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Cease the storm - Successful stellate ganglion block in terminating refractory electrical storm

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ABSTRACT

An electrical storm also known as a ventricular tachycardia storm (VT storm) tends to recur and form a vicious cycle, eventually leading to a refractory electrical storm, refractory to electrical and pharmacological cardioversion. The treatment of refractory VT storm is challenging. Here we discuss the case of a middle-aged gentleman who presented to our emergency department 6 months apart with a refractory VT storm. When all the anti-arrhythmic agents and multiple cardioversion attempts failed in terminating the storm, we attempted ultrasound-guided stellate ganglion block. On both occasions, it successfully terminated the storm. Hence emergency physicians need to be aware of the right technique and timing of stellate ganglion block and ultrasound-guided needle tracking, as it can be a final rescue technique in treating refractory electrical storm in the emergency department.

1. Introduction

Electrical storm refers to a state of cardiac electrical instability characterized by multiple episodes of ventricular tachycardia (VT storm) or ventricular fibrillation (VF storm) within a relatively short period, typically 24 h [1].

In patients without an implantable cardioverter-defibrillator (ICD), electrical storm has been variously defined as [1,3-5]:

a) The occurrence of three or more hemodynamically stable ventricular tachyarrhythmias within 24 h
b) VT recurring soon after (within five minutes) termination of another VT episode
c) Sustained and non-sustained VT resulting in a total number of ventricular ectopic beats greater than sinus beats in a 24-h period

In patients with an ICD, the most widely accepted definition of electrical storm is three or more appropriate therapies for ventricular tachyarrhythmias, including anti-tachycardia pacing or shocks, within 24 h [2].

We present the case of a 48-year-old patient who presented to our emergency department with a refractory VT storm. The electrical storm of this patient was refractory to all conventional modalities of treatment including multiple electrical and pharmacological cardioversion techniques. It was finally settled with ultrasound-guided stellate ganglion block.

2. Case description

A 48-year-old gentleman who is a known case of diabetes mellitus, systemic hypertension, and coronary artery disease post stenting to the Left circumflex artery, with an ejection fraction of 20% and morbid obesity presented to the Emergency department with complaints of palpitations and diaphoresis.

On initial evaluation, his vitals were stable with a respiratory rate of 20 cycles per minute with a room air saturation of 99%. His heart rate was 190 beats per minute, with a blood pressure of 120/70 mmHg. There were no complaints of ischemic chest pain, shortness of breath, altered sensorium, or signs of shock. An ECG was taken which showed monomorphic ventricular tachycardia (Fig. 1).

Since the patient was hemodynamically stable, pharmacological cardioversion was attempted with Amiodarone. Injection of Amiodarone 150 mg i.v. bolus over 15 min followed by an infusion was started at 1 mg/mt. During the course of treatment patient became hemodynamically unstable with hypotension and synchronised DC cardioversion (DCCV) was done with 100 joules after giving a procedural sedation with Injection of Etomidate 10 mg and Injection of Fentanyl 100 μg, following which the rhythm did not revert. His VT persisted with pulse, two more synchronised DCCV were performed with 200 joules, following which his rhythm became ventricular fibrillation. Defibrillation was

