Stellate Ganglion Block for the Treatment of Posttraumatic Stress Disorder

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Editor’s note: Elspeth Cameron Ritchie, MD, MPH (Col. US Army, retired) is the guest editor for Psychiatric Annals’ ongoing series in 2013 on complementary and alternative treatments for posttraumatic stress disorder.

The following article by Capt. Anita H. Hickey, MD, and colleagues on stellate ganglion block is an excellent addition to the literature on innovative therapies for posttraumatic stress disorder (PTSD).

It could be argued that this technique does not fall under the rubric of complementary and alternative medicine, which traditionally focuses on herbal medicine and acupuncture. That is somewhat true. It is a standard invasive procedure commonly performed in ambulatory facilities, outpatient surgical centers, procedure suites in physicians’ offices, as well as in hospitals. However, it is a new, promising, and as yet unproved technique for the treatment of PTSD.

It is clear that new methods of treatment for PTSD are desperately needed. Although psychotherapy and pharmacotherapy are effective for many who are willing to go through the treatment regimen, they are not effective for all. Perhaps more importantly, many service members will not go to the current treatment regimens or stick to it for the 20 sessions often required for prolonged exposure therapy or the weeks or months for pharmacotherapy. The time required is too much for most service members, who usually have a very full schedule of deployments or trainings in the field.

I am not at all dismissing the benefits of psychotherapy or pharmacotherapy. They are evidence-based treatments. However, I do suggest this exciting new technique is a modality that should be further studied. Other modalities in the treatment of PTSD will be explored in Psychiatric Annals, including virtual reality, acupuncture, and animal-assisted therapy, throughout 2013.

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Posttraumatic stress disorder is growing as one of the most intractable psychiatric conditions faced by clinicians and patients. Recent research into influencing the peripheral sympathetic nervous system indicates that there might be applications in psychiatric conditions, particularly in refractory cases of posttraumatic stress disorder.

Nerve blocks have long been used to treat both acute and chronic pain. When performing regional anesthesia procedures, clinicians realized that pain relief could be achieved not only by blocking the afferent somatic nerves but also by anesthetizing the efferent nerves of the sympathetic nervous system at sites containing regional collections of autonomic ganglia.

The sympathetic nervous system (SNS) is a key mediator of the “fight or flight” response. During periods of stress, pre-ganglionic, cholinergic nerves in the spinal cord fire, releasing the neurotransmitter acetylcholine. Some of these pre-ganglionic neurons transmit directly to the adrenal medulla, causing bulk release of adrenaline and other stress-hormones. However, most pre-ganglionic SNS neurons synapse with peripheral neurons and release noradrenaline at nerve terminals, which induce stress-appropriate responses specific to the tissue involved. Masses of postganglionic, adrenergic neurons can be found in a chain of ganglia that lay along the spinal cord.

The stellate ganglion (SG) is the result of the fusion of the inferior cervical ganglion (C7) and the first thoracic ganglion into a single, star-shaped mass measuring about 1.5 cm³. It is normally situated lateral and posterior to the lateral edge of the longus colli muscle anterior to the first rib and posterior to the subclavian artery. About 80% of individuals will have fused anatomy, with the remaining 20% having unfused ganglia that lay in a similar area anterior to the transverse process of the C7 vertebra. All pre-ganglionic sympathetic nerves innervating the head and neck, as well as many to the upper extremity, either synapse here or pass through to more distal sites. The anatomically distinct nature of each ganglion and their position outside the spinal cord make them appropriate targets for regional anesthetic blocks, one of the most common being SGB.

**SGB Technique**

Several techniques and sites have been reported and commonly utilized by anesthesiologists and interventional pain management physicians to perform SGB. The authors do not recommend a nonguided technique, given the increased risk for injury. A more acceptable technique is performing SGB at the level of the C6 or C7 vertebra utilizing either fluoroscopy or ultrasound guidance. SGB at the level of the C6 vertebra is preferred due to a more successful sympathetic blockade to the head and neck when compared with injection at the C7 vertebra, which has been shown to be associated with a greater risk for injury to the vertebral artery because it has no anterior tubercle and lies posterior to the vertebral artery at this level. The risk for pneumothorax is also increased with injection at the C7 level due to the proximity of the C7 vertebra to the pleura.

