

Effects of right and left stellate ganglion block on blood pressure and QT-QTc intervals in patients with primary Raynaud's phenomenon

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Aim: To examine the effects of right and left stellate ganglion block (SGB) on blood pressure and the RR, QT, and QTc intervals in patients with primary Raynaud's phenomenon.

Materials and methods: Right and left SGBs were performed with 8 mL of 0.5% bupivacaine in 10 patients with primary Raynaud's phenomenon. There was an interval of at least 1 week between the right and left blocks of each patient. The blood pressure and the RR and QT intervals were measured before the block and 5, 10, 15, 20, and 30 min after the block. The QTc interval was calculated using Bazett's formula.

Results: The RR and QT intervals were longer 20 and 30 min after right SGB when compared with the preblock value ($P = 0.037$ for RR and $P = 0.008$ for QT). The QT and QTc intervals 20 and 30 min after left SGB were shorter than the preblock values ($P = 0.011$, $P = 0.012$ for QT; $P = 0.013$, $P = 0.009$ for QTc).

Conclusion: We conclude that right SGB prolongs the RR and QT intervals while left SGB shortens the QT and QTc intervals in patients with primary Raynaud's phenomenon. Precautions must be taken, taking into account the risk of fatal arrhythmia following right SGB.

Key words: Stellate ganglion block, QT interval, Raynaud's phenomenon

Primer Reynaud fenomeni olan hastalarda sağ ve sol stellat gangliyon bloğunun kan basıncı ve QT-QTc interval üzerine olan etkileri

Amaç: Primer Reynaud fenomenli hastalarda bilateral (sağ ve sol) stellat ganglion bloğu (SGB)'nin kan basıncı, RR, QT ve QTc intervali üzerine olan etkisini araştırmak.

Yöntem ve gereç: Primer Reynaud fenomenli 10 hastaya 8 mL % 0,5 bupivakain ile sağ ve sol SGB uygulandı. Her hastanın sağ ve sol blokları arasında en az 1 hafta beklenildi. Kan basıncı, RR, QT interval blok öncesi ve blok sonrası 5, 10, 15, 20 ve 30. dakikalarda ölçüldü. QTc intervali ise Bazett'in formülü kullanılarak hesaplandı.

Bulgular: Sağ SGB sonrası RR ve QT intervali 20. ve 30. dakikalarda blok öncesi değerlere göre daha uzundu ($P = 0,037$, $P = 0,008$ RR ve QT için sırasıyla). Sol SGB sonrası QT ve QTc intervali 20. ve 30. dakikalarda blok öncesi değerlere göre daha kısaydı ($P = 0,011$, $P = 0,012$, $P = 0,013$, $P = 0,009$ QT ve QTc için sırasıyla).

Sonuç: Primer Reynaud fenomenli hastalarda sağ SGB'nin RR ve QT intervalini uzattığı, sol SGB'nin ise QT ve QTc intervalini kısalttığı sonucuna varılmıştır. Özellikle sağ SGB sonrası fatal aritmi gelişebilme ihtimali göz önünde bulundurularak, bu duruma hazırlıklı olunmalıdır.

Anahtar sözcükler: Stellat ganglion bloğu, QT interval, Raynaud fenomeni

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Introduction

Raynaud's phenomenon (RP) was first defined as bouts of reversible vasospastic ischemia of the fingers and toes by Maurice Raynaud in 1862 (1). It typically manifests as an initial white discoloration (pallor) of the digits as a reaction to cold, which leads to cyanosis, pain, and numbness, followed by a postischemic red flush upon rewarming. Treatment can include nonpharmacological treatment (protecting the extremity from the cold and keeping it warm, decreasing emotional stress, stopping smoking), pharmacological treatment, surgical treatment, and stellate ganglion block (SGB). Stellate ganglion block is an established procedure for the diagnosis and treatment of pain, impaired vascular circulation, reflex sympathetic dystrophy, causalgia, and herpes zoster (2).