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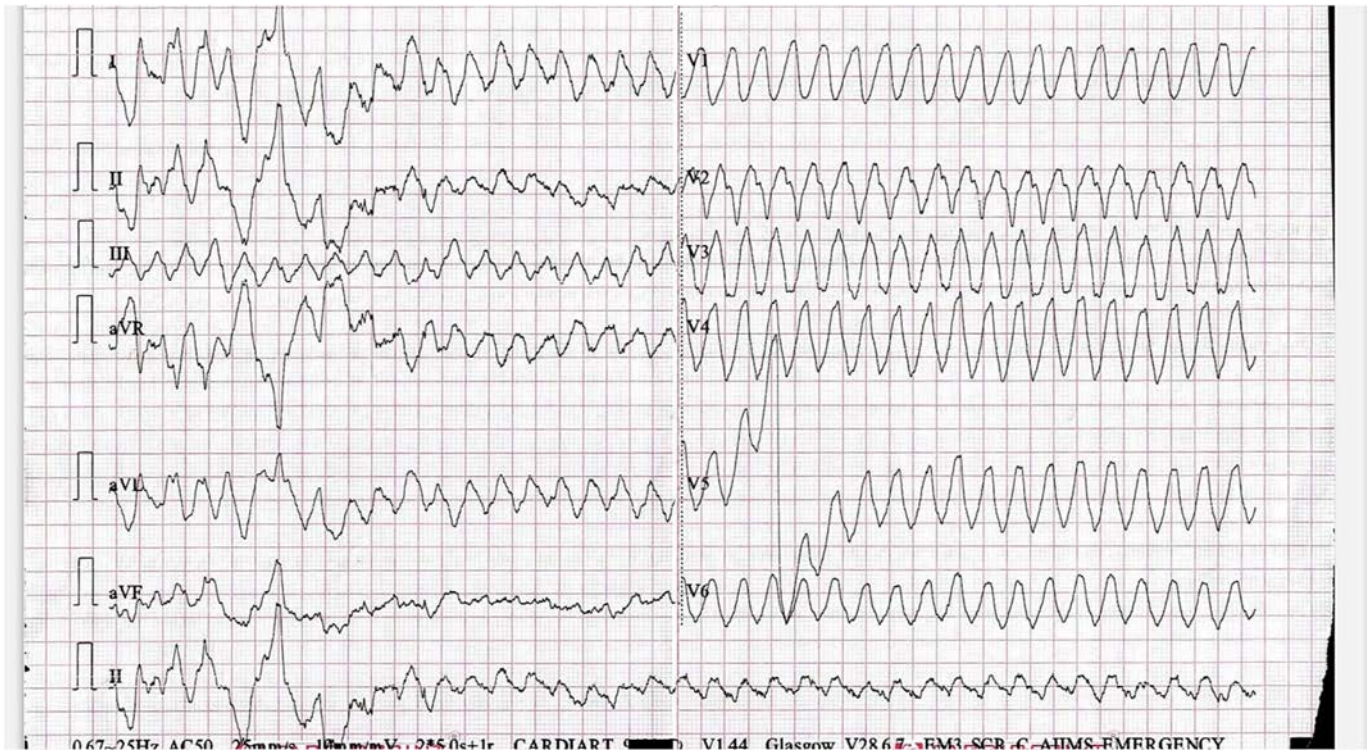

Fig. 1. showing monomorphic ventricular tachycardia.

done with 200 joules and cardiopulmonary resuscitation (CPR) was initiated. After one cycle of CPR, the return of spontaneous circulation (ROSC) was achieved. Again the rhythm continued to be VT with pulse. Amiodarone 150 mg repeat bolus was given. Meanwhile, the patient was intubated and put on mechanical ventilation in view of hemodynamic instability and refractory VT storm. Since the VT persisted, one more synchronised DCCV was attempted and the patient was started on other antiarrhythmics like lidocaine 150 mg iv bolus followed