There is no standardized technique used by physician specialists to perform a SGB. However, the approach described herein is common practice and one that has been adopted by the primary author. As shown in Figure 1, following peripheral intravenous access, the patient is positioned supine on a fluoroscopy table, placed into cervical extension with a shoulder roll and hemodynamically monitored (eg, pulse oximetry, electrocardiogram). Sedation may be used or the procedure may be performed under local anesthesia. Fluoroscopy is utilized to verify that the anesthetic is safely injected and to prevent intravascular injection. The right C6 vertebral body is identified and a local anesthetic (ie, lidocaine 1%) skin wheal is made at the needle entry site. A 22-gauge needle is directed percutaneously to the anterolateral C6 vertebral body at its junction with the right C6 tubercle. A right-sided SGB is necessary because right-sided blocks affect right hemisphere structures that are pertinent.
to PTSD since the right hemisphere is responsible for producing autonomic responses to emotional stimuli and the right amygdala is critically linked to unconscious emotional memories.9

Following confirmation of proper location by fluoroscopy, and negative aspiration for blood and cerebrospinal fluid, approximately 2 mL of non-ionic contrast media is injected through the needle. The dye is visualized to spread over the pre-vertebral plane. This step is followed by digital subtraction angiography to further confirm lack of vascular uptake. A 1 mL test dose of a local anesthetic is administered. If no signs of vascular uptake are observed, 7 cm³ of 0.5% ropivacaine or bupivacaine is injected incrementally. The needle is then removed and the procedure is considered complete. Evidence of a temporary Horner’s syndrome (ie, myosis, ptosis, and analphalathmos) and associated conjunctival injection, nasal congestion and facial anhidrosis following the SGB injection are signs of a successful sympathetic block.10

POTENTIAL COMPLICATIONS OF SGB

Mortality and morbidity related to SGB are rare, thus the procedure is considered to be very safe.4 The complication rate associated with SGB is extremely low at 1.7 per 1,000 procedures.11 SGB is sometimes used as a one-time treatment, but also commonly repeated when symptoms return within days to weeks of the initial procedure. The direct effects of the anesthetics on neurons last only a few hours, so it is unclear why the benefits are often of longer duration.1,2

When explaining the potential risks of SGB to patients (See Figure 2, page 90), physicians generally divide complications into three categories: technical, infectious, and pharmacological.2 Technical complications can include injury to the nerves and nearby viscera during insertion of the needle. This includes damage to the brachial plexus, trauma to the trachea and esophagus, injury to the pleura and lung (pneumothorax or hemothorax), bleeding at injection site and local hematoma. Airway compression and vasovagal attacks can also occur. Infectious complications can result if there is a breach in the aseptic barrier. These can include local abscess, cellulitis, and osteitis of the vertebral body and transverse process.

Pharmacological complications are related to the dose, volume, type of local anesthetic and site of deposition of the solution. This includes hoarseness of voice due to paralysis of the recurrent laryngeal nerve. Additionally, phrenic nerve paralysis may lead to respiratory distress, especially if there is contralateral dysfunction of the phrenic nerve. Other adverse events may include seizures, loss of consciousness, profound hypotension due to a high spinal anesthetic blockade, air embolism, and loss of cardiovascular activity that may lead to various bradyarrhythmias and hypotension.

