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ORIGINAL ARTICLE

Effect of deep pressure input on parasympathetic system in patients with wisdom tooth surgery

Hsin-Yung Chen [a,b], Hsiang Yang [c], Ling-Fu Meng [a,d], Pei-Ying Sarah Chan [a,e], Chia-Yen Yang [f], Hsin-Ming Chen [c,g,h,i,*]

[a] Department of Occupational Therapy and Graduate Institute of Behavioral Sciences, College of Medicine, Chang Gung University, Taoyuan, Taiwan
[b] Department of Neurology and Dementia Center, Chang Gung Memorial Hospital, Taoyuan, Taiwan
[c] Department of Dentistry, National Taiwan University Hospital, Taipei, Taiwan
[d] Division of Occupational Therapy, Department of Physical Medicine and Rehabilitation, Chang Gung Memorial Hospital, Chiayi, Taiwan
[e] Department of Psychiatry, Chang Gung Memorial Hospital, Taoyuan, Taiwan
[f] Department of Biomedical Engineering, Ming-Chuan University, Taoyuan, Taiwan
[g] Department of Dentistry, National Taiwan University, Taipei, Taiwan
[h] Graduate Institute of Clinical Dentistry, National Taiwan University, Taipei, Taiwan
[i] Graduate Institute of Oral Biology, National Taiwan University, Taipei, Taiwan

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Background/purpose: Deep pressure input is used to normalize physiological arousal due to stress. Wisdom tooth surgery is an invasive dental procedure with high stress levels, and an alleviation strategy is rarely applied during extraction. In this study, we investigated the effects of deep pressure input on autonomic responses to wisdom tooth extraction in healthy adults.

Methods: A randomized, controlled, crossover design was used for dental patients who were allocated to experimental and control groups that received treatment with or without deep pressure input, respectively. Autonomic indicators, namely the heart rate (HR), percentage of low-frequency (LF) HR variability (LF-HRV), percentage of high-frequency (HF) HRV (HF-HRV), and LF/HF HRV ratio (LF/HF-HRV), were assessed at the baseline, during wisdom tooth extraction, and in the posttreatment phase.

Results: Wisdom tooth extraction caused significant autonomic parameter changes in both groups; however, differential response patterns were observed between the two groups. In particular, deep pressure input in the experimental group was associated with higher HF-

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* Corresponding author. Department of Dentistry, National Taiwan University Hospital, Number 1, Changde Street, Zhongzheng District, Taipei City 10048, Taiwan.
E-mail address: hmchen51@ntuh.gov.tw (H.-M. Chen).

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HRV and lower LF/HF-HRV during extraction compared with those in the control group.
Conclusion: LF/HF-HRV measurement revealed balanced sympathovagal activation in response to deep pressure application. The results suggest that the application of deep pressure alters the response of HF-HRV and facilitates maintaining sympathovagal balance during wisdom tooth extraction.

Introduction

Wisdom tooth extraction is one of the most common procedures associated with a high pain level, high stress, and anxiety regarding applying local anesthesia, and using invasive instruments.[1,2] These extraction procedures commonly lead to unpleasant sensory experiences that may complicate dental procedures,[1,3,4] resulting in inferior postoperative recovery.[5] The sensory dimension of pain is markedly suppressed by local anesthesia; however, reports on anxiety have revealed that a complex combination of cognitive, emotional, and affective factors causes wisdom tooth extraction per se to be unique to the individual.[1,2] Therefore, stress and anxiety management during tooth extraction is crucial for reducing risks and treating patients with high anxiety, particularly those with special needs.[6,7]

The autonomic nervous system (ANS) is crucial for the adaptation to anxiety.[8,9] Heart rate variability (HRV) is typically used as an index to investigate the central regulation and modulation of autonomic functions.[10,11] The ANS, comprising the sympathetic nervous system and parasympathetic nervous system, conveys information regarding autonomic influences on the rate and rhythm of the heart.[8] Although the HR levels are influenced by both sympathetic and parasympathetic activity, parasympathetic influences are pervasive over the frequency range of the HR frequency spectrum, whereas sympathetic influences "roll-off" at approximately 0.15 Hz.[12,13] Therefore, the high-frequency (HF) component (0.15—0.4 Hz) represents a marker primarily parasympathetic; influences with a low-frequency (LF) component (0.04—0.15 Hz) represent a mixture of sympathetic and parasympathetic autonomic influences;[11,13] and the LF/HF HRV ratio (LF/HF-HRV) reflects a predominance of sympathetic over parasympathetic balance.[10,11]

The parameters of HF-HRV have been hypothesized to be crucial in behavioral regulation and emotional adaptation theoretically and empirically.[14—16] Increased HF-HRV (vagally mediated) is associated with enhanced cognitive performance, particularly with the capacity for self-regulation, working memory, and psychological flexibility,[17—19] whereas the relative reduction in HF-HRV is associated with alterations in autonomic control over the cardiac function of behavioral and emotional dysregulation,[20,21] cognitive and behavioral inhibitory deficit,[15,20] and cognitive disorder.[20,22,23] Moreover, neuroimaging studies have indicated positive correlations between HF-HRV and the large number of cortical, subcortical, and brainstem structures that coordinate autonomic function.[17,24,25] In the dental environment, reduced HF-HRV in an attentional task indicates that the cognitive and behavioral regulation function might not provide an appropriate endogenous coping effect to alleviate anxiety in people with dental anxiety.[3] Therefore, exogenous stress management should be considered to be a supplement for stress and anxiety management in tooth extraction.

Deep pressure input is a type of tactile pressure stimulation exerted by firm touching, holding, stroking, hugging, swaddling, and squeezing, and it is carried by the dorsal column-medial lemniscal system to the somatosensory cortex.[26—28] Various modes of deep pressure strategies (e.g., weight blanket, weight vest, and papoose board) have been reported to alleviate feelings of anxiety and produce a calming effect.[28—30] Although physiological evidence is relatively scarce, the application of deep pressure input plays a role in ANS modulation under dental conditions. A few studies have reported a positive increase in HF-HRV, an indicator of emotion regulation, in dental prophylactic treatment with sustained deep pressure input in healthy individuals and patients with special needs;[31,32] however, the participants in these studies underwent dental treatment without anesthetic procedures. Although parasympathetic activity is increased, dental procedure-induced pain is still confounded by deep pressure input in psychological stress alleviation. Because local anesthesia is essential for pain suppression, *in vivo* exposure to deep pressure input during wisdom tooth extraction provides an opportunity for clarifying the contribution of deep pressure input through ANS response in behavioral adaptation for stress management and a calming effect.

The aim of the present study was to evaluate the effects of deep pressure input exerted by a weight blanket during wisdom tooth extraction in healthy adults under local anesthesia. Frequency domain HRV analysis in a relatively painless dental procedure potentially leads to sympathetic and parasympathetic responses during the treatment. We hypothesized that deep pressure input is an effective intervention strategy for altering the parasympathetic response in tooth extraction. In addition, the ANS modulation pattern during tooth extraction was investigated based on the basis of the LF/HF-HRV to verify the effect of deep pressure input.

Methods

Participants

Patients requiring wisdom tooth extraction were eligible to be recruited in this single-blind, randomized, crossover