

[MUSIC PLAYING]

**CARL** Thank you, David. We're going to try to keep this very practical about things that you can do in the operating room or even before you get to the operating room to make your surgeries less bloody.

**SNYDERMAN:**

I have no disclosures that are relevant to this presentation.

So with this presentation, my objectives are, one, to recall the risk factors for bleeding; summarize techniques, both materials and tools, that can be used to enhance intraoperative hemostasis, and also help you develop a strategy for managing particular situations.

Everything you need to know about hemostasis can be found in this book that I co-edited with Dr. Harshita Pant from Adelaide, Australia-- she did a fellowship in cranial-based surgery with me a number of years ago-- and this really covers all hemostatic aspects in otolaryngology, and has a number of very relevant chapters for no matter what aspect of otolaryngology that you practice, so I highly recommend it.

Well, why is bleeding a problem? Lots of reasons. I think most importantly, it interferes with visualization. And I think that's probably the number one cause of complications, especially during endoscopic sinus surgery. If you can't see well because of a bloody surgical field, the risk of a complication such as a spinal fluid leak or orbital injury or cranial nerve injury goes way up.

It also interferes with your ability to complete the surgery. There are certainly medical morbidity associated with bleeding. And it contributes to quality of life issues with the postoperative care of patients, and adds additional costs to the care of patients, especially if they have to be readmitted for treatment of postoperative epistaxis.

Some surgical bleeding is expected. Patients who with extensive mucosal disease as this patient with nasal polyposis, or patients with an active inflammation are expected to bleed more. Tumors that involve the bone, such as this meningioma are known to have a rich blood supply and can be quite bloody. And finally, a very large vascular tumor, such as angiofibroma, you can anticipate that this is going to be a very vascular surgery.

We also have to worry about inadvertent vascular injuries. Here's an example of a small carotid injury they were able to control with bipolar electrocautery, but this is certainly everybody's greatest fear doing endoscopic sinus surgery.

Well, before we ever get to the operating room, there are some things we can do to help minimize the risk of bleeding. And so we really, the first thing we need to ask ourselves is, is our patient at increased risk for bleeding? Are there any risk factors that we should inquire about?

And so these are some of the things that you should talk to your patients about. It's important to know what medications they're on, whether they have a preexisting bleeding disorder, what kind of pathology you're dealing with, whether there is active inflammation that could be treated beforehand. Certainly patients who are morbidly obese have elevated venous pressure, which can contribute to bleeding. And prior therapy may also play a role in the extent of bleeding.

The history is oftentimes the most important part of the assessment of patients, and it's very important to ask them about their medications-- and not just the ones that are prescribed, but what they may be taking on their own. There are many herbal products that have antiplatelet effects. It's important to remember the three G's-- garlic, ginseng, and ginkgo. Many times, patients are taking products that have anticoagulant effects in addition to the antiplatelet drugs that they're on.

It's also important to ask about vitamin supplements, such as vitamin E, fish oil supplements, and other things that we don't think about as often-- alcohol has some mild antiplatelet effects, and so it's good to ask about that. Certainly if someone has underlying chronic liver or renal disease that may contribute or if they have a hematologic malignancy.

Also, patients who are being treated for cancer, they may be taking unproven supplements that many times can have antiplatelet or anticoagulant effects, so it is very important to know what you're dealing with.

Prior to surgery, so there are things that we can do to optimize the patient for surgery. If they are taking antiplatelet drugs, it's good to stop them at least 10 days before surgery to allow the body time to recover. If there's inflammation, you can treat that beforehand to decrease the vascularity of the tissues. preoperative corticosteroids are often given in patients with nasal polyposis to shrink the polyps, and this may also have a beneficial effect on bleeding.

And finally, if we know that we are dealing with a vascular tumor, there are things that we can do to devascularize that tumor prior to dissecting the tumor.

There are multiple good sources for learning about antiplatelet therapy and how to manage them in the perioperative period. Here's a good summary article that recommends interrupting treatment seven-to-10 days prior to surgery. And in most cases, you can resume therapy within 24 hours after surgery without expecting an increase in bleeding complications.

Sinus surgery, however, may be a bit unique in that oftentimes we're leaving exposed raw tissues that may be at increased risk for bleeding, but there are studies showing that it can be resumed in the early postoperative period safely without complications. Either way, it's always good to coordinate with other health care providers to make sure that you're handling the patient's medications in the optimal fashion.

Do postoperative steroids improve the surgical field and decrease bleeding? Although many people will treat patients preoperatively with steroids, we currently lack adequate data to really make a strong recommendation. There are several options for administering steroids. You can provide topical steroids, oral steroids, or a single preoperative dose.

The value of steroids and the presence of other hemostatic agents or strategies is not really known, but it may be part of your overall treatment regimen.

