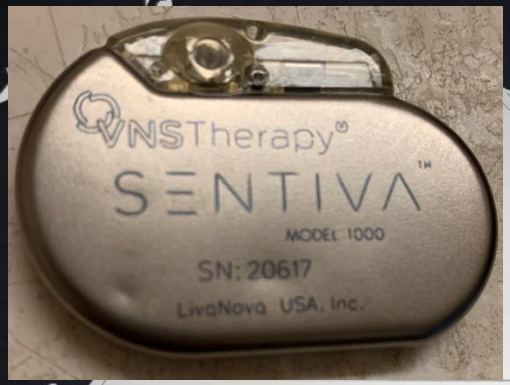

ANESTHETIC MANAGEMENT OF PATIENTS FOR PATIENTS WITH VAGAL NERVE STIMULATORS

Quiz 57

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SNACC
SOCIETY FOR NEUROSCIENCE
IN ANESTHESIOLOGY AND CRITICAL CARE

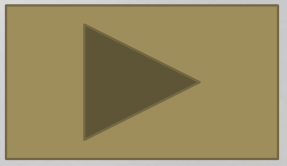
1. MR.Y IS SCHEDULED FOR A VAGAL NERVE STIMULATOR PLACEMENT.WHICH INDICATION WOULD YOU **NOT EXPECT** TO SEE WHEN YOU WALK INTO PERFORM YOUR PRE-OPERATIVE EVALUATION?

A. Intractable temporal lobe epilepsy in a patient with partial seizures

B. Patient with h/o parietal lobe cavernous malformation and uncontrolled grand mal seizures despite Levetiracetam therapy

C. Refractory Depression

D. Cluster Headaches



Contributor- Sarah Kroh, MD,
CA-3 resident, Allegheny Health Network

A. INTRACTABLE TEMPORAL LOBE EPILEPSY IN A PATIENT WITH PARTIAL SEIZURES

- This is true. This condition is an indication for placement of a VNS.
- Intractable epilepsy is an indication for VNS regardless of seizure type. For patients who have failed medical treatment and are not candidates for surgical resection of the foci this can be an important treatment option. VNS tends to produce a 50% or greater reduction in seizures in 48% of patients after 18 months of stimulation.
- The postulated mechanism of action involves the stimulation of afferent vagal nerve fibers that modulate cerebral neuronal excitability through the activation of either the limbic system or the noradrenergic neurotransmitter

system, or through generalized brain stem arousal.

Source: Anesthesiologist's Manual of Surgical Procedures. Jaffe. 2014. Wolters Kluer Health.

B. PATIENT WITH A H/O PARIETAL LOBE CAVERNOUS MALFORMATION WITH UNCONTROLLED GRAND MAL SEIZURES DESPITE LEVETIRACETAM THERAPY

- Correct answer.
- In patients with epilepsy due to a structural lesion the treatment modality of choice is microsurgical resection. Surgical resection is more effective than VNS..

C. REFRACTORY DEPRESSION

- This is True. Refractory depression is an indication for vagal nerve stimulator placement. The FDA has approved this treatment for patients who are resistant to treatment. Patients must have tried 4 medications or ECT or both without adequate improvement. They are required to continue standard treatment after VNS placement. The mechanism by which vagal nerve simulation helps refractory depression is not fully understood however studies have shown positive outcomes.

Aaronson ST, et al. Vagus nerve stimulation changing the paradigm for chronic severe depression? Psychiatry Clinics of North America. 2018;41:409

D. CLUSTER HEADACHES

❖ This is True. As research continues VNS is proving to be a potential treatment modality for other conditions such as cluster headaches. The FDA has now approved VNS for this purpose.

❖ Further research is currently underway as to whether VNS could definitively help patients with conditions such as inflammatory bowel disease, obesity and Alzheimer's.

2. ALL OF THE FOLLOWING ARE TRUE CONCERNING VAGAL NERVE STIMULATOR PLACEMENT SURGERY EXCEPT:

A. Arrhythmia and bradycardia can occur during placement

B. Hypoventilation may precipitate seizures

C. OSA may be worsened during stimulation intervals

D. Laryngeal dysfunction is a possible postoperative complication

Contributed by Wael Sassouh, CA-2 resident, Detroit medical center.