The QT interval of the electrocardiogram (ECG) represents ventricular depolarization and repolarization. Drugs, electrolyte imbalances, and some neurological, cardiac, and metabolic disorders can lead to QT prolongation. Abnormal sympathetic modulation or vagal withdrawal may directly alter ventricular repolarization, also leading to a prolonged QT interval (3). Previous studies have shown that right SGB induces significant increases of the QT interval and the corrected QT (QTc) interval, while left SGB induces a significant decrease of the QT-QTc interval (4,5). Sinus arrest has also been reported following right SGB (6). Prolongation of the QT interval may lead to grave, life-threatening arrhythmias, including polymorphic ventricular tachycardia (torsades de pointes (TdP)) and ventricular fibrillation (7). Although the exact etiology and underlying pathophysiology of RP are unclear, sympathetic hyperactivity is one of the mechanisms (8). If we consider that there is sympathetic hyperactivity in patients with primary RP, we can postulate that the QT interval may decrease in these patients. As the QT interval increases after SGB, it should be interesting to analyze the QT interval in patients with primary RP and sympathetic hyperactivity after SGB. There are no prospective trials concerning the effects of SGB on the QT interval in patients with RP. There are no previous reports analyzing this phenomenon in patients with primary RP, as far as we know. The aim of this study was to investigate the effects of right and left SGB on blood pressure and the RR interval, QT interval, and QTc interval in patients with primary RP.

Materials and methods

A total of 10 patients with ASA status I or II, between 20 and 60 years old, weighing between 50 and 90 kg, and scheduled to receive right and left SGB for primary RP, were prospectively enrolled in the study after obtaining institutional ethics committee approval and receiving written informed consent from the patients. A detailed history was taken and an examination was performed for each patient, and any abnormality with respect to a preexisting conduction defect was ruled out. Exclusion criteria were any contraindications to SGB, a known allergy to bupivacaine, pregnancy, diabetes mellitus, severe liver or renal disease, electrolyte abnormalities, documented coronary heart disease or intake of drugs that can influence the conduction of cardiac impulses, and abnormalities of cardiac conduction on the preoperative 12-lead ECG.

All patients were placed in the supine position and standard monitors were applied, including automatic blood pressure cuff, pulse oximetry, hand skin temperature, and standard 12-lead ECG. An intravenous line was established and the ECG was recorded at a paper speed of 25 mm/s before performing the block. Randomly, using computer-generated random numbers, patients received right and left SGBs, with a 1-week interval between the 2 blocks. A paratracheal technique was used. A 25-gauge needle was inserted at the medial edge of the sternocleidomastoid muscle, just below the level of the cricoid cartilage at the level of the transverse process of C7 (approximately 1.5 cm below the transverse process of the sixth vertebra). The nonoperative hand was used to retract the muscle together with the carotid sheath prior to needle insertion. The needle was advanced to the transverse process and withdrawn 2 mm prior to injection. Following a negative aspiration for blood and cerebrospinal fluid, a 1-mL test dose of 0.5% bupivacaine (Marcain, AstraZeneca Co., İstanbul, Turkey) was injected. After a wait of 30 s, the injection was completed to a total of 8 mL of 0.5% bupivacaine. The needle was then withdrawn. The subjects were moved from the supine position to a sitting position (70° upright), and manual pressure was applied to the insertion point for 2-3 min just after SGB. A sympathetic block was confirmed by an increase

in the skin temperature of the ipsilateral hand and evidence of Horner's syndrome. Skin temperatures were recorded with Siemens temperature probes (Infinity Delta) attached to the third finger on each side of the patient. All blocks were performed by the same anesthesiologist.

An electrocardiogram was recorded after right or left SGB. Systolic and diastolic arterial blood pressure, hand skin temperature, RR interval, and QT interval measurements were performed before and 5, 10, 15, 20, and 30 min after the block. The QT intervals were measured manually from the onset of the QRS complexes to the end of the T wave (defined as the intersection of the isoelectric line and the tangent of the maximal downward limb of the T wave). QT intervals were measured in all 12 leads and corrected for heart rate according to Bazett's formula (9). ECG measurements and analyses were performed by a cardiologist blinded to the group receiving the block.

Statistical analysis

Statistical analysis was performed using SPSS 15.0 for Windows (SPSS, Inc.). We expressed the results as mean \pm SD. The univariate analysis of variance test was used to compare the systolic blood pressure (SBP), diastolic blood pressure (DBP), RR, QT, and QTc measurements before and after SGB within the groups. The Tukey honestly significant difference (HSD) test, Tamhane t-test, or Dunnett t-test were used to analyze intragroup differences according to the homogeneity of variances. P-values less than 0.05 were considered to be statistically significant in all analyses.

