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Retention of Finger Blood Flow against Postural Change Has the Potential to Become a New Indicator of Sympathetic Block in the Upper Limb - A Preliminary Study

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Abstract

Introduction: Increased skin temperature and decreased sweating are used to identify the adequacy of sympathetic block in the upper limb. This, however, requires a thermography device to precisely evaluate skin temperature and a diaphoremeter to measure sweating. Baroreflexes elicited by postural change induce a reduction in peripheral blood flow to sustain systemic blood pressure and cerebral blood flow. We hypothesized that sympathetic blockade in the upper limb results in minimal changes in finger skin blood flow against postural change from the supine to sitting position.

The aim of this study was to evaluate whether retention of finger blood flow against postural change can be used as a new indicator of sympathetic block in the upper limb.

Methods: We tested for the following three signs after performing stellate ganglion block (SGB): Horner's sign, brachial nerve blockade and finger blood flow, which was measured by a laser blood flow meter before and after SGB in the supine and immediately after adopting the sitting position. The criterion for determining effective sympathetic blockade in the upper limb was defined as follows:

(Blood flow in the sitting position) / (Blood flow in the supine position) > 90%.

Results: We executed a total of 80 SGBs in 7 patients. Two SGBs were excluded from analysis due to the absence of Horner's sign. Brachial nerve blockade after SGB was absent in all patients. The criterion of (Blood flow in the sitting position) / (Blood flow in the supine position) > 90% was observed significantly more often on the SGB (45 cases) than non-SGB side (3 cases).

Conclusion: Our results indicate that retention of finger blood flow against postural change has the potential to become a new indicator of sympathetic block in the upper limb.

Keywords

Autonomic nerve block, Baroreflex, Upper extremity, Regional blood flow

Introduction

Sympathetic block in the upper limb is commonly used for diagnostic, therapeutic and prognostic purposes, for a variety of conditions involving pain syndromes, vascular insufficiency and hyperhidrosis in the upper extremity. Increased skin temperature and decreased sweating are used to identify the adequacy of sympathetic block in the upper limb. However, this requires a thermography device to precisely evaluate skin temperature, and a diaphoremeter to measure sweating.

Under normal conditions, when changing from the supine to sitting position, baroreflexes elicited by the postural change induce a reduction in peripheral blood flow by increasing the sympathetic tone of peripheral blood vessels, in order to sustain systemic blood pressure and cerebral blood flow [1]. We hypothesized that sympathetic nerve block in the upper limb, in minimal changes in finger skin blood flow against postural change from the supine to sitting position.

The aim of this study was to evaluate whether retention of finger blood flow against postural change can be used as a new indicator of sympathetic block in the upper limb.

Methods

This study was approved by the ethics committee of Shimane University Faculty of Medicine. We received written informed consent from all patients for participation in the study. Seven patients, 2 males and 5 females, aged 36-82 years (mean age 68.6 years), required treatment of pain due to herpes zoster and other diseases by stellate ganglion block (SGB). The patients had no history of orthostatic intolerance, such as orthostatic hypotension and related diseases affecting the sympathetic nervous system, and were not on prescription vasoactive or cardiac medication.

Stellate ganglion block was performed via an anterior approach,

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Table 1: Number of stellate ganglion blocks (SGBs) and patient exclusion criteria

Number of SGBs performed	
Right side	32
Left side	46
Exclusion criteria	
Negative Horner's sign	2
Brachial plexus block	0

Table 2: Finger blood flow

	Before SGB		After SGB	
	supine	sitting	supine	sitting
Side of SGB	35.0 ± 15.7	21.1 ± 13.8*	45.3 ± 14.5	39.8 ± 16.9*
Contralateral side	39.6 ± 14.7	22.4 ± 12.3*	42.0 ± 14.3	21.6 ± 12.3*

mean ± SD, ml·min^{-1}·100g tissue^{-1}

*p<0.0001, Student's t-test

Table 3: Number of procedures in which (blood flow in the sitting position) / (blood flow in the supine position) was > 90%

	Before SGB	After SGB
Side of SGB	2	45*
Contralateral side	3	3

* P=0.0003, Chi-square test

using a 25-gauge and 25mm length injection needle, with injection of 5ml of 1% mepivacaine below the prevertebral fascia (longus colli muscle) at the C6 level, using the microconvex transducer of an ultrasound system (S-Nerve, Sonosite Co. Ltd., USA). The technique of ultrasound-guided SGB differs from that of conventional SGB, in which a needle is inserted perpendicular to the skin and contacts the transverse process of C6. As the anatomical basis of this technique is that the cervical sympathetic trunk lies entirely subfascially [2], the needle is not required to contact the transverse process of C6 under ultrasound-guided SGB. This technique allows for a more effective and precise sympathetic block with the use of a small injectate volume, and may improve the safety of the procedure by direct visualization of vascular and soft tissue structures [3].

Thereafter, the following 3 parameters were assessed in all patients:

1. Horner's sign. This was assessed to identify the success of nerve block of the cervical sympathetic trunk.

2. Presence of brachial nerve blockade, to exclude sympathetic block in the upper limb due to inadvertent brachial plexus block. In patients in whom it did occur, a significant increase in blood flow to the fingers of the blocked hand was observed throughout the period of brachial plexus anesthesia [4].

