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Well-Managed Postural Orthostatic Tachycardia Syndrome during Dental Therapy and Analysis of Heart Rate Variability: A Case Report

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Abstract: *This is the first case report of well-managed postural orthostatic tachycardia syndrome (POTS) intraoperatively monitored by heart rate variability (HRV) analysis in dentistry. POTS-associated autonomic dysfunction is induced by postural changes and easily leads to disturbances in circulatory dynamics; however, most dental practices have not yet realized the importance of managing POTS. We measured autonomic activity in a patient with POTS during dental therapy and assessed the clinical significance of HRV analysis for POTS. The patient was a 40-year-old Japanese male. He was diagnosed with impacted wisdom teeth and was in treatment for bronchial asthma and POTS. A surgical procedure to extract the teeth was safely performed under local anesthesia. During the therapy, he developed neither orthostatic tachycardia nor compensatory hypotension in either the upright or supine position. HRV analysis revealed POTS-associated autonomic dysfunction, that is, autonomic instability during postural change. Thus HRV analysis should become a useful tool for safe and secure dental management of POTS.*

Keywords: *Dental management, Postural orthostatic tachycardia syndrome, Heart rate variability*

I. Introduction

Postural orthostatic tachycardia syndrome (POTS), which was first described in 1993 [1], is a subtype of orthostatic dysregulation (OD) and is characterized by orthostatic tachycardia without obvious hypotension [2-5]. POTS has bothersome symptoms: palpitation, orthostatic and exercise intolerance, syncope, dizziness, lightheadedness, migraine, acrocyanosis, and so on [2-6]; these POTS-associated symptoms are considered results of autonomic dysfunction [2-4,6]. POTS is more common in young females [5], but is generally regarded as an uncommon disease in dentistry. Postural changes that are likely to induce POTS-associated autonomic dysfunction are routinely performed during dental therapy. POTS-associated autonomic dysfunction easily leads to disturbance in circulatory dynamics; however, most dental practices haven't realized the importance of managing POTS. We experienced a case of OD manifested during postural change on the dental chair and reported the importance of secure and safe dental management of OD patients [7].

Analysis of heart rate variability (HRV) is useful to assess autonomic activity and to diagnose autonomic neuropathy because HRV is a biosignal for the functions of the autonomic nervous system (ANS) [7-9]. An HRV analyzer looks just like a pulse oximeter and analyzes pulse-to-pulse variations in pulse rate by a built-in HRV analyzing system; it enables easy measurements of autonomic activity without inducing any stress in patients. We intraoperatively monitored autonomic activity of OD by HRV analysis and showed that HRV analysis revealed autonomic dysfunction associated with OD, that is, parasympathetic dominance due to postural change [7]. Autonomic activity in POTS during dental therapy has not previously been measured or elucidated by HRV analysis. We experienced a case of well-managed POTS and intraoperatively monitored the autonomic activity of POTS by HRV analysis. In this study, we assessed the clinical significance of HRV analysis for POTS in a dental practice.

II. Case Report

The patient was a 40-year-old Japanese male. He attended the Department of Oral Surgery and Dental Anesthesiology, Tokushima University Hospital and was diagnosed with impacted wisdom teeth. He was in treatment for bronchial asthma; however, he had gone undiagnosed and untreated since his adolescence, even though he had suffered orthostatic and exercise intolerance. In advance of surgery, he received diagnosis of

POTS and appropriate medication, a beta-adrenergic blocking agent (beta blocker), bisoprolol fumarate (5.0 mg/day) at the Cardiovascular Internal Medicine department of Tokushima University Hospital. At the onset of therapy, he developed neither orthostatic tachycardia nor compensatory hypotension in the upright or supine position, with a heart rate (HR) of 75 bpm and systolic/diastolic blood pressure (S/DBP) of 119/89 mmHg (Table 1, Figure 1). Local anesthesia, namely, infiltration of 1.8 ml of lidocaine containing 0.002% adrenaline was performed. The surgical procedure to extract the teeth was safely performed. When his posture was returned upright after surgery, tachycardia didn't develop.

