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Effect of Stellate Ganglion Blocks for Refractory Ventricular Tachyarrhythmia: An Observational Study

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Abstract

Background: Stellate ganglion block (SGB) is a minimally invasive, simple bedside procedure. Although it is easy to perform, caution should be implemented because it lies near large vessels, multiple nerves, and the airway. Occasionally ventricular arrhythmias like ventricular tachycardia (VT) and ventricular fibrillation (VF) can be refractory to usual drug therapy and electrical defibrillations. Stellate ganglion blockade (SGB) has been described as an effective intervention in patients with refractory ventricular arrhythmia.

Method: Anaesthesiologists in cardiac critical care units performed Stellate ganglion block on six patients at the bedside. Outcomes of left SGB for VT and VF burden and defibrillations at 24 hours of SGB were studied.

Result: Six patients underwent left SGB, hemodynamic stability and rate control was observed in all patients (100%) after successful blockade but conversion to normal sinus rhythm was seen in only three (50%) of the patients. Defibrillation after blockade was not required for 24 hours in 50% of the patients, 18 hours in 1(17%) of the patients and rest 2 (33%) required after 12 hours. None of the patients had any side-effects' except hoarseness of voice in one patient which was resolved spontaneously after 6 hours..

Conclusion: The perioperative management of non-cardiac tumors with cardiovascular extension is unique and challenging. The facilities of cardiovascular team with CPB, one lung ventilation, DHCA, rapid transfusion and TEE were useful for a perfect outcome.

Keywords: Stellate ganglion block; Ventricular tachycardia; Ventricular fibrillation; Electrical defibrillation.

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INTRODUCTION

Anaesthesiologists and pain physicians have used stellate ganglion block (SGB) for relieving sympathetically maintained pain like in complex regional pain syndromes, vascular insufficiencies, and treatment of medical conditions such as post-traumatic stress disorder, cluster headache, or intractable angina. Lately, it has been used successfully to ablate intractableventricular tachycardia (VT) and ventricular fibrillation (VF). The recurrence of three or more episodes of VT/VF within a period of 24 hours is known as a ventricular electrical storm (VES). The mechanism behind VES is thought to be a combination of several factors and usually presents in patients with some combination of structural heart disease, an inciting trigger, and activation of sympathetic activity.[1]

The inferior cervical ganglion joins with the first thoracic ganglion to form the stellate ganglion. The stellate ganglion is 2.5 cm long, 1 cm wide, and 0.5 cm thick; it lies in front of the interspace between the C7 and T1 vertebral bodies, but the local anesthetic injected at the level of C6, will result in caudal spread to the stellate ganglion. This results in the blockade of cardiac sympathetic fibers. A low concentration and low volume of local anesthetic should be used for the block to decrease the risk of local anesthetic systemic toxicity (LAST).[2]

The stellate ganglion provides efferent sympathetic outflow to the myocardium, upper extremity, neck, and face. The left stellate ganglion contributes more to the sympathetic tone of the myocardium, so a left SGB is preferred for the indication of VES.[3] A combination of left and right SGB was also used for the successful reversal of inappropriate sinus tachycardia, which was medically refractory.[4]

Herein, we studied the effect of left SGB in treating refractory ventricular arrhythmias.

MATERIALS AND METHOD

This observational study was conducted at a tertiary healthcare institute over a period of 2 years. We studied 6 patients who were admitted to critical care units and who had three or more sustained episodes of VT or VF. The patients were not responding to pharmacological and electrical defibrillation therapy, producing significant hemodynamic deterioration. Stellate ganglion block was planned to treat the ventricular arrhythmias and converting them to normal sinus rhythm. Patients with local or systemic infection, coagulopathy, pneumothorax and pneumonectomy on the contralateral side, recent myocardial infarction, and patients with pre-existing conduction blockade were excluded.

The block was performed with the patient in the supine position and patient's head turned to the right side. The left side of the neck was prepared and draped aseptically. A high frequency (6-15 MHz) linear array ultrasound probe was used to identify the target area i.e. C6 transverse process (Chassaignac'stubercle). Needle trajectory should be in-plane and lateral to medial fashion with real-time ultrasound imaging. The needle tip placed anterior to the longuscolli muscle located between the posterior aspect of the carotid artery andanterior to the C6 transverse process. Color Doppler was used to detect the position of the vessels. After negative aspiration, we injected 10ml solution (8ml of ropivacaine 0.375%+ 1ml (50mcg) dexmedetomidine + 1ml (500mg) magnesium sulphate), which was visualized as hydro-dissection by local anesthetic just anterior to longuscolli muscle and behind carotid artery at the area of the lower cervical sympathetic chain. Five minutes later, all patients were assessed for signs of successful stellate ganglion blockade like Horner'syndrome (miosis, anhidrosis, and ptosis) as well as vasodilatation of the ipsilateral upper extremity. Patients were observed for any procedure-related complications or side-effects of SGB.

