

## The Utility of Interventional Anesthesia

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### Introduction

Anesthesia is not commonly requested for procedures in the interventional neuroradiology department except during an emergency. This may include Endovascular treatment for stroke or aneurysmal subarachnoid hemorrhage to name a few. With the increasing complexity of procedures conducted by interventional neuro-radiologists however, adequate planning of sedation and peri-interventional management should be a goal (Boggs & Luedi, 2019).

Elective diagnostic and therapeutic procedures performed in the interventional neuroradiology suite include interventions to treat:

- Arteriovenous malformations;
- Dural arteriovenous fistulas;
- Intracranial Aneurysms;
- Carotid Artery Stenosis;
- Venous Angioma;
- Retinoblastoma; and,
- Vein of Galen Malformations,

To name a few. In addition, neuro-modulation for the treatment of chronic back pain due to spinal cord lesions (Padwal et al., 2014) or percutaneous kyphoplasty for osteoporotic vertebral compression fractures.

This article will examine the utility of interventional radiology for anesthesia utilizing minimally invasive techniques.

### Demand for Pain Relief

Interventional radiology uses minimally-invasive techniques to diagnose and treat patients with image-guided procedures. While being minimally-invasive, pain management is an important factor during IR procedures as “effective pain control enables procedural success and improved patient satisfaction”(Sag& Yawar, 2022). Many IR procedures are done under moderate sedation with local anesthesia being the first step. The higher the demand for IR procedures in patients

the higher the demand for pain control using anesthesia (Li & Scott, 2022). It can be said the less a procedure hurts the better the outcomes for the doctors and patients.

### CT

Sometimes anesthesia supplies are limited. In these instances an interventional radiologist can apply injections for nerve blocks that can lessen the anesthetic requirement while also lowering the pain post procedure. This can be acquired by blocking the deep plexi with CT guidance. With the trends increasing towards more than moderate sedation the need for skilled interventional radiologists also increases. Some patients with painful conditions might not feel enough relief with moderate sedation. This can be especially so if they are already taking high doses of pain medication. Using CT guidance to administer a nerve block would also be preferable to patients who are not good candidates for general anesthesia (Sag& Yawar, 2022). In any case it will always be better to have more options for pain relief.

With CT, deeper and novel targets are becoming more accessible for anesthesia techniques. CT offers real time imagery of the locations of where the needle is going, although CT may not always be the key method for all targets (Sag& Yawar, 2022). Sometimes CT may not show a direct and simple path for a needle to avoid viscera (Berde et al., 2022). These are instances where CT imaging faces challenges.

### Fluoroscopy

One of the more popular types of anesthesia is the epidural guided by fluoroscopy. Fluoroscopy is another method to view needle advancement to ensure it does not pierce nearby viscera. The same can be said about viewing needles utilizing ultrasound (Berde et al., 2022). In fluoroscopy-guided epidural anesthesia post operational pain levels are reported lower than if the patient was given general anesthesia. There were

also a lower number of patients reported who needed rescue analgesics in the recovery room from those who had the epidural anesthesia. From these observations it can be said that epidural anesthesia is preferential to general anesthesia for the recovery period during early post operations, as less patients were discomforted. Epidural anesthesia may also be preferential to older patients where concerns for morbidities of general anesthesia exist. Other advantages to this type of anesthesia include lower facial injuries and the patient being able to position themselves once awake (Abd-Elseyed et al., 2023).

### Ultrasound

Ultrasound can be used to place vascular catheters as well as dialysis catheters. By using ultrasound the increase in safety lowers complications that may occur during the procedure (Abd-Elseyed et al., 2023). Ultrasound guidance gives added safety and accuracy when performing local anesthesia (Abd-Elseyed et al., 2023; Abd-Elseyed et al., 2023). Today many instruments are portable in size. Point-of-care ultrasound (POCUS) is able to evaluate cardiac, thoracic, and abdominal pathology when it is more convenient to do so and when other larger radiological instruments are not viable (Noikham et al., 2023). Ultrasound-guided cradle-like infiltration anesthesia (UCIA) studies were shown to be a safe and effective way to administer analgesia. It is minimally invasive and produces minimal pain for patients who have to undergo percutaneous transluminal angioplasty (PTA). Anesthesia is injected into the area the PTA will be placed, resulting in some relief for when the PTA dilates and causes pain (Lu et al., 2022). Typically anesthesia is comparable to other sedoanalgesia drugs and nerve blocks in relation to the amount of comfort it can offer a patient. While anesthesia can be used to lower patient movement it can also cause hemodynamic instability, lower the benefits of endovascular approach, and may affect the outcome of the procedure. Regional anesthesia safety and efficacy is increased when using ultrasound guidance versus using landmark techniques (Noikham et al., 2023).