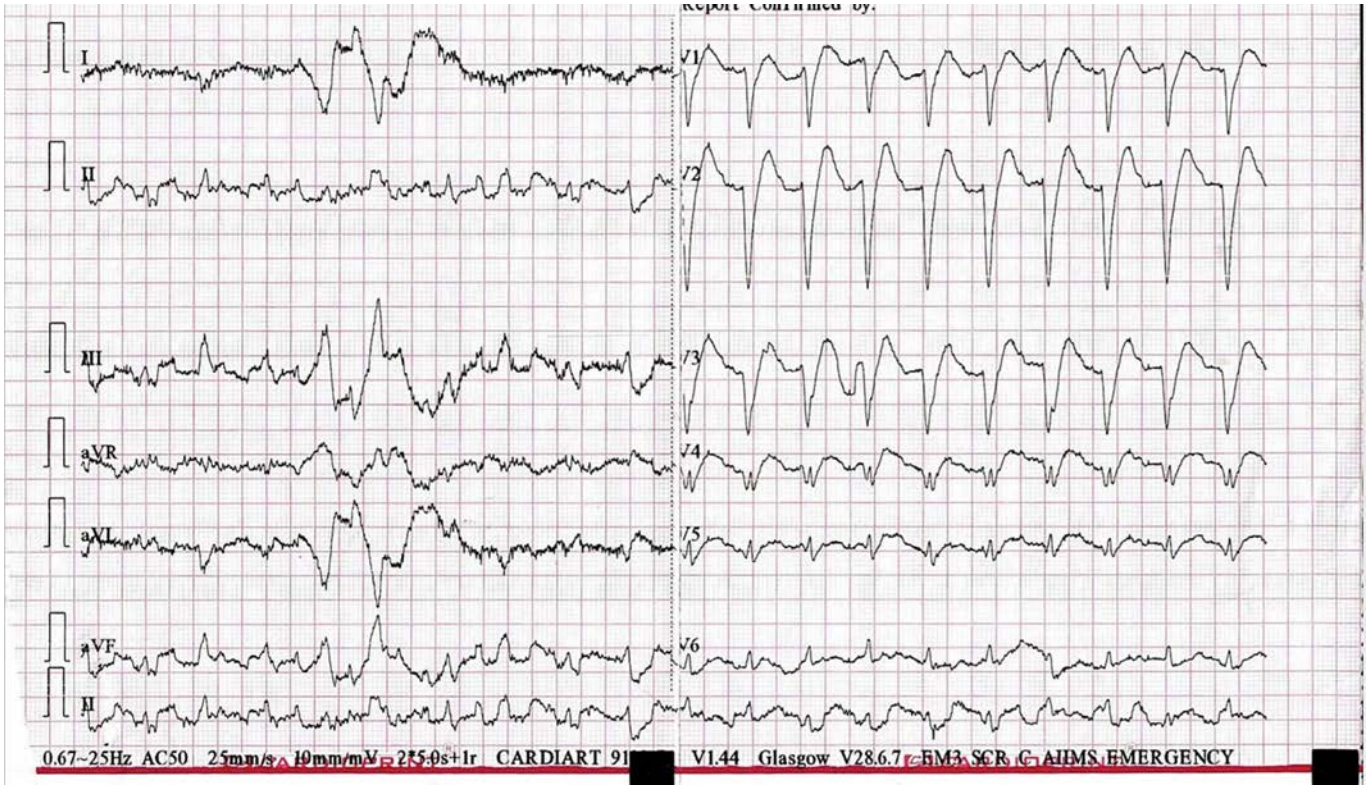

Fig. 2. rhythm reverted to sinus tachycardia after stellate ganglion block.

by an infusion. A bolus dose of Esmolol 50 mg was given. Despite multiple cardioversion attempts and antiarrhythmics, the rhythm continued to be VT with a pulse. Finally, an ultrasound-guided left stellate ganglion block was given with 2% 10 ml Lidocaine and the VT storm subsided. Rhythm was reverted to sinus tachycardia (Fig. 2). A central venous catheter was inserted and inotropes and anti-arrythmic infusions were continued. The patient was admitted to the coronary care unit (CCU). There were no further VT/ VF episodes. He was extubated on the 5th day of CCU stay and was discharged after inserting an automatic implantable cardioverter-defibrillator (AICD) in a hemodynamically and neurologically intact state.

The same patient presented to us 7 months later with a history of multiple AICD shocks and again ECG was suggestive of VT storm. Initially, as the patient was stable, we started with Amiodarone and later due to hypotension patient was given synchronised cardioversion. Like the previous event, the electrical storm was refractory. Eventually when all pharmacological and multiple electrical cardioversion failed, left stellate ganglion block was given and the storm settled.

Sequelae of events are depicted in Fig. 3.

3. Discussion

The challenge with the VT storm is not terminating one individual episode of VT. Rather, the problem is often that the VT keeps recurring – so it's difficult to keep patients out of VT for a prolonged period. VT storm is a vicious cycle. VT/VF increases intracellular calcium levels, which could be pro-arrhythmic. Shocks and episodes of cardiac arrest (e.g. treated with epinephrine) may cause myocardial injury. Myocardial injury and pain cause an outpouring of endogenous catecholamines, resulting in recurrent arrhythmia***. To successfully treat refractory electrical storm, we need to cut down this vicious cycle.*** Electrical storm can be classified based on 3 gross electrocardiographic (ECG) surface morphologies: monomorphic VT, polymorphic VT, or VF [6].