Statistical analysis: The data were noted in mean, standard deviation, and percentage. Appropriate statistical tests were used to derive the significance. A p-value of <0.05 was considered significant.

RESULTS

Patients' demographics and diagnosis are summarized in Table 1, and the effect of stellate ganglion block is summarized in Table 2. All of the patients had drug and defibrillation refractory VT and VF and were hemodynamically unstable. All of the patients have received successful block which is confirmed by Horner's syndrome and rise in left upper extremity temperature by 1-3˚C. None of them had any complications except in one patient in which hoarseness of voice occurred but it was subsided spontaneously after 6 hours without any residual effects. Rate control was observed in all of the patients (100%) and 50% of the patients' attained

a heart rate of <80/min and rest 50% of the patients' heart was between 80-110/min. Conversion to normal sinus rhythm was seen in only three (50%) of the patients. Defibrillation after blockade was not required for 24 hours in 50% of the patients, 18 hours in 17% of the patients and rest 33% required after 12 hours.

Table 1: Patient characteristics with diagnosis and response to Drugs & Defibrillation

Patient number	1	2	3	4	5	6
Age (years)	50	21	42	25	34	23
Sex (M/F)	M	M	M	F	M	F
Weight (kg)	58	46	60	36	58	46
Diagnosis	DCM with Severe LV dysfunction	RV mass	CAD, LV dysfunction	LQTS	DCM with EF = 15%	Idiopathic recurrent VT
Response to Drugs & Defibrillation	0	+	+	0	0	0

*DCM - Dilated cardiomyopathy, * LV - Left ventricular, *CAD - Coronary artery disease, *LQTS - Long QT syndrome, *EF - Ejection fraction

Response: 0 was- no response; + was minimal response

Table 2: Effect of Stellate Ganglion Block in six patients

Patient number	1	2	3	4	5	6
Effect of SGB (Based on clinical signs)	+++	++	+++	+++	++	++
Conversion to NSR	Yes	No	Yes	Yes	No	No
Rate Control	+++	++	++	++	+++	+++
Complications	Hoarseness of voice	0	0	0	0	0
Duration of Block	24 hours	12 hours	18 hours	12 hours	24 hours	24 hours

Effect of SGB:+++ Horner's syndrome persisted for 6-8 hours, ++Horner's syndrome persisted for 3-5 hours, +Horner's syndrome persisted for 1-2 hours

Heart rate: +++ was <80/ min, ++was 80-100/ min, + was 101-120/ min

DISCUSSION

The very first attempt of SGB was made by Jonnesco, who attempted surgical sympathectomy by performing left cardiac sympathetic denervation for refractory angina in a syphilitic aortitis patient.[5] Since then, many approaches have come targeting multiple sites along the sympathetic chain, like thoracic epidural, stellate ganglion blockade, renal artery denervation, and surgical stellate ganglion resection. Cardiac sympathetic denervation is indeed useful in certain conditions. However, guidelines regarding its use in regular practice remain to be established.[6] Electrical storm is a medical emergency with very high risk of death and if pharmacological therapy has failed to treat VES, SGB can reduce VA burden and bridge patients to more definitive therapy like catheter ablation, surgical sympathectomy, heart transplant, or repeat stellate ganglion block.[3]

Ropivacaine is an amide local anesthetic and is used in a variety of nerve block treatments. It is a long-acting local anesthetic and has a high affinity to nerves because of its lipid solubility. It also has low cardiac and neurotoxicity. It has higher blocking efficacy on pain conducting Aδ and C fibers. Ropivacainehelps to break the pain-inflammatory loop.[7] Many adjuvants have been used for peripheral nerve blockade, like adrenaline, sodium bicarbonate, clonidine, buprenorphine, tramadol, midazolam, magnesium sulfate, dexamethasone and dexmedetomidine. Dexmedetomidine, as an adjuvant, exerts its anti-

reduction in arrhythmic events 12 hours before and after PSGB was 100% (interquartile range- 100 to 92.3%). Arrhythmic episodes requiring treatment were significantly reduced, comparing 12 hours before the first PSGB with 12 hours after the last procedure (P < .0001) and comparing 1 hour before with 1 hour after each procedure (P < .001). One major complication, respiratory depression due to local anesthetic systemic toxicity (LAST), occurred (0.5%)as the patient was already on high dose IV lidocaine infusion and was treated by lipid infusion, and no further complications were noted.[10]

