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ORIGINAL ARTICLE

The effect of celiac plexus block on heart rate variability

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Abstract
Background Celiac plexus block (CPB) can be used for treating intra-abdominal visceral pain syndromes. The celiac plexus is the largest plexus of the sympathetic nervous system. Several nerve blocks have a marked effect on autonomic nervous activity. Furthermore, stellate ganglion block changes cardiac autonomic nervous activity. Thus, CPB could influence the sympathetic activity of the cardiac plexus. The aim of the present study was to see whether CPB modulated heart rate variability (HRV) in patients with pancreatic cancer.
Methods Twelve patients received neurolytic CPB using 14 ml absolute alcohol. Data recorded in a palm-sized electrocardiographic unit were analyzed for HRV.
Results CPB using a neurolytic solution did not induce any significant changes in the low-frequency (LF)/high-frequency (HF) ratio of HRV (LF/HF, $P = 0.4642$). Furthermore, the procedure did not induce any significant changes in blood pressure (systolic, $P = 0.5051$; diastolic, $P = 0.5180$).
Conclusion CPB did not induce any significant changes in HRV or hemodynamics.

Keywords Celiac plexus block · Heart rate variability · Sympathetic nerve activity

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Introduction

Celiac plexus block (CPB) can be used for treating intra-abdominal visceral pain syndromes. Usually, we apply it, using a neurolytic solution, in order to relieve pain in patients with pancreatic cancer [1–3]. The celiac plexus is the largest of the three great plexuses of the sympathetic nervous system (the cardiac, celiac, and hypogastric plexuses). Neuraxial blockade influences sympathetic nerve activities not only in anesthetized segments but also in unanesthetized segments [4]. Also, several nerve blocks have a marked effect on autonomic nervous activity, as shown by heart rate variability (HRV) analysis [5, 6]. Stellate ganglion block changes cardiac autonomic nervous activity [7]. Moreover, several studies have shown that the blockade to splanchnic nerves including sympathetic nerve fibers affects endocrine–metabolic responses to invasive procedures and plasma renin activity [8, 9]. Although there have been no data on the influence of CPB on HRV, it is possible that CPB could influence the sympathetic activity of the cardiac plexus.

HRV analysis is a non-invasive technique used to provide information about the cardiovascular autonomic nervous system [10–12]. HRV analysis provides important information about the effects of anesthesia on the autonomic and central nervous systems because variation of the heart rate is mediated by central and peripheral neural mechanisms. Frequency fluctuations in the range of 0.04–0.15 Hz (low frequency; LF) are considered to be markers of both sympathetic and parasympathetic nerve activity, and high-frequency (HF) fluctuations in the range of 0.15–0.4 Hz are considered to be markers of parasympathetic nerve activity. Thus, the LF/HF ratio is considered to be an index of sympatho-vagal balance [10–12].

We hypothesized that CPB using a neurolytic solution could influence the sympathetic activity of the cardiac

plexus, thereby changing HRV. The aim of the present study was to see whether CPB modulated HRV in patients with pancreatic cancer.

Methods

First, our institutional treatment guidelines for patients with pancreatic cancer mandate that patients who are referred to our palliative care team will be candidates for CPB while receiving the recommended systemic analgesics according to the WHO analgesic ladder; patients with uncorrectable coagulopathy or allergy to local anesthetics or alcohol, or those reluctant to undergo CPB were excluded from the study. After obtaining approval from the Ethics Committee of Aichi Medical University and receiving the patients' written informed consents, we studied 15 patients with pancreatic cancer. Patients who had a history of psychological illness or central nervous system or cardiovascular system dysfunction were not invited to participate in the present study.

A palm-sized electrocardiographic unit (Active Tracer.AC300; GMS, Tokyo, Japan) was placed on each patient for continuous recording of variations in autonomic nervous activity before the CPB operation. The unit was worn in a pouch at the waist with three electrodes taped to the chest until the day after the operation.

All patients were fasted for 3 h before the CPB operation, but were encouraged to take clear fluids until 1 h before the operation. The CPB operations were guided by computerized tomography (CT). After the patient's arrival in a CT room at 16:00, we used a traditional technique of the posterior approach with the patient placed in the prone position. We estimated the appropriate vertebral level for the insertion of a 140-mm, 22-gauge needle with a scale. Then the needle was inserted at the level of the first lumbar vertebra, about 6 cm away from the midline, below the twelfth rib. After lidocaine infiltration at the insertion site, the needle was advanced toward the front of the vertebral body. The CT scan was repeated in order to direct the needle 0.5–1.0 cm in front of the vertebral body, near the aorta [1]. After the CT scan confirmation of the needle tip location using contrast medium, 14 ml absolute alcohol was injected via the needle. The patients were instructed to rate their pain using an 11-point verbal rating scale (VRS) ranging from 0 to 10 (0, no pain; 10, worst imaginable pain). The VRS was measured before and 24 h after the CPB operation. If patients did not show more than 1 point decrease on the VRS, they were excluded from the present study.

Data recorded in the palm-sized electrocardiographic unit were analyzed for HRV by the maximum entropy method (CHIRAM; Suwa Trust Japan, Tokyo, Japan). The R–R intervals (RRI) were obtained every 5 min. The two components of power of the RRI (ms ms), LF (0.04–0.15 Hz) and HF (0.15–0.5 Hz), were calculated. Heart rate (HR) and the LF and the HF values and the LF/HF ratio of HRV were analyzed.

Data are presented as medians (ranges). Data were analyzed using the Friedman test. After the Friedman test for repeated-measure analysis, post hoc multiple comparison tests were performed with Dunn's method. A P value of <0.05 was considered statistically significant.