Radiological imaging is always evolving and it can improve upon older methods in which another imaging type was used. Intravascular ultrasound can replace fluoroscopy when finding those hard to locate portal veins. Intravascular ultrasound can give direct visuals in real time in order to gain access to the portal vein from the hepatic vein. Using the older fluoroscopy imaging it could take multiple passes to get into and complications due to multiple passes could cause a hemorrhage (Dastmalchian et al., 2022).

### Angiography

Interventional radiology is not always used to treat and diagnose patients. Sometimes it is used as a tool to measure the effectiveness of drugs and treatments. A study was done using angiography to measure the effects of peribulbar anesthesia administered to glaucoma patients. In this study it was shown that peribulbar anesthesia negatively affects patients' vision who suffer from glaucoma. This study used optical coherence tomography angiography (OCT-A) to look at the state of the blood vessels in the eyes (Awwad et al., 2022).

### Foreign Object Removal

Medical accidents happen, and when they do it is imperative they be solved quickly and safely. When things like broken needles get lost in the body typically it is better to remove them from the patient to allow for psychological peace and as a precaution that it does not travel to other parts of the body where it can do damage. CT and fluoroscopy can be used to locate and guide the surgery for removal. Usually fluoroscopy provides a low-cost solution to foreign object removal (Pierri et al., 2022).

### Risks

As with many medical procedures there will always be underlying risks involved, and choosing the correct method can be the difference between success and complications. With CT there can be a risk for ionizing radiation, and extra care must be taken, especially with pediatric patients, to ensure exposure is minimized. MRI can also pose risks with potential adverse effects when sedation is used in conjunction with this imaging type. Those potential risks include, but are not limited to, difficulty breathing, the rare death, or cardiac arrest. Although these risks are present, they vary between age and the type of condition they have. Even then, the degree of risks also vary from patient to patient. Nowadays radiologists would not conduct the sedations, rather an anesthesiologist will be better suited to maximize safety and minimize discomfort for the patient. It is imperative that radiologists and anesthesiologists communicate well to ensure the patient is cared for and to discuss what the best method for imaging is. After weighing out the options, it is normally advantageous to go after the method that will produce the best and clearest image (Callahan & Joseph, 2022).

### Cost

Frequently the costs of procedures act as a hurdle. Coupling anesthesia with imaging may drive up costs of care. It should be reasonable to provide cheaper alternatives to patients when possible. For example if a patient needs to be sedated for an MRI scan not only is that an added cost for the sedative but there will also be a recovery period once the sedative wears off. Alternatively a CT scan can be done without sedation and can be completed quicker. This choice makes CT a much more affordable option for the patient (Callahan & Joseph, 2022).

### AI

Currently AI is being tested in the hopes it can aid in ultrasound-guided anesthesia. This AI would help new trainees in locating the best place to insert the needle and administer the anesthesia. Although the technology is still new it has shown to have a high rate of success on the first insertion. This in turn would reduce any complications multiple attempts at insertion would have, though currently it is not without its limitations. During the ultrasound there are times where the AI experiences tracking failures where the target nerve is lost. This could be due to the image not being clear enough, sudden movement, or needle detection fails. There are also challenges the AI faces when the ultrasound images patients with abnormal anatomy. Another risk of using AI with ultrasound-guided anesthesia

is the risk of needle trauma to non-intended structures. These shortcomings can be improved upon by mapping the best target site by detecting the relevant landmarks and by improving the target IDs of the anatomy through ultrasound (Viderman et al., 2022). The use of AI in ultrasound has the potential to simplify finding the best route to administer anesthesia as the technology evolves.

### Effectiveness

A study done by Shibiao Chen et al showed that the patient satisfaction with ultrasound-guided caudal epidural blocks was superior to spinal anesthesia. Because more patients who received the epidural showed satisfaction in the resulting comfort following surgery it should be utilized more regularly. This study parallels the retrospective study done by Seung Youn Kang et al where the pain relief was significantly higher with patients who received fluoroscopy-guided epidural anesthesia versus general anesthesia. The patients' pain scores were recorded at 10 minutes, 24 hours, and 48 hours postoperatively. In both studies side effects did not differ between the two groups (Kang et al., 2022; Chen et al., 2022).

### Takeaway

There is a direct correlation between the demand for immediate comfort and pain relief in patients and anesthesiologists to administer anesthesia. A skilled anesthesiologist will increase patient satisfaction and from then hopefully a patient will put forth more trust in the healthcare system.

Depending on the patient their needs may not be one or the other. Sometimes they would need both. They would need both a nerve block and some type of anesthesia. These are the times radiologists and anesthesiologists must work coherently and communicate with each other to minimize risks for the patient. Sometimes the standard procedure does not fit the patient, and these are the times novel targets can be used. This way interventional radiology and anesthesia becomes available to them.

With the modern techniques and technology injections with anesthesia can be guided with fluoroscopy, ultrasound, and/or CT imaging. All these methods increase patient safety because landmark techniques are not always reliable due to individual anatomical differences. These techniques and technology will only get better and evolve with time. Current methods will always improve.

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