HRV analysis was performed with an HRV analyzer (SA-3000P, Tokyo Iken Co. Ltd., Tokyo, Japan) during therapy. His postural change from supine to upright caused almost all parameters to decrease significantly (Table 1, Figure 1). At the moment of local anesthesia, all parameters except for the high-frequency (HF) components increased significantly (Figure 1). Normalized LF (LF norm) increased to 85.0 nu, and normalized HF (HF norm) decreased to 15.0 nu; the low-frequency/high-frequency (LF/HF) ratio increased to 5.665 (Figure 1). The LF/HF ratio remained at a high level, 6.178, during the incision and drilling procedures, and returned to an almost normal level, 2.051, at the moment of tooth extraction (Figure 1). After surgery, return of his upright posture caused almost all parameters to increase significantly (Table 1, Figure 1). The LF norm increased to 95.7 nu, and the HF norm relatively decreased to 4.3 nu; LF/HF ratio rose to 22.07 as a result (Table 1, Figure 1).

In advance of this study, the procedure for HRV analysis was explained to the patient and his informed consent was obtained.

III. Discussion

To our knowledge, this is the first case report of well-managed POTS intraoperatively monitored by HRV analysis in dentistry.

Diagnostic criterion of POTS for adults is the presence of orthostatic intolerance with an increase in HR of >30 bpm or with a HR of >120 bpm on head-up tilt test [3,5,6]. The pathogenesis of POTS is complex and multifactorial [2]; a reasonable hypothesis for the mechanism is as follows. Hypovolemia due to low volume of plasma or insufficient venous constriction causes a compensatory increase in sympathetic outflow and results in tachycardia [2-4]. In fact, most POTS patients increase blood norepinephrine (NE) levels on standing up [5]; an NE level of >600 pg/ml has been proposed as one diagnostic criterion [3,4,6]. In our case, the urinary NE level was abnormally elevated up to 235.1 μg/day in spite of normal blood NE level at rest. A high NE level predicts responsiveness to beta blockers [4], which are the most commonly prescribed medication for treatment of POTS. Beta blockers seem to reduce peripheral venous pooling and to increase venous return [6]. If their effects are insufficient, alpha-1 or -2 agonists are concomitantly used [6,10]. Actually, in our case, alpha-1 agonists were first chosen in consideration of exacerbated asthma, but when they proved insufficient, we switched to beta blockers. Oral intake of water and sodium is essential to maintain plasma volume [6]; furthermore, elastic support hose can help minimize the degree of peripheral venous pooling and enhance venous return [6]. Sodium intake and elastic support hose were applied effectively in our case.

HRV variables are as follows: total power (TP), very low-frequency (VLF) component, low-frequency (LF) component, HF, LF norm, HF norm, and LF/HF ratio. TP is the total variance of VLF, LF, and HF [11-13]. VLF, which ranges from 0.0033 to 0.04 Hz, is recognized as a supplemental marker of sympathetic function. LF, which ranges from 0.04 to 0.15 Hz, reflects sympathetic activity; HF, which ranges from 0.15 to 0.4 Hz, reflects parasympathetic activity [11,12,14]. LF or HF norm is defined as follows: LF or HF norm = 100× LF or HF / (TP – VLF). LF and HF norm are indices of sympathetic and parasympathetic activity, respectively. The LF/HF ratio is an index of autonomic balance and should be maintained between 0.5 and 2.0; higher values reflect sympathetic dominance, while lower ones reflect parasympathetic dominance. HRV analysis revealed autonomic instability in postural change. More specifically, postural change to an upright position increased autonomic activity and resulted in relatively sympathetic dominance; the opposite change led to the opposite result. Local anesthesia induced sympathetic dominance due to extrinsic epinephrine in the anesthetic.

Dental providers should be familiar with the clinical features of POTS patients so that we can treat them properly; we describe a recommended method to manage them based on our case. When taking a medical history, we should specifically inquire about the presence of POTS-associated symptoms [2] and attempt to discover the onset of the symptoms because POTS is often triggered by viral infection, trauma, surgery, or pregnancy [3,4]. Furthermore, it should be noted that POTS patients are often misdiagnosed as having severe anxiety or panic disorders [3,4]. In advance of dental therapy, we should contact the patient's physician appropriately [2]. Intraoperative HRV analysis should be applied as an essential tool for safe and secure dental management of OD including POTS [7], as well as intraoperative monitoring of BP and HR [2]. We should make efforts to prevent syncope from developing. More specifically, we should avoid frequent or abrupt changes in posture during dental therapy and slowly return patients from the supine to upright position after therapy and then assist them to gradually stand up [2]. POTS patients often have elevated scores on the Beck Anxiety Inventory [3]; intravenous sedation may possibly be beneficial in dental management of POTS. In fact, concomitant use of midazolam and nitrous oxide has been reported to elicit fully sedative effects for the management of OD [7]. Further investigation is required regarding sedative application to POTS.