So now let's talk about what you can do in the operating room to minimize bleeding. Patient position is often overlooked, and this can be quite important, especially in patients with sinus surgery, especially in our obese population. Elevating the head of the bed can improve venous return and decrease venous stasis in the nasal tissues.

And studies show that somewhere between 10 and 20 degrees is optimal. You can get a little free app on your phone called a clinometer where you can actually measure the angle of the table to make sure you're getting at least 15 degrees of head elevation.

There are also special OR tables that are available. Here's an example of the Mizuho table, which is nice because it goes very low to the floor, which allows you to put it in a lot of reverse Trendelenburg, but still not have the table too high for you to operate. So it allows you to operate at a comfortable position.

A randomized study looking at positioning of the patient with reverse Trendelenburg showed that there was a very significant difference in comparison to the horizontal position. So I always put my patients at 15 degrees head elevation and I confirm that with my phone app.

Anesthetic technique is also important. There is good evidence that using total intravenous anesthesia in comparison to inhalational agents will decrease the risk of bleeding. Laryngeal mask ventilation also has a decreased risk of bleeding compared to insertion of an endotracheal tube.

For routine sinus surgery, many surgeons will also apply hypotensive anesthesia to lower the mean arterial pressure less than 80 millimeters of mercury, and this can be very beneficial. However, I caution you, if you are doing skull-based surgery or if you're operating on somebody who has poor circulation, they may have a pituitary tumor that's compressing the optic nerves, you don't want to lower the blood pressure too much because that may cause further ischemia and risk loss of nerve function or stroke.

Many agents can be used to provide vasoconstriction. Typically we rely on topical agents. Oxymetazoline has a very favorable safety profile and is quite effective as a topical agent. Typically we insert these in the nasal cavity using cottonoids soaked in oxymetazoline at the time of induction of anesthesia, and give that time to work before starting the surgery.

And in comparison to other drugs such as cocaine or epinephrine, I think it's a much safer drug to use and it gives equivalent if not better hemostatic effects.

You can also inject vasoconstrictors, and I've found that using a 0.5% xylocaine solution with 100,000 to 200,000 epinephrine is more than adequate as long as you give it time for the medication to work.

You can also do a regional block injecting vasoconstrictor into the greater palatine foramen, but I have avoided doing that just because of the technical difficulty, and always the potential risk of injecting into the foramen. And I'm not sure that it adds anything beyond what we can achieve with topical and other agents.

Looking at the safety of topical agents, we can see that oxymetazoline and epinephrine can be used safely if you're using appropriate doses. However, topical phenylephrine should not be used because of its risk profile.

As always, hemostasis depends on good surgical technique, being very meticulous about avoiding mucosal trauma, about getting hemostasis as you proceed through the surgery. So there are some things you can do to minimize bleeding. One is preserving the mucosa as much as possible using cutting instruments instead of stripping mucosa off the bone. A microdebrider may provide a more precise removal of tissues so you're not removing excess tissue.

Be careful with your suctions. Avoid traumatizing the tissue. Be careful you're not using a suction tip that's been drilled on and has a very sharp edge.

And also, always visualize your instruments. You know, follow the passage of instruments into the nose so that you're not bumping against the septum or the turbinates.

During surgery, if there's bleeding from the mucosa or nasal polyps, we have several effective regimens. Suction electrocautery can be used for hemostasis. You can reinsert pledgets soaked in oxymetazoline. And one of my favorite tools is the use of hot water irrigation. This is probably the most important thing I have to tell you in this presentation, and this is based on the work of Dr. Stanger up from Denmark. And he's shown that it is a very effective means for treating severe epistaxis.

And so we maintain a hot water bath at the bedside at 40 degrees centigrade. And so whenever we have diffuse oozing from the mucosa, we just irrigate the nose with warm saline at about 40 degrees centigrade. If you review his studies, you can see that the optimal temperature is around 45 degrees centigrade.

And this can be used in all kinds of surgery, and it really has revolutionized how I perform endoscopic sinus surgery, and I think that's one of the most effective tools that we have during surgery.

It has also been shown to be beneficial for adenoidectomy, and it really can be applied to any surgery that you do. Just irrigate the field with warm saline.

So here's an example of a super cellular approach, and we really can't put packing on the surface of the brain tissue to get hemostasis, and so many times, we just rely on warm saline irrigation. And so small capillaries, after a few minutes of irrigation, you can just see the vessel stop bleeding. And so here's before irrigation, and here's-- you can see how clear the field is now after about five-to-10 minutes of just warm saline irrigation.

It's also important to maintain proper temperature in the operating room. Patients who become hypothermic will develop platelet dysfunction. And so this is a problem with trauma patients in particular. And so always be careful, be cognizant of keeping