Results

Horner's syndrome developed in all patients following right and left SGB, and the skin temperature had increased by more than 2 °C by 20 min after the block. There was no significant difference in SBP or DBP following right or left SGB ($P < 0.05$) (Tables 1 and 2). The RR and QT intervals were longer than the preblock value 20 and 30 min after right SGB ($P = 0.037$ for RR, $P = 0.008$ for QT) (Table 3). The QTc interval was longer than the initial value for all measurement times except at 5 min, but this increase was not statistically significant (Table 3).

Table 1. Systolic and diastolic blood pressure values before and after right SGB (mean \pm SD).

	SBP (mmHg)	DBP (mmHg)
Preblock (baseline)	109.9 \pm 9.4	72.6 \pm 9.3
5 min after the block	113.0 \pm 16.0	72.1 \pm 7.4
10 min after the block	110.0 \pm 10.3	71.0 \pm 6.3
15 min after the block	109.8 \pm 8.9	73.1 \pm 5.8
20 min after the block	106.2 \pm 9.7	69.9 \pm 6.2
30 min after the block	106.8 \pm 9.2	68.3 \pm 6.5
P-value	0.436	0.187

SBP: systolic blood pressure, DBP: diastolic blood pressure.

Table 2. Systolic and diastolic blood pressure values before and after left SGB (mean \pm SD).

	SBP (mmHg)	DBP (mmHg)
Preblock (baseline)	105.5 \pm 10.1	68.3 \pm 7.7
5 min after the block	112.1 \pm 12.6	73.2 \pm 11.2
10 min after the block	113.6 \pm 11.3	73.5 \pm 10.6
15 min after the block	109.8 \pm 14.3	72.4 \pm 11.7
20 min after the block	111.1 \pm 15.9	71.2 \pm 10.0
30 min after the block	109.8 \pm 12.9	71.4 \pm 12.1
P-value	0.169	0.527

SBP: systolic blood pressure, DBP: diastolic blood pressure.

The QT and QTc intervals were found to be lower than the preblock values 20 and 30 min after left SGB ($P = 0.011$, $P = 0.012$ for QT; $P = 0.013$, $P = 0.009$ for QTc) (Table 4). There was no difference in the RR intervals ($P = 0.666$) (Table 4).

Discussion

The principal findings of this preliminary study demonstrate that right SGB caused prolongation of the RR and QT intervals, while left SGB caused a shortening of the QT and QTc intervals in patients with RP.

Table 3. RR, QT, and QTc values before and after right SGB (mean \pm SD).

	RR (ms)	QT (ms)	QTc (ms)
Preblock (baseline)	760.5 \pm 80.0	358.9 \pm 19.0	412.7 \pm 25.8
5 min after the block	781.9 \pm 54.7	361.8 \pm 38.5	409.2 \pm 39.4
10 min after the block	798.9 \pm 42.6	373.4 \pm 29.9	417.9 \pm 33.1
15 min after the block	790.0 \pm 63.4	377.1 \pm 29.1	424.2 \pm 23.2
20 min after the block	819.5 \pm 33.2*	384.6 \pm 17.4*	425.0 \pm 21.5
30 min after the block	825.6 \pm 17.6*	378.8 \pm 22.2*	416.9 \pm 24.8
P-value	0.016	0.012	0.044

*P = 0.037 versus baseline, +P = 0.008 versus baseline.

Table 4. RR, QT, and QTc values before and after left SGB (mean \pm SD).

	RR (ms)	QT (ms)	QTc (ms)
Preblock (baseline)	827.5 \pm 55.3	360.8 \pm 29.5	396.7 \pm 29.9
5 min after the block	819.7 \pm 55.3	363.6 \pm 33.1	401.7 \pm 33.4
10 min after the block	838.8 \pm 40.2	354.7 \pm 37.1	387.2 \pm 37.6
15 min after the block	833.1 \pm 40.8	354.9 \pm 20.9	388.9 \pm 20.8
20 min after the block	829.6 \pm 55.1	343.0 \pm 21.9*	376.9 \pm 23.9 [#]
30 min after the block	838.9 \pm 49.1	340.4 \pm 29.6**	371.7 \pm 30.4 ^{##}
P-value	0.666	0.045	0.025

*P = 0.011 versus baseline, **P = 0.012 versus baseline, [#]P = 0.013 versus baseline, ^{##}P = 0.009 versus baseline.