A. ARRHYTHMIA AND BRADYCARDIA CAN OCCUR DURING PLACEMENT

- This is True. Various degrees of bradycardia (and possible asystole) can occur during stimulation.
- This is more attributed to intraoperative factors (lead placement location for example) and is typically not seen in the postoperative period.

References:

Hatton et al. Vagal Nerve Stimulation: Overview and Implications for Anesthesiologists. Anesth Analg. 2006 Nov;103(5):1241-9.

Ben-Menachem. Vagus nerve stimulation, side effects, and long-term safety. J Clin Neurophysiol. 2001;18(5):415-8.

B. HYPOVENTILATION MAY PRECIPITATE SEIZURES

- This is True. Seizures may be worsened by hyperventilation and should be included in the differential diagnosis of a postoperative patient with delayed awakening or altered mental status.
- Hyperventilation is one of the methods used to evoke seizure activity in susceptible individuals. Hyperventilation has even been shown to induce high-amplitude, slow and rhythmic brain activity even in those without epileptic activity, an entity known as Hyperventilation-Induced, High-Amplitude Rhythmic Slowing (HIHARS).
- The mechanism is thought to be related to respiratory alkalosis and the pH buffer system causing vascular tone and electrolyte disturbances leading to altered electrical signaling in the brain.

References

Salvati et al. Out of thin air: Hyperventilation-triggered seizures. Brain Research 2019;1703:41-52.

C. OSA MAY BE WORSENED DURING STIMULATION INTERVALS

- This is true. A correlation between refractory epilepsy and OSA has been reported, and it has been noted that there may be an effect of stimulation on the vagal efferents leading to respiratory depression and compromise. This may be made worse by opioid administration.
- In one study, OSA was a finding in about one third of patients presenting for VNS insertion and their symptoms were worsened during stimulation intervals due to central and peripheral effects of stimulation.
- References:

  - Jain et al. Cardiac surgery in a patient with implanted vagal nerve stimulator. Ann Card Anaesth 2018;21:57-9.

D.LARYNGEAL DYSFUNCTION IS A POSSIBLE POSTOPERATIVE COMPLICATION

- This is True. Postoperative respiratory distress can be caused by surgical damage to the superior laryngeal or recurrent laryngeal nerves, vocal cord paralysis, or stimulator-induced respiratory depression.
- Laryngeal dysfunction is possible especially with chronic VNS use (discomfort, voice change, hoarseness, cough, pharyngitis, dyspnea).
- This dysfunction has been reported in a case where the VNS malfunctioned and was in the "ON" state continuously.

- References:

  - Hatton et al. Vagal Nerve Stimulation: Overview and Implications for Anesthesiologists. Anesth Analg. 2006 Nov;103(5):1241-9.
  - Ben-Menachem. Vagus nerve stimulation, side effects, and long-term safety. J Clin Neurophysiol. 2001;18(5):415-8.

3. MR.Y HAD SUCCESSFUL IMPLANTATION OF A LEFT-SIDED VAGAL NERVE STIMULATOR A YEAR AGO.HE NOW PRESENTS TO THE HOSPITAL FOR A HERNIA SURGERY. WHICH OF THE FOLLOWING CONSIDERATIONS IS TRUE IN PATIENTS WITH VAGAL NERVE STIMULATORS?

A Monopolar cautery is safe to use in these patients

B MRI scans are absolutely contraindicated in patients with vagal nerve stimulators

C Vagal nerve stimulators are not responsive to magnets

D Patients with vagal nerve stimulators can be at increased risk of perioperative respiratory events

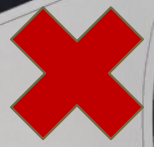
Contributor-Adele Budiansky MD,FRCPC, Fellow, Cleveland clinic

A. MONOPOLAR CAUTERY IS SAFE TO USE IN THESE PATIENTS

- This is False.
- Similar to other implantable electrical devices, electrocautery can damage the VNS or interfere with its function. In keeping with recommendations for other devices, monopolar cautery should be avoided, short bursts of electrocautery should be used, and grounding pads should be placed away from the generator or leads of the device

Reference: Venkatraghavan et al. Non-cardiac implantable electrical devices: brief review and implications for anesthesiologists. Can J Anesth. 2009;56:320-326.