Antiarrhythmic drugs (AADs) are the first-line agents in the treatment of electrical storm (ES). The efficacy, adverse effects and pro-arrhythmic activity should be considered while choosing the AAD. Pro-arrhythmic effects have been reported in up to 7% of the patients treated with anti-arrhythmics and are more prevalent in patients with severe LV dysfunction [7]. Amiodarone is usually the first AAD

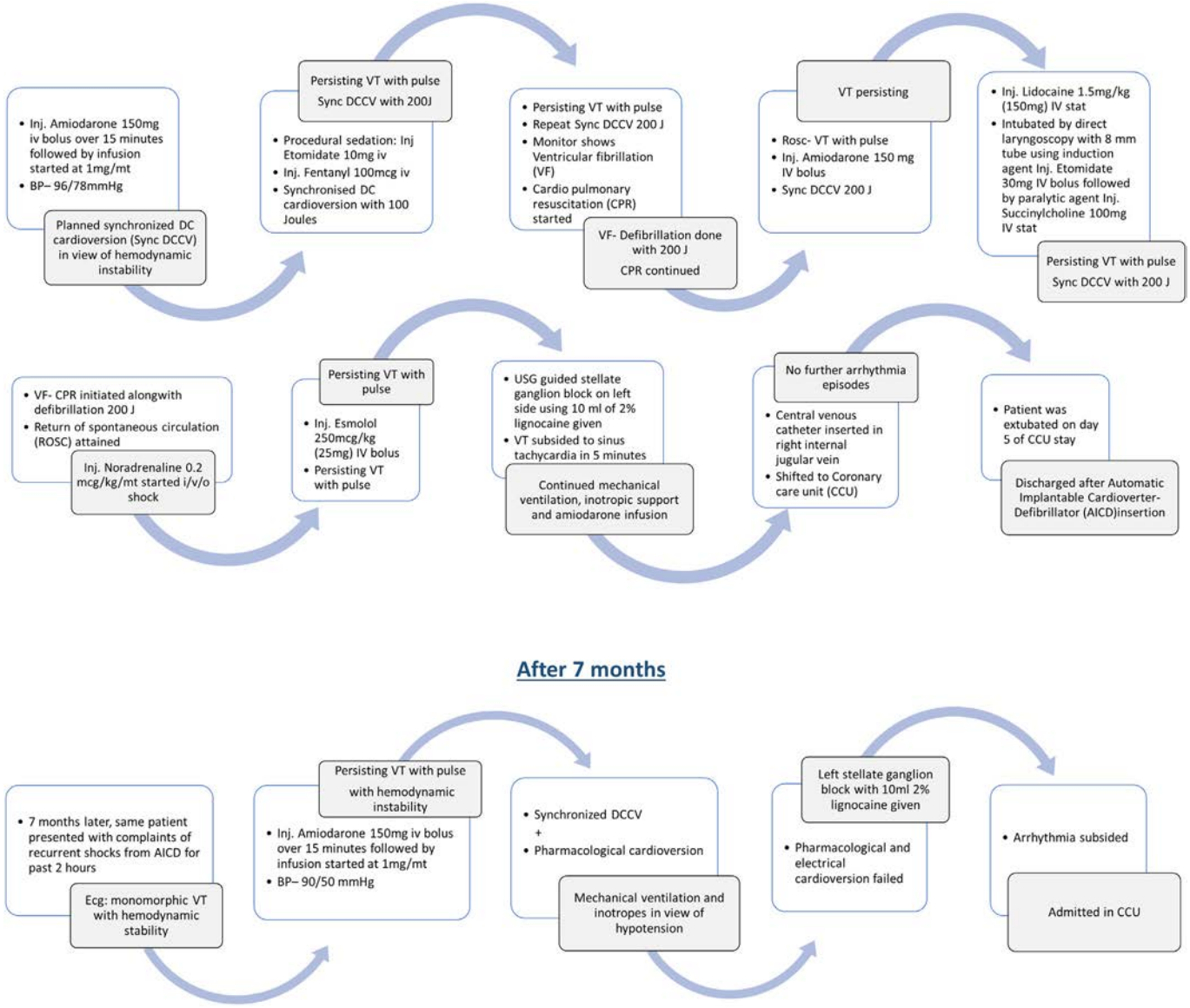

Fig. 3. Sequelae of events.

administered in the acute management of ES and can generally be used safely unless hyperthyroidism or QT prolongation is present.

