quantity of pain threshold using electrical stimulation. The device was developed to measure the sense of touch threshold for the diabetic patient, but that was available to assay the pain threshold such this experiment.

The pain threshold of gingiva without sound showed the lower value than that on the forearm. The sensibility in the oral cavity is known to be more sensitive compared with other parts of body. Therefore, it was suggested that the pain threshold of gingiva was also more susceptible than that on the forearm, although there were individual differences in these values. In consideration of the individual difference, there was a strong correlation between the pain threshold of gingiva and forearm. It was suggested that the individual difference of the sense might be common through a whole body.

The value of the pain threshold on the forearm in listening to pops was significant higher than that without sound, in classical music and scaler sound. The value on the gingiva in listening to classical music or pops was significant higher than that without sound. On the both of gingiva and forearm, the pain threshold in listening to pops showed the highest value in five condition. Our results showed that music made the pain threshold increase, and pops was more effective than classical music for skin threshold.

It was reported that listening to music reduced pain, anxiety and stress, and increased patient satisfaction both in adult and pediatric patients [13-17]. Especially, classical music is widely used in dental or medical clinic and at nursing side to enhance relaxation induced from physiologic and psychological responses [18-20]. Moreover, the music affects the formation of morphine-6-glucuronide and the expression of the μ opioid receptor [21], and promotes the generation of the endorphin [22]. It is thought that music performance (tempo, rhythm and song) could elevate positive emotion through amygdala, which results in the relief of pain, anxiety and stress.

We tried two kinds of music as pleasant sounds and scaler sound or alarm as unpleasant sounds in thin study. It was reported that pain threshold were increased during the listening of pleasant music and were decreased in unpleasant music, suggesting the involvement of descending pain modulatory mechanisms in the effects of musical emotions on pain [12]. Therefore, before our examination, we hypothesized that unpleasant sound could make the pain threshold decrease. However, in our results, all sounds made the pain threshold on the gingiva and forearm increase, compared with that without sound. It was thought that subjects were paying attention to the some sounds during delivering the electrical stimulation. These results suggested that the pain sensitivity of acute pain might decrease in hearing any sound,

In this study, as subjects could not hear scaler sound and alarm during all time including interval of three times measurements, all sound was stopped at the same time as electrical stimulation. If the sound was delivered during all measure, we might obtain different results.

This study has several limitations. The sample size was small and only women were included. We tried one sound in a day to remove the influence of other sounds. Therefore, as subjects needed four days for four sound, they might be different condition on each day.

In summary, the pain threshold on the forearm was higher than that on gingiva and there was positive correlation between the pain threshold of gingiva and forearm. The present study showed that listening to pop music increases the pain threshold on the gingiva or skin, suggesting the involvement of descending pain –modulatory mechanism and the generation of the endorphin.

Conclusion

The pleasant sound is effective to increase the pain threshold on the forearm and gingiva. Music therapy which is one of auditory stimulation can be easily executed in the field of medicine as a low-cost therapy with no side effects.

Grant Details

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