B. MRI SCANS ARE ABSOLUTELY CONTRAINDICATED IN PATIENTS WITH VAGAL NERVE STIMULATORS



- This is False. Magnetic resonance imaging can present a risk to patients with vagal nerve stimulators due to the risk of generator damage and thermal injury of the vagus nerve. However, vagal nerve stimulators are typically considered "MRI-conditional." Hence this is the correct answer. Multiple studies have reported the safety of MRI, including brain MRIs, in patients with vagal nerve stimulators. Prior to MRI imaging, manufacturer instructions should be consulted, and the device should be interrogated post-procedure.

Reference: Benbadis et al. MRI of the brain is safe in patients implanted with the vagus nerve stimulator. Seizure. 2001;10:512-5.
De Jonge et al. Safety of a dedicated brain MRI protocol in patients with a vagus nerve stimulator. Epilepsia. 2014;55:e112-5.

C. VAGAL NERVE STIMULATORS ARE NOT RESPONSIVE TO MAGNETS

Magnet

- This is False. Vagal nerve stimulators respond to device-specific magnets. Placement of the VNS magnet for a period of at least one second can activate the vagal nerve stimulator and therefore may be used during a seizure. Placement of a magnet for a duration longer than one minute typically deactivates the device. A neurologist should be consulted for magnet management.

Reference: Hatton et al. Vagal nerve stimulation: overview and implications for anesthesiologists. Anesth Analg. 2006;103:1241-9.

D. PATIENTS WITH VAGAL NERVE STIMULATORS CAN BE AT INCREASED RISK OF PERIOPERATIVE RESPIRATORY EVENTS

- This is True. Vagal nerve stimulator placement can cause acute as well as chronic respiratory complications. Immediately post-insertion a patient can experience complications such as transient vocal cord palsy or airway obstruction due to a paratracheal hematoma. In patients with chronic vagal nerve stimulators, persistent vocal cord adduction resulting in increased aspiration risk, dyspnea, and airway obstruction has been reported. Patients with OSA and a VNS have been shown to have worsened obstructive symptoms due to alterations in airflow during sleep.

Reference: Hatton et al.
Venkatraghavan et al.

4. MR. Y HAS A VAGAL NERVE STIMULATOR AND IS HERE FOR AN APPENDECTOMY. WHICH STATEMENT IS TRUE.

A. The VNS should be turned off for an appendectomy.

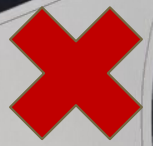
B. Electrocautery does not damage the VNS generator.

C. Peri-operative use of opioid, is associated with increased inhibition of post operative respiratory efforts in patients with VNS, when compared to normal population

D. VNS is usually placed on the right side

Contributor- Arun George, MD,
CA-1 resident, Allegheny Health Network

A.THE VNS SHOULD BE TURNED OFF FOR AN APPENDECTOMY?



❖ False. VNS does not need to be deactivated or inhibited (via magnet placement) during surgery. The correct functioning of the VNS system may need to be confirmed after the procedure.

❖ Physician's Manual VNS Therapy™ Pulse Model 102 Generator and VNS Therapy™ Pulse Duo Model 102R Generator, May 2003, U.S. Domestic Version. Houston, TX: Cyberonics, 2004.

B. ELECTROCAUTERY DOES NOT DAMAGE THE VNS GENERATOR

- False. Electrocautery or radio frequency ablation may damage the VNS generator. Although the VNS does not need to be deactivated or inhibited (via magnet placement) during surgery, recommended maneuvers to minimize damage to the electrical circuitry from electrocautery include positioning grounding pads (similar to pacemaker recommendations) so as to prevent current flow through the system and as far away from the VNS generator as possible.

- Physician's Manual VNS Therapy™ Pulse Model 102 Generator and VNS Therapy™ Pulse Duo Model 102R Generator, May 2003, U.S. Domestic Version. Houston, TX: Cyberonics, 2004.ure.

C.PERI-OPERATIVE USE OF OPIOID, IS ASSOCIATED WITH INCREASED INHIBITION OF POST OPERATIVE RESPIRATORY EFFORTS IN PATIENTS WITH VNS, WHEN COMPARED TO NORMAL POPULATION

- True. Use of opioids in a patient with implanted VNS may lead to exaggerated respiratory depression or severe postoperative apneic episodes. It is therefore important to obtain a thorough history regarding sleep and respiratory patterns. VNS can cause sleep apnea or exacerbate sleep apnea in patients with a preexisting diagnosis.

- Hatton KW, McLarney JT, Pittman T, Fahy BG. Vagal nerve stimulation: Overview and implications for anesthesiologists. Anesth Analg. 2006;103:1241–9.
- Malow BA, Levy K, Maturen K, Bowes R. Obstructive sleep apnea is common in medically refractory epilepsy patients. Neurology. 2000;55:1002–7
- Parhizgar F, Nugent K, Raj R. Obstructive sleep apnea and respiratory complications associated with vagus nerve stimulators. J Clin Sleep Med 2011;7:401–407.

D. VNS IS USUALLY PLACED ON THE RIGHT SIDE

❖ This is False. The left is preferred over the right vagus nerve for VNS placement because of the greater number of cardiac efferent fibers from the right vagus nerve, whose stimulation may result in more frequent adverse cardiac complications.

❖ Saper CB, Kibbe MR, Hurley KM, et al. Brain natriuretic peptide-like immunoreactive innervation of the cardiovascular and cerebrovascular systems in the rat. Circ Res 1990;67:1345–54.

5. WHICH OF THE FOLLOWING STATEMENTS IS FALSE ABOUT VAGAL NERVE STIMULATORS?

A. Right vagus nerve innervates the AV node while the Left vagus nerve innervates the SA node.

B. Voice side effects are the most common side effects reported following VNS device implantation in adults.

C. An LMA is not recommended as an airway adjunct intraoperatively in a patient with active VNS device.

D. The VNS requires activation on demand to prevent or abort a seizure.

Contributor- Deepali Garg, MD,
Anesthesia resident, University of Iowa

A. RIGHT VAGUS NERVE INNERVATES THE AV NODE WHILE THE LEFT VAGUS NERVE INNERVATES THE SA NODE.

- This is False and hence the correct answer. Branches from the right vagus nerve innervate the sinoatrial node while branches from the left vagus nerve innervate the atrioventricular (AV) node. Right-sided VNS caused more cardiac slowing than left-sided VNS in a canine model. To avoid cardiac slowing, the VNS electrode array is almost always placed surrounding the left vagus nerve caudad to the origin of cardiac branches

Back to Q1

B. VOICE SIDE EFFECTS ARE THE MOST COMMON SIDE EFFECTS REPORTED FOLLOWING VNS DEVICE IMPLANTATION IN ADULTS.

- This is True. Vocal cord dysfunction and related side effects are the most common complaints following VNS device implantation in adults and children, with an incidence reported as high as 66%. Voice side effects are related to stimulation of the recurrent laryngeal nerve during VNS.

- Ref; Fahy BG. Intraoperative and perioperative complications with a vagus nerve stimulation device. Journal of clinical anesthesia. 2010 May 1;22(3):213-22.

C. AN LMA IS NOT RECOMMENDED AS AN AIRWAY ADJUNCT INTRAOPERATIVELY IN A PATIENT WITH ACTIVE VNS DEVICE.

- This is True. Dysfunction of the vocal cords or fold may be caused by surgical trauma, inflammation of the vagus nerve, or repeated stimulation of the VNS. This dysfunction may lead to aspiration. Aspiration may occur during a seizure without VNS, and some patients treated with VNS are prone to aspiration due to severe mental and motor retardation, making it difficult to ascertain the contribution of VNS. Aspiration has been reported in adults and children after VNS device placement. A Laryngeal Mask Airway (LMA) is not recommended as an adjunct airway owing to the risk of aspiration.

THE VNS REQUIRES ACTIVATION ON DEMAND TO PREVENT OR ABORT A SEIZURE.

- This is True. The VNS should be on demand to prevent a potential seizure or abort it. This activation occurs by programming the device to respond to a specifically designed compact magnet. The pulse generator should be activated by placing the VNS magnet over the pulse generator for one second and then removing it; this action may be repeated as needed.

End of set