3. Finger blood flow in both thumbs. This was measured using a laser blood flow meter (Laser Doppler ALF 21D, ADMEDIC co. Ltd. Japan), on ipsilateral and contralateral sides, in the supine position and immediately after changing to the sitting position, before and 20 min after SGB. Laser Doppler flowmetry is an excellent noninvasive technique for the measurement of cutaneous microcirculation [5,6]. Laser Doppler probes were attached to the ball of both thumbs to measure cutaneous microcirculation bilaterally. Finger blood flow just after changing to the sitting position was measured as the lowest blood flow data. The results of blood flow were expressed as ml·min^{-1}·100g tissue^{-1}.

The criterion for determining effective sympathetic blockade in the upper limb was:

(Blood flow in the sitting position) / (Blood flow in the supine position) > 90%

This is because an efficacious SGB may suppress baroreflexes in the upper limb and sustains finger blood flow against postural change. Comparisons of finger blood flow were made between the supine and sitting positions on the ipsilateral side before and after the block.

Statistical analysis of the blood flow pre and post SGB was made with Student's t-test. Analysis of the efficacy of the block, by assessing finger blood flow on the SGB and contralateral sides was made with the chi-square test. Stat view for Macintosh (version 5.0; SAS Institute Inc. NC, USA) was used for all statistical analysis. P values < 0.01 were considered to be significant.

Results

We executed a total of 80 SGBs in 7 patients. Two SGBs were excluded from analysis because of absence of Horner's sign (Table 1). There was no patient with brachial nerve blockade after SGB (Table 1). Bleeding as a complication during and after the procedure did not occur in any of the procedures. Before SGB, finger blood flow in the thumbs of both the SGB and non-SGB sides decreased significantly with a change in posture from the supine to sitting position (Table 2). After SGB, finger blood flow significantly decreased with a change in posture on both ipsilateral and contralateral sides, the amount of decrease being lower on the SGB side as compared to the non-SGB side (Table 2). On the contralateral sides, the finger blood flow in the sitting position decreased to almost half that in the supine position (Table 2). The number of procedures in which (Blood flow in the sitting position) / (Blood flow in the supine position) was > 90% was not significantly different between the ipsilateral and contralateral sides before SGB (Table 3). However, after SGB, the number of procedures in which (Blood flow in the sitting position) / (Blood flow in the supine position) was > 90% were significantly higher on the SGB as compared to the non-SGB side (Table 3).

Discussion

The signs of successful SGB are Horner's syndrome (miosis, ptosis, enophthalmos), lack of sweating, nasal congestion, venodilation in the hand and forearm and increase in skin temperature of the blocked limb by at least 1 degree Celsius [7]. The most commonly used method for assessing successful sympathetic blockade of the upper limb is measurement of the temperature of the skin. Skin temperature assessment with an infrared thermometer is a reliable early indicator of a successful nerve block [8]. Other techniques include measurement of skin-resistance and the sweat test.

As an index of successful sympathetic blockade in the upper limb after SGB, we initially decided to merely evaluate the rate of increase in finger blood flow after the block. Increased blood flow in the hand is considered an indicator of sympathetic blockade, although it may be affected by human mental stress. Mental stress elicits robust and reproducible increases in skin sympathetic nerve activity in humans [9]. SGB is an invasive procedure that is performed in individuals who are physically and mentally stressed by their primary pathology, the procedure itself inducing further physical and mental stress, since performing the procedure by an anterior approach involves insertion of a needle through the front of the neck. Relief from mental strain after SGB itself results in a decrease in sympathetic activity and an increase in finger blood flow by the resultant vasodilatation. Hence, an increase in blood flow after SGB is, by itself, not a reliable indicator of successful blockade of sympathetic nerve activity in the upper limb. On the other hand, the vasoconstriction reflex due to postural change is not affected by mental strain. In general, baroreflexes elicited by postural change induce vasoconstriction of peripheral vessels and a reduction in peripheral blood flow, in order to sustain systemic blood pressure. The sympathetic nerve block induced in the upper extremity by SGB prevents efferent nerve conduction to the peripheral vessels, and hence, postural change-induced vasoconstriction. In fact, it induces peripheral vasodilation in the upper extremity and maintains blood flow in the face of postural change.

Blockade of the sympathetic nerves is thought to be an all or none phenomenon. Hence, it is not suitable to only evaluate the difference in mean blood flow before and after sympathetic blockade. Szili-Torok et al. considered the measurement of blood flow was less reliable for assessing sympathetic blockade than for evaluating reflex responses. They reported that the determination of baroreflex stimulus-induced microvascular responses might serve as a feasible

method for monitoring the effectiveness of sympathetic blockade by axillary brachial plexus block [10]. They were calculated cutaneous vascular resistance to evaluate sympathetic activity, but it seems to be complicated in clinical situation. In this study, finger blood flow significantly decreased on both the SGB and non-SGB sides by postural change after SGB. However, we assessed the efficacy of sympathetic blockade by comparing the SGB with the non-SGB side, regardless of the difference in mean finger blood flow, to confirm that the postural change was indeed due to the effect of sympathetic blockade. Retention of finger blood flow at > 90% of its value before the block was taken to indicate an adequate sympathetic blockade. The data indicated significant differences between the groups. The number of procedures with retention of finger blood flow on the SGB side was significantly higher than the number on the non-SGB side. This indicates that sympathetic blockade of the upper limb maintains blood flow despite the baroreflex stimulated by postural change.

In conclusion, our study shows that retention of finger blood flow against postural changes has the potential to become a new indicator of sympathetic block in the upper limb. A larger clinical study will be required to evaluate the correlation between postural change and retention of finger blood flow.

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