Table 1 Scores of HRV variables during dental therapy

	Therapy onset	Pause	Local anesthesia	Incision and drilling	Teeth extraction	Pause	Therapy end
Posture	Upright	Supine	Supine	Supine	Spine	Supine	Upright
S/DBP[1] (mmHg)	119/89	118/73	121/65	112/65	118/68	122/67	118/64
Mean HRT[2] (bpm)	75	73	73	76	75	71	71
TP[3] (ms^2)	1859.6	1186.5	1426.2	1039.2	293.8	605.6	4891.1
VLF[4] (ms^2)	1109.6	976.4	1157.2	791.3	185.5	217.0	835.7
LF[5] (ms^2)	556.6	155.5	228.6	213.3	72.8	309.7	3879.6
HF[5] (ms^2)	193.4	54.6	40.4	34.5	35.5	78.9	175.8
LF norm[7] (nu)	74.2	74.0	85.0	86.1	67.2	79.7	95.7
HF norm[8] (nu)	25.8	26.0	15.0	13.9	32.8	20.3	4.3
LF/HF[9]	2.877	2.848	5.665	6.178	2.051	3.924	22.07

HRV, heart rate variability. [1]Systolic/Diastolic blood pressure, [2]Heart rate, [3]Total power, [4]Very low frequency, [5]Low frequency, [6]High frequency, [7]Nomalized low frequency, [8]Normalized high frequency, [9]Low-frequency/high-frequency ratio.

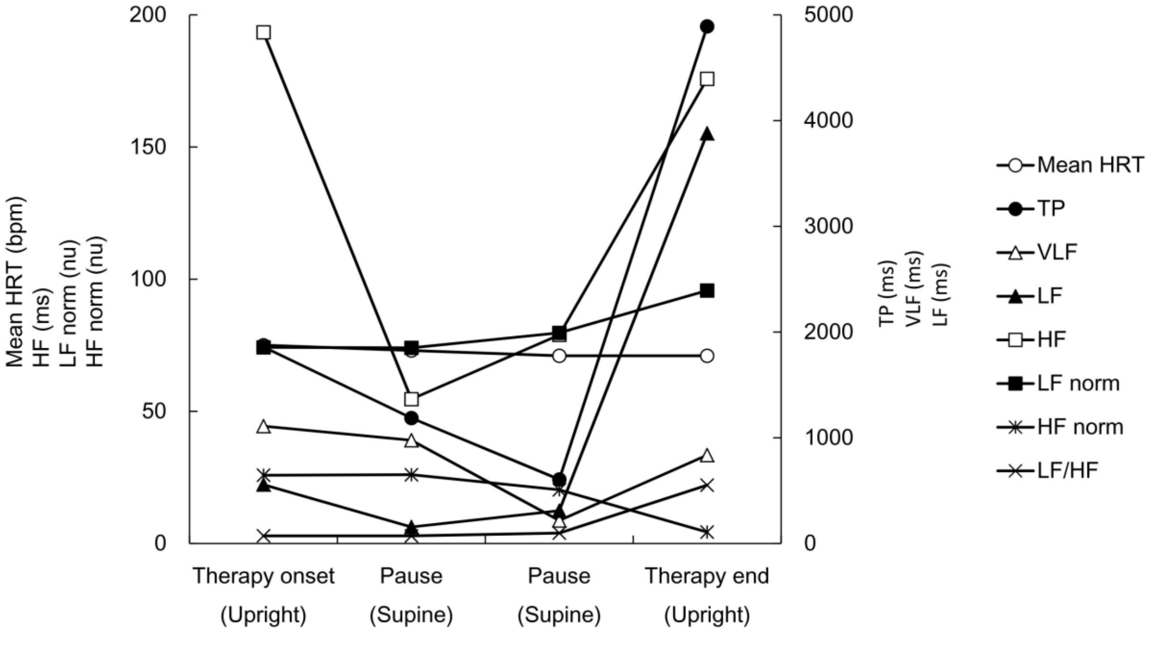

Figure 1 Time course of HRV variables with postural change.

IV. Conclusion

We experienced a case of well-managed POTS and performed dental surgery with intraoperative monitoring of autonomic activity of POTS by HRV analysis. HRV analysis revealed POTS-associated autonomic dysfunction, that is, autonomic instability during postural change. Our experience emphasizes the importance of HRV analysis with respect to secure and safe dental management of POTS patients.

Conflict of Interests

The authors have no conflict of interests regarding this study or the publication of this paper to declare.

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