Endotracheal intubation is generally warranted for a refractory VT storm. Intubation offers multitudinous benefits: Patients may lose airway control during VT/VF. Sedation itself is therapeutic. Intubation may ease the safe performance of procedures (e.g., VT ablation). Patients might require deep sedation, analgesia and pressor support, as we have given in our patient.

3.1. Stellate ganglion block (SGB)

The inferior cervical ganglion located at the C6–7 level fuses with the first thoracic ganglion to form the stellate ganglion. The cervical sympathetic block cuts off sympathetic outflow to the upper extremity, head, neck and myocardium. Case studies have shown a reduction in arrhythmia burden following SGB [8]. A successful SGB will also cause ipsilateral Horner's syndrome. The most common indication is sympathetically mediated pain. Other indications include peripheral vascular disease, scleroderma and Raynaud's disease, post-surgical pain, post-traumatic stress disorder, intractable angina, and refractory ventricular arrhythmias. The ultrasound-guided technique of SGB is now the standard of care, the technique requires the skill of ultrasound along with the skill of needle tracking and neck anatomy. The left stellate ganglion is more important in autonomic regulation of the heart, hence initial literature has described unilateral left-sided blockade. In a recent systematic review of the literature, 34/38 reported cases received left-sided blocks and the remaining four were given bilateral blocks. [9] Bilateral blockade could be more effective. Hence clinicians are practising more bilateral blockade these days. [10] The various SGB techniques are: surface landmark technique, USG guided, fluoroscopic technique and CT guided, among which USG guided is the most easily and precisely performed technique in the emergency department.

1. Landmark technique approach:
   Earlier, stellate ganglion blocks were performed using the surface landmark technique, which is as follows:

Fig. 5. Patient and probe position.

a) Patient position: supine with slight neck extension and head turned to the other side
b) Locating the lateral process of the C6 vertebra also known as the Chassaignac's tubercle (Fig. 4), by palpating adjacent to the trachea. The cricoid cartilage is palpated to find the C6 level.
c) Insert a needle straight into the neck until it hits Chassaignac's tubercle.
d) Inject some local anaesthetic, then withdraw the needle 1–2 mm to come out of the longus colli muscle and inject the preferred dose of anaesthetic agent.
e) There can be a risk of injury to the vertebral artery

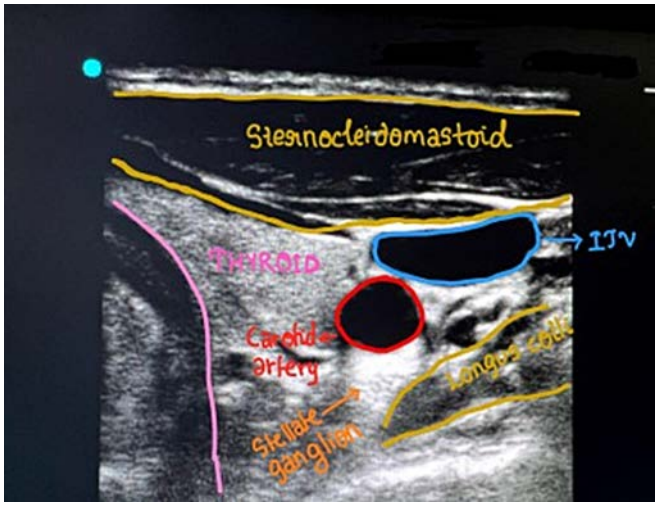

Fig. 4. Chassaignac's tubercle and Sono anatomy.
Structures labelled:
1 Sternocleidomastoid
2 Internal jugular vein
3 Carotid artery
4 Thyroid gland lobe
5 Trachea
6 Esophagus
7 Longus colli muscle
8 Stellate ganglion

