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Autonomic nerve activity indexed using 24-h heart rate variability in patients with burns

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ABSTRACT

Background: Heart rate variability (HRV) is a noninvasive method used to quantify fluctuations in the time interval between normal heart beats. The purpose of this study was to compare the autonomic nervous system functioning of patients with burns to healthy participants after their burn scars had been re-epithelialized.

Materials and methods: The authors prospectively performed 24-h HRV monitoring in 60 patients with electrical burns, those with other major burns, those with other minor burns, and 10 healthy participants. Analysis of HRV in the time and frequency domain was performed.

Results: The difference in sympathetic nerve measures (standard deviation of NN intervals [SDNN], total power [TP] and a low frequency [LF] band) and parasympathetic nerve measures (Root mean square successive difference [RMSSD], the number of interval differences of successive NN intervals greater than 50 ms [NN50], the percentage of differences between following RR intervals greater than 50 ms [pNN50] and a high frequency [HF] band) in patients with burns was significantly decreased during the daytime and the nighttime. the difference in parasympathetic nerve measures were more significantly decreased during the nighttime compared with measures of HRV in healthy participants. The groups of other burns showed significantly lower HRV than the electrical burn group indexed by a very low frequency (VLF) measure and TP during the daytime.

Conclusion: We hypothesized that HRV is a surrogate for autonomic nervous system dysfunction in patients with burns. The patients with burns were observed a sympathetic predominance during daytime and a decreased parasympathetic activity during nighttime. These results of patients with other major burns were more predominant compared with the results of patients with other groups.

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1. Introduction

There are some reports about diffuse burn-associated peripheral neuropathy (BAPN) in major burn patients and they reported burn injuries may induce an inflammatory reaction that results in neuropathy [1]. The report presented cases of low voltage electrical injury with associated peripheral nervous symptoms without clinically significant skin surface burns. The mechanism of peripheral nervous injury is a compressive peripheral neuropathy induced by a low-voltage electrical burn [2]. One case report indicated sympathetic nervous dysfunction in an electrical burn and with development of significant palmar and axillary hyperhidrosis [3]. The autonomic nervous system may involve a generalized process rather than a local process and be related with sympathetically mediated pain [4,5].

Initially, the monitoring of fetal HRV has an important role in assessing the health of fetus. Most clinicians agree that minimal or absent HRV could be an indicator of fetal distress. Recent interest has focused on measures of heart rate variability (HRV), a important predictor of patients who are at risk for a complicated post-injury course. Analysis of heart rate variability during the first 24 h after a burn injury has been recommended to mark out patients with abnormal autonomic regulation who are predisposed to life-threatening arrhythmias [6]. HRV in the first 24 h after injury is a surrogate for autonomic nervous system dysfunction and a high probability of dying from trauma, including patients who are burned [7–9]. Some research studied chronic pain was related with autonomic nervous system dysfunction, specifically low HRV mediated by reduced parasympathetic cardiac activity [10]. Autonomic symptoms (orthostatic lightheadedness, erectile dysfunction, cold/warmth intolerance) may negatively affect the quality of life and psychological health of these patients. Detection and control of autonomic derangement can prevent many psychological, social, and financial complications.

There is no study that has evaluated autonomic nerve activity by using 24-h HRV monitoring in patients with burns after their burn scars had been re-epithelialized. This study was performed to find out the effects of electrical burns, the other major burns with more than 25% TBSA and the other minor burns with below 25% TBSA on HRV as an indicator of autonomic nervous system involvement.

2. Methods and materials

This study included 60 patients with burns who were admitted between December 2015 and June 2017. 20 patients with electrical burns, 20 patients with other major burns of more than 25% TBSA and 20 patients with other minor burns in Hangang Sacred Heart Hospital participated in this study. This research was approved by Institutional Review Board of the hospital. The participants provided written informed consent prior to the pretest. Exclusion criteria were the presence of peripheral neuropathic disease, diabetes mellitus, cardiac arrhythmia, paced rhythms on admission, and consumption of any drug affecting the autonomic nervous system (pregabalin, nortriptyline), any sign of autonomic system involvement (cold/warmth intolerance, orthostatic hypotension, tachycardia at rest, or erectile dysfunction), or if there was potential for additional damage to the skin due to the use of patches for holding the HRV recorder. The values were presented as mean ± standard deviation. Patients with electrical burns were all men with a mean age of 43.90 ± 10.93 years. The mean time from injury was 79.15 ± 22.46 days. 19 patients exposed high voltage (≥1000 V) and 1 patient exposed low voltage (<1000 V). Patients with other major burns were 18 men and 2 women with a mean age of 46.50 ± 14.00 years. The mean time from injury was 88.05 ± 24.86 days. The mean % TBSA involved in patients with other major burns was 44.25 ± 13.62%. Patients with other minor burns were 18 men and 2 women with a mean age of 46.70 ± 10.04 years. The mean time from injury was 75.90 ± 31.4 days. The mean % TBSA involved in patients with other minor burns was 12.25 ± 8.78% (Table 1). We also gathered a control group of 10 healthy, age-matched male participants (without any burns or conditions qualifying them for exclusion, and a mean age of 41.7 ± 2.2).

All tests were performed for 24 h. The patients were fitted with a long-term R-R interval (RRI) T-REX® (Monitor and Care;

Table 1 – Demographic and clinical characteristics of the participants.

	Patients with electrical burns (n=20)	Patients with other major burns (n=20)	Patients with other minor burns (n=20)	Difference
Male:female	20:0	18:2	18:2	P=0.34
Mean age (years)	43.90 ± 10.93	46.50 ± 14.00	46.70 ± 10.04	P=0.71
TBSA (%)	15.40 ± 9.28§	44.25 ± 13.62*	12.25 ± 8.78	P<0.001
Duration from burn to HRV measurement (days)	79.15 ± 22.46	88.05 ± 24.86	75.90 ± 31.41	P=0.33

Values are presented as mean ± standard deviation, P-values were calculated by ANOVA with post-hoc Tukey's test. TBSA: total burn surface area, HRV: heart rate variability.
* $p < 0.05$ vs. patients with other minor burns.
§ $p < 0.05$ vs. patients with other major burn.

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