Results

After three patients were excluded, data from 12 patients were analyzed (5 males, 7 females). Demographic data and narcotic doses are presented in Table 1. The VRSs before and 24 h after the CPB operation were 3 (2–4) and 1 (0–2), respectively.

CPB using a neurolytic solution did not induce any significant changes in the LF/HF ratio of HRV (LF/HF, $P = 0.4642$) (Fig. 1). Furthermore, the procedure did not induce any significant changes in blood pressure (systolic, $P = 0.5051$; diastolic, $P = 0.5180$) (Fig. 2).

Discussion

The cardiac, celiac, and hypogastric plexuses are the three great plexuses of the sympathetic nervous system, of which the celiac plexus is the largest. CPB can be used for treating intra-abdominal visceral pain syndromes. Also, neurolytic CPB could be optimal for the management of refractory pancreatic cancer pain and to reduce the usage of opioids [1–3].

Table 1 Demographic data and narcotic doses

Patient	Gender	Age (years)	Weight (kg)	Narcotics and doses
1	Female	69	41	Oxycodone 10 mg/day
2	Male	76	51	Fentanyl 25 mg/h
3	Female	66	63	Fentanyl 25 mg/h
4	Male	76	52	Oxycodone 10 mg/day
5	Female	77	40	Oxycodone 10 mg/day
6	Female	61	61	Oxycodone 15 mg/day
7	Male	63	61	Oxycodone 15 mg/day
8	Female	74	48	Oxycodone 10 mg/day
9	Female	79	49	Oxycodone 10 mg/day
10	Female	66	35	Fentanyl 100 mg/h
11	Male	73	53	Oxycodone 10 mg/day
12	Male	59	60	Oxycodone 10 mg/day

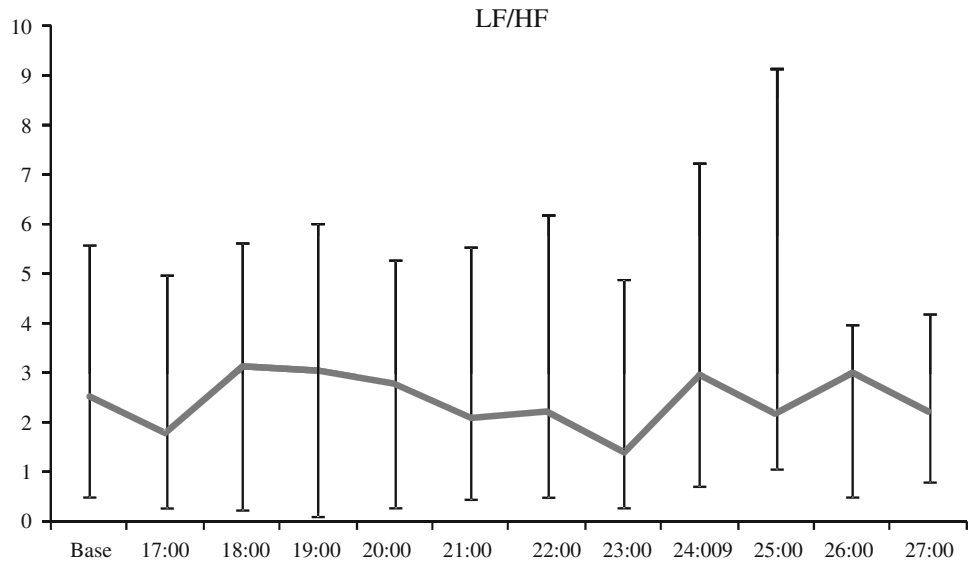

Fig. 1 Time course of changes in low-frequency (*LF*)/high-frequency (*HF*) ratio of heart rate variability

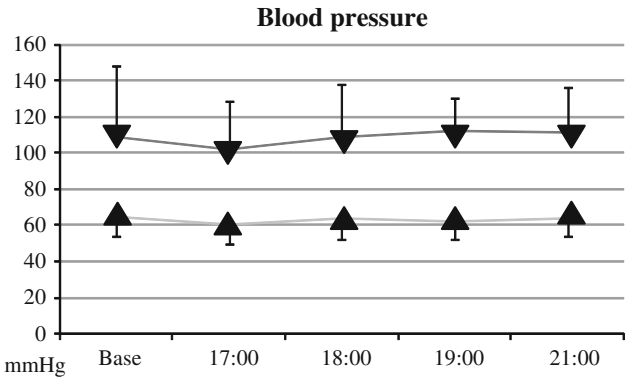

Fig. 2 Time course of changes in blood pressure

Neuraxial blockade changes sympathetic nervous activities in anesthetized segments [4, 5] and, furthermore, a significant influence is observed in unanesthetized segments [4]. Also, stellate ganglion block markedly influences not only cardiac sympathetic nervous activity [7] but also the sympathetic neural outflow of the lower extremity [13]. Furthermore, elimination of impulse activity in a sympathetic trunk influences synaptic efficacy at synapses in remote ganglions [14]. We thus hypothesized that CPB could influence the sympathetic activity of the cardiac plexus, but we found that neurolytic CPB did not induce any changes in HRV.

One explanation for the lack of CPB effect on HRV in the present study could be that all the patients had been taking opioids for the management of cancer pain. Several studies have shown that opioids modulate sympathetic nervous activity [15, 16]. We thus speculate that under the opioid influence, neurolytic CPB would not have shown any changes in HRV.

The clinical significance of the present study is that because CPB using a neurolytic solution did not induce any significant changes in HRV or hemodynamics, these results indicate that we can apply CPB to patients with cardiac dysfunction.

In conclusion, the present study is the first described report of the effect of CPB on HRV. The main finding is that CPB using a neurolytic solution did not induce any significant changes in HRV or hemodynamics.

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