The effect of SGB on the QT interval has previously been studied in healthy subjects (4,5,10-12); patients with recurrent supraventricular tachycardia (13); patients suffering from chronic headache, neck, or upper extremity pain not accompanied by trophic changes due to causes such as capsulitis, tendinitis, and brachialgia (14); and patients with long QT durations (15). However, the effects of SGB on the QT interval in humans remain controversial. Kashima et al. (10) reported that right SGB lengthened the corrected QT interval significantly in healthy patients, while a left-sided block did not. Egawa et al. (4) and Fujii et al. (5) demonstrated that right SGB increased the QT and QTc intervals while left SGB decreased the QT and QTc intervals in healthy patients. Cinca et

al. (13) reported that right SGB prolonged the QT interval slightly, while left SGB did not, in patients with supraventricular tachycardia. Fujiki et al. (11) reported that neither right nor left SGB changed the corrected QT interval in healthy subjects. Similarly, Gardner et al. (12) did not find any significant change in the QT interval after left or right SGB in patients without QT prolongation.

We have shown a significant decrease in the QT interval after left SGB and a significant increase after right SGB in the present study. There is normally considerable right-left asymmetry in the distribution of the sympathetic fibers to the heart (16). Fibers from the left stellate ganglion are distributed to the posterobasal wall of the left ventricle, and those from

the right stellate ganglion are mainly distributed to the anteroapical wall of the left ventricle. The difference between the reactivities of left SGB and right SGB are thought to be due to the laterality of the sympathetic nerve distribution. The differing effects of right and left block may also be related to consequences of SGB via the spread of the local anesthetic to the cardiac branch of the vagal nerve (11,17). Yokota et al. (18) also reported that unintentional block of the vagus nerve following SGB results in severe hypertension with facial palsy.

We observed prolongation of the RR interval following right SGB. There is controversy in the literature about the effects of SGB on the RR interval. Fujii et al. (5) and Egawa et al. (4) could not find any significant change in the RR interval after right SGB, but Saxena et al. (14) and Kashima et al. (10) found an increase. The RR interval is determined by both sympathetic and parasympathetic neural activity. The cardiac vagal trunks travel close to the stellate ganglion, and local anesthetics may infiltrate not only the stellate ganglion but also the parasympathetic cardiac fibers. The decrease in both sympathetic and parasympathetic influence on the sinus node may therefore inconsistently counterbalance and change the RR interval.

Patients are usually kept in the supine position for 15-20 min following SGB in clinical practice. The postural change from the supine position to the sitting position has been reported to prolong the QT and QTc intervals and cause hemodynamic changes (19,20). Fujii et al. (5) have reported a further increase

in the prolonged QT interval following right SGB with a head-up position. A head-up tilt after right SGB may therefore induce a further risk of arrhythmias and adverse hemodynamics. Our patients are quickly brought to the sitting position following the SGB injection to ensure optimal distribution of the anesthetic around the ganglion and to the upper thoracic region. We believe that bringing the patients into a sitting position before the block's effects appear may prevent further prolongation of the QT interval. The effect of the time at which the patient is brought to a sitting position on the QT and QTc interval after SGB should therefore be demonstrated and confirmed.

Medication-related QT pattern changes and TdP-type arrhythmias are reported to be more frequent in females (21). We did not observe this difference because of the limited number of cases, which might be the main limitation of this study. There was also no control group. This study should be followed by a larger controlled trial to confirm the present findings.

In conclusion, we observed a statistically significant prolongation of the RR and QT intervals after right SGB and a shortening of the QT and QTc intervals following left SGB in patients with primary RP. Perioperative cardiovascular events may be prevented in all patients with primary RP, whether they are known to suffer from cardiac problems or not, by careful preprocedural investigation and preparation, proper monitoring, and close observation, in addition to providing the proper conditions and technical equipment so that any necessary intervention can be performed.

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