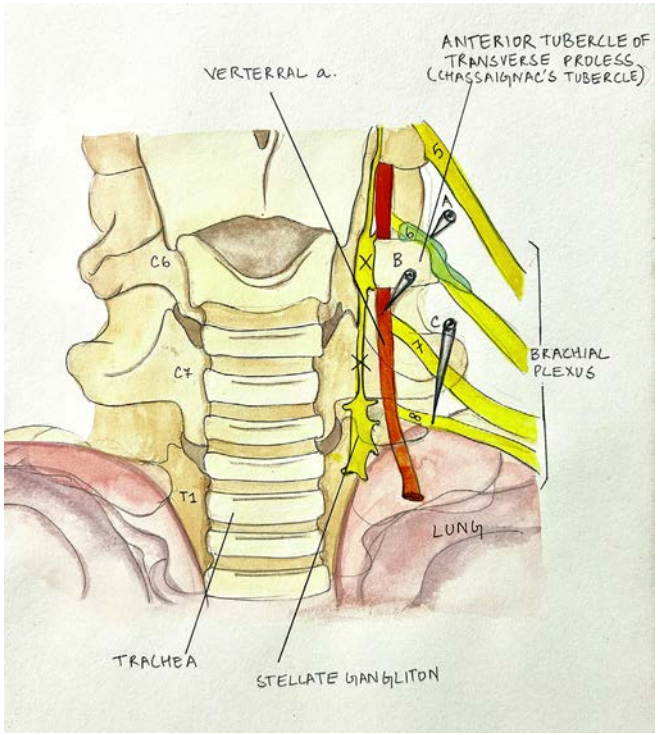

Fig. 6. Anatomy of neck. Illustration credit: artist Atufa Rais.

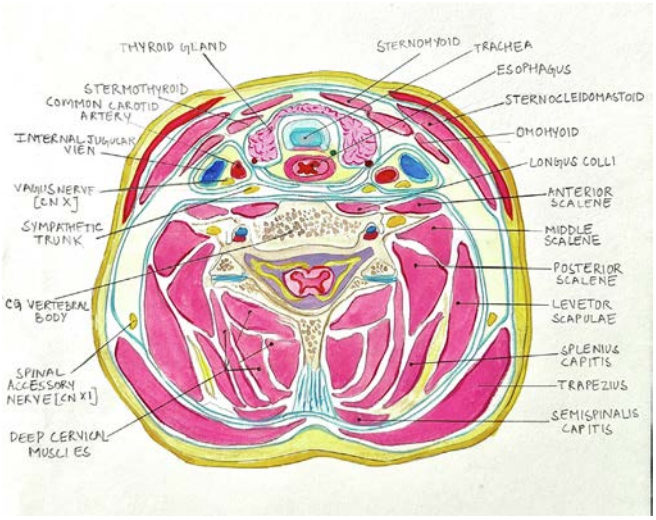

Fig. 7. Anatomy of neck- cross section at C7 level. Illustration credit: artist Atufa Rais.

2. USG guided SGB

a) Technique (C7 transverse process approach)
b) Intravenous access and the emergency resuscitation kit must be kept ready
c) Step 1: Patient positioning is the same as in the landmark approach. The patient should be in the supine position, and the neck should be slightly extended and turned to the opposite side (Fig. 5).
d) Step 2: After cleaning the neck with chlorhexidine or any available antiseptic agents, a US transducer (with high-frequency linear probe 6–13 MHz), is placed transversely at cricoid cartilage and slide laterally to identify the Chassaignac tubercle of C6 vertebrae. A cross-section of the neck at C6 level is given in Fig. 6. The transducer is then moved slightly downwards to visualise the transverse process of C7 vertebrae. Anatomical structures visualized at this level are the carotid artery, internal jugular vein, vertebral artery, inferior thyroid vessels, thyroid gland, trachea and longus colli muscle covered with prevertebral fascia (Fig. 7).
e) Step 3: A 23 gauge spinal needle is carefully tracked under US guidance using an in-plane approach to reach the longus colli muscle [11]. Once the needle enters the prevertebral fascia, hydro dissection of longus colli is done with 1 ml of normal saline. If the spread is appropriate, as evident by the clear separation of tissue planes, the anaesthetic agent is injected [11]
f) Patient should be monitored following the block

4. Conclusion

Refractory ventricular arrhythmias can be treated successfully by ultrasound guided stellate ganglion block.

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CRediT authorship contribution statement

Archana Nair: Writing – original draft, Data curation, Conceptualization. **Sanjeev Bhoi:** Writing – review & editing, Supervision. **Yatharth Choudhary:** Methodology.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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