Chouairi F et al. conducted a study on 117 patients for treatment-refractory ventricular arrhythmia, demonstrated reduction in the ventricular arrhythmia burden and the need for defibrillation therapy after stellate ganglion block. The median episodes of VT/VF 24 hours before SGB were 7.5 (Q1-Q3: 3.0-27.0), and 24 hours after SGB, the median decreased to 1.0 (Q1-Q3: 0.0-4.5; P <0.001). At 24 hours before SGB, the median defibrillation events were 2.0 (Q1-Q3: 0.0-8.0), and 24 hours after SGB, the median decreased to 0.0 (Q1-Q3: 0.0-1.0; P < 0.001).[11]

In a retrospective case series by Suheil D et al, eleven patients underwent ultrasonography guided pharmacological cardiac sympathetic denervation (CSD) eight patients underwent Left CSD and three underwent Bilateral CSD, for acute control of drug refractory ES.Five patients (46%) had complete resolution of ventricular tachycardia (VT) after CSD and one had 90% reduction in episodes of VT.[12]

Limitation: This study was conducted with small sample size so further research with large sample size randomized controlled trials are required to assess the effectiveness of the blockade and use of adjuvants.

CONCLUSIONS

In patients with refractory ventricular arrhythmia, this observational study has shown that SGB is a simple, bed side procedure for acute control of life threatening ventricular electrical storm and choice of local anaesthetics with adjuvants will definitely increase the intensity and the duration of block like dexmedetomidine and magnesium without increasing any side effects. SGB use was associated with rate control in all 6 patients, conversion to normal sinus rhythm in 50% of patients and hemodynamically more stable requiring less pharmacological and defibrillation therapy. Hence, SGB can act as a successful treatment modality for nociceptive effects by inhibiting Aδ and C fibers. It acts on the α2 receptors in peripheral vascular smooth muscle cells to constrict the peripheral blood vessels, reduce the absorption of local anesthetics, and prolong the block time and also, inhibits hyperpolarisation activation current (Ih) for pain control (Na+ and K+ based inward mixed cation current generated by activation of cell membrane hyperpolarization of cyclic-nucleotide gated channel) to reduce pain.[8] Magnesium is an excellent analgesic adjuvant and its analgesic property seems to be associated with the regulation of calcium influx into the cells, or antagonism of N-Methyl-D-Aspartate (NMDA) receptors in the central nervous system. Additionally, magnesium is known to have an anti-inflammatory effect via peripheral or central sensitization. Another mechanism for analgesic effect of magnesium is the systemic absorption; serum magnesium levels decreases the post-synaptic activity of slow conducting un-myelinated C-fibers which are the main afferent fibers transmitting pain signals from the periphery to central nervous system.[9]

In this study, we have used ropivacaine along with adjuvants like dexmedetomidine and magnesium, which have increased the potency of local anaesthetic and duration of the block without causing any side effects. We observed that rate control was achieved in all patients, and 50% of the patients had conversion to normal sinus rhythm. Defibrillation after blockade was not required for 24 hours in 50% of the patients, 18 hours in 17% of the patients, and the rest 33% required after 12 hours. The complications were insignificant except for the hoarseness of voice in one patient, which resolved spontaneously after six hours.

Stellate ganglion block is performed by a standard, commonly used USG-guided percutaneous technique. CT scan or fluoroscopy are also helpful in detecting the exact location of SGB. It is usually performed on the left side, but either side or both sides can be used to perform SGB. Bilateral blocks have also been used to further help in controlling VES. Also, considering the high levels of neuroplasticity displayed by the cardiac sympathetic system, it is possible that an increasing contribution of the right stellate ganglion can develop after left-sided SGB.[6]

Savastano S et al. conducted an observational study in 131 patients to determine the effectiveness and safety of percutaneous stellate ganglion block (PSGB). They compared the reduction in the arrhythmic events by at least 50%, 12 hours before and after PSGB. In about 92% of the patients median

ventricular electrical storm or bridging treatment before final intervention.

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