THERAPEUTIC UTILITY OF SGB

Nonpsychiatric Conditions

SGB has been shown to have utility for diagnostic, therapeutic, and prognostic purposes for a variety of conditions, including: chronic regional pain syndrome types I and II to the upper extremities (CRPS I and II); chronic and acute vascular insufficiency/occlusive vascular disorders of the upper extremities, such as Raynaud’s disease, intravascular embolization and vasospasm. SGB has also been found an effective treatment for poor lymphatic drainage and local edema of the upper extremity following breast surgery; postherpetic neuralgia; and phantom limb pain or amputation stump pain. Patients with quinine poisoning; sudden hearing loss and tinnitus; hyperhidrosis of the upper extremity; cardiac arrhythmias and ischemic cardiac pain; Bell’s palsy and a variety of orofacial pain syndromes, including neuropathic orofacial pain and trigeminal neuralgia; vascular headache such as cluster and migraine headaches; and neuropathic pain syndromes among cancer patients are all also candidates for SGB.2,3,12-16

SGB has also been recommended for improving blood flow to the cranium for angiography and following stroke/cerebrovascular accident and hyperhidrosis to the upper extremities.13,14 Additionally, SGB’s use has been reported in the treatment of Ménière’s syndrome3 and hot flashes.17-19

Psychiatric Conditions

It might seem counterintuitive that treating the peripheral nervous system could affect psychiatric conditions presumably mediated in the brain. Most psychiatrists, however, are probably familiar with the observation that vagal nerve stimulation improves depression.20 As early as 1947, reported cases of improvements in depression subsequent to SGB treatment began emerging in the literature.21 More recently, unexpected benefits of SGB have been reported for hallucinations in schizophrenia,22 and in “climacteric psychosis” (a term for mental illness associated with menopause).23

Although not specifically SGB, similar techniques of lesioning the sympathetic chain has been reported widely as a potential treatment for social phobia.24-26
In the case of social phobia, the mechanism is presumably because the techniques prevent blushing. For patients with both blushing and social phobia, sympathectomy proved as good as or better than sertraline in improving anxiety.\textsuperscript{27} Taken together, the evidence suggests that techniques that influence the peripheral sympathetic nervous system could potentially be used to treat psychiatric conditions.

**APPLICATION OF SGB TO PTSD**

The earliest published report of SGB’s use in a patient with PTSD was in 1990 in an adolescent with co-occurring reflex sympathetic dystrophy (RSD).\textsuperscript{28} In that case report, the authors concluded that SGB was primarily treating the patient’s chronic pain as an associated symptom of RSD, not PTSD.

In subsequent years, multiple case reports of patients with PTSD who experienced marked improvements in symptom severity after one or more SGB treatments began emerging in the literature. These studies were implemented across diverse health care settings and were in both civilian\textsuperscript{29,30} and military populations (ie, US veterans and active duty service members).\textsuperscript{31-33} In all of these reports, patients had refractory PTSD (eg, persistent symptoms for at least 1 year despite standard treatment).

Cumulatively, the growing body of preliminary evidence about the potential therapeutic benefits of SGB for PTSD is compelling. Starting in 2008, a series of case reports were published in which SGB relieved symptoms of PTSD, even when co-occurring pain was not present among patients in a private clinic practice.\textsuperscript{29-31} The effect was usually immediate and often dramatic. SGB appeared to produce some form of a “calming effect” that primarily impacted symptoms associated with avoidance and hyperarousal. However, to experience sustained symptom relief, patients often required at least two SGB injections over a short follow-up period (< 30 days).\textsuperscript{31} In some cases, radiofrequency ablation of the SG was needed to prolong the duration of benefit.\textsuperscript{30} Similar clinical observation of improved PTSD symptoms after SGB was reported by other researchers in cases of combat-related PTSD at Walter Reed Army Medical Center.\textsuperscript{32} Early or subthreshold PTSD often spontaneously resolves, thus a placebo effect may be suspected. However, investigators at Naval Medical Center San Diego (NMCSD) observed comparable improvements in a case series of active duty service members for whom the diagnosis of PTSD was confirmed by structured interviews.\textsuperscript{33} All of those patients had chronic PTSD subsequent to failed responses to evidence-based treatments. This finding was inconsistent with earlier reports in which PTSD symptom improvements lasted at least many months and resulted in full remission.\textsuperscript{29-32}

The body of research specific to the utility of SGB as a potential treatment for PTSD continues to grow as evidenced by a new case report in which SGB proved to be a successful therapeutic option for a more complex patient with comorbid PTSD and alcohol use disorder.\textsuperscript{34}

**POSSIBLE MECHANISMS OF ACTION**

The specific mechanisms responsible for the actions of local anesthetics on the SG have yet to be fully elucidated. Regarding its effect on PTSD, SGB might best be considered within the broader framework of the neural network connecting several cortical regions that regulate the formation of memory, cognition, and behaviors. This complex interaction involves numerous neurochemicals, including corticotropin-releasing hormone, cortisol, the locus coeruleus-norepinephrine system, neuropeptide Y, galanin, dopamine, serotonin, testosterone, estrogen, and dehydroepiandrosterone (DHEA).\textsuperscript{35,36}
An extensive network of noradrenergic terminals project from the locus coeruleus and cell groups in the medulla and pons to innervate the entire neuraxis from the olfactory bulb to spinal cord, visceral organs, and integument. This widespread organization allows the noradrenergic system, by means of both central connections and peripheral sympathetic nervous system to influence the entire nervous system under conditions of elevated levels of norepinephrine (NE). 12

Some investigators have proposed that SGB may influence PTSD via connections that exist between the SG and insular cortex and other intracerebral structures. 13 Yet other researchers have focused on the extensive transneuronal labeling in sympathetic related regions of the cerebral cortex with viral tracing methods after injecting the adrenal gland, SG, and celiac ganglion. 14 The cortical areas labeled included the extended amygdaloid complex, lateral septum, insular and ventromedial temporal cortical regions, and deep temporal lobe structures. Alternative theorized explanations suggest that the overall mechanism of SGB involves changes in melatonin rhythm and sleep. 15

An overall decrease in sympathetic tone also might be involved in improving PTSD symptoms. SGB is known to result in decreased levels of circulating noradrenaline, and although this neurotransmitter does not freely cross the blood-brain barrier, it is postulated that decreased peripheral nonadrenaline represents reduction of central non-adrenaline levels due to a shared nucleus controlling both systems.

SGB can also reduce the expression of peptides, such as nerve growth factor (NGF), that play a role in maintaining the perpetual hyperarousal state. 16 NGF encourages sprouting of sympathetic neurons in the brain, and is able to cross the blood-brain barrier 17 where it has a number of complex interactions with the brain-body communications in stress regulation. 18

The reduction of NGF by SGB removes the necessary peptide for maintenance of PTSD, reverting intracerebral sympathetic nerves to a pretrauma state. Similar, downstream mechanisms might explain why the apparent benefit of SGB lasts long beyond the direct period when the anesthetic is slowing nerve conduction.

CONCLUSIONS

SGB is dramatically different from all current, evidence-based treatments for PTSD. The typical course for current therapeutic options for PTSD with either psychotherapy or psychopharmacology takes weeks to months to be effective and is often plagued by high attrition. 19 By contrast, SGB is a minimally invasive procedure that shows promise to have an almost immediate effect. Although getting an injection in the neck to treat PTSD might seem off-putting to some, SGB has been used for many decades as a successful pain management technique, where it has proven to be popular, tolerable, and safe. An additional benefit of SGB is that it offers a biologic approach to treating PTSD; the medical nature of such an intervention might lower the stigma of seeking mental health-based treatment for PTSD.

Current published evidence for the use of SGB in PTSD and other psychiatric conditions is based entirely on case reports. Randomized controlled trials are clearly needed to establish if SGB is an effective therapeutic option for PTSD. Furthermore, although in some of the case reports, long term, full remission of PTSD have been documented, such results are not universal. Thus, additional research is needed to discover what factors impact the sustained effects of SGB in resolving PTSD symptoms, the frequency by which the SGB procedure may need to be repeated for preservation of effect, and how SGB might be combined optimally with other evidence-based treatment modalities. Lastly, it will be important to further investigate the potential mechanism of action for SGB in the treatment of PTSD to discover if a new pathway may be at play specific to the pathology of the disorder, or if SGB could be a viable treatment option for other psychiatric conditions.

REFERENCES


