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LETTER TO THE EDITOR

Perfusion index as a tool to evaluate the efficacy of stellate ganglion block for complex regional pain syndrome

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Keywords Sympathetic block · Stellate ganglion block · Complex regional pain syndrome · Temperature · Perfusion index

Abbreviations

CRPS	Complex regional pain syndrome
SGB	Stellate ganglion block
PI	Perfusion index
T	Temperature
ΔPI	Side differences in perfusion index increase
ΔT	Side differences in temperature increase

Dear Editors,

Vasomotor disturbance symptoms such as abnormal thermal sensation are common in patients with complex regional pain syndrome (CRPS) [1]. Sympathetic blocks can be applied to treat such vasomotor symptoms, and stellate ganglion block (SGB) is commonly used to manage CRPS involving the upper extremities [2]. To date, observations of the temperature increase on the treated side and the Horner's sign have been used as indicators of successful SGB [3]. However, in clinical practice, patients with chronic CRPS often have ambiguous changes in parameters such as temperature after a sympathetic block.

Perfusion index (PI) is a parameter calculated from photoplethysmography and reflects the perfusion state of the monitoring site. PI is expressed as the ratio (%) of the amplitude of the non-pulsatile signal to the amplitude of the pulsatile signal and its value ranges from 0.02–20% [4]. In previous studies, PI was reported more sensitive than temperature as a parameter to measure the effects after various interventions [5, 6]. However, PI has not been studied as an indicator of the effects of a sympathetic block in neuropathic conditions such as CRPS.

We retrospectively analyzed the medical records of 22 patients with chronic upper extremity CRPS whose temperature and PI were recorded after SGB between April 2016 and March 2018. The SGB was performed when the patient complained of pain and abnormal sensation of coldness on the CRPS-affected side. All diagnoses met the criteria for CRPS as recommended by the International Association for the Study of Pain [7]. The Institutional Ethics Committee of the Daejeon St. Mary's Hospital in Daejeon, Republic of Korea, approved this retrospective study analysis (DC18RESI0089).

The baseline temperature and PI were recorded after 10 min of bed rest in all patients under an ambient temperature of 24–26 °C. The pulse oximetry sensors (patient monitor VM 8; Phillips Inc., Amsterdam, Netherlands) were applied to the tip of the third finger bilaterally. Temperature was measured by touch thermometer (patient monitor VM 8; Phillips Inc.) at the volar aspect of the second fingertip bilaterally.

After SGB was performed, actual values of each parameter (PI and temperature) and the percentage of changes in each parameter over time were compared at 5, 10, and 20 min after the procedure.

The percentage of changes in PI and temperature at certain time points were obtained using the following formula:

$$\left(\left[\text{PI at certain time point} - \text{baseline PI}\right]/\text{baseline } PI\right) \times 100\,(\%),$$

$$([\text{Temperature at certain time point} - \text{baseline temperature}]/\text{baseline temperature}) \times 100\ (\%).$$

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To evaluate sympatholytic effects of SGB, side differences in PI increase (ΔPI) and temperature increase (Δ*T*) were obtained using the following formulas at 20 min after the procedure:

ΔPI = PI increase on the SGB-conducted side − PI increase on the contralateral side;

Δ*T* = temperature increase on the SGB-conducted side − temperature increase on the contralateral side.

If the patient reported pain relief and improvement in abnormal cold sensation on the CRPS-affected side after SGB, and the side difference of the parameter increase (ΔPI or ΔT) was a positive value, then the parameter was considered to reflect the effectiveness of the sympathetic block. In addition, if the side difference of the parameter increase was a negative value, the parameter was considered to not reflect the effect of the procedure.

Pain intensity was evaluated using a numerical rating scale (NRS) before and 20 min after the procedure.

Before and 20 min after the procedure, the NRS was 7.63 ± 0.49 and 3.77 ± 1.06, respectively. The overall reduction of NRS was 50.87 ± 12.41%. All patients reported improvement in abnormal sensation of coldness on the treated side.

Both PI and temperature showed overall chronological changes on the SGB-conducted side over time. Temperature did not show a significant increase over baseline at all time points. However, PI showed a significant increase at all time points compared with baseline on the SGB-conducted side. On the SGB-conducted side, the percentage of changes in PI was significantly higher than in temperature at all time points.

The ratios in which the side difference of the parameter increase (ΔPI or Δ*T*) had a positive value were significantly greater in the PI measurement method than in the temperature measurement method (PI measurement method: 22/22, 100% vs. temperature measurement method: 17/22, 77.27%, $p = 0.018$).

In chronic neuropathic conditions, alterations in peripheral circulation are very common phenomena and the capillaries on the affected site are already occluded in many cases of chronic CRPS [8]. The reduction of sympathetic function in patients with chronic CRPS has previously been described [1], and endothelial dysfunction, such as decreased vasodilatory nitric oxide and increased vasoconstrictive endothelin-1 concentration, has also been reported [9, 10].

Temperature has a relatively narrow range due to the homeothermic nature of the human body. In situations where the sympathetic outflow has already been reduced and the capillaries have been occluded, a clinical sign such as a temperature increase due to a sympathetic block may be less noticeable than in other pathologic conditions. Therefore, numerical changes in temperature following sympathetic block may be smaller in chronic CRPS patients. In addition, the temperature may not increase after a sympathetic block. Therefore, the temperature increase on the treated side after the sympathetic block may not be greater than the increase on the contralateral side.

In the present study, the percentage of PI changes from the baseline was significantly higher compared with the temperature, and the ratio of side difference of the parameter increase exhibiting a positive value was significantly greater in the PI measurement method than in the temperature measurement method.

In conclusion, PI reflects the sympatholytic effects of SGB better than temperature in patients with chronic CRPS. In situations where the peripheral circulatory environment is altered, such as chronic CRPS, the PI is a more recognizably displayed parameter than the temperature and is useful as an alternative substitute for temperature to measure the sympathetic block effects. Based on this preliminary study, prospective studies with adequate sample size are needed to demonstrate the usefulness of PI in the measurement of sympathetic block effects.

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Compliance with ethical standards

Conflict of interest The authors confirm that there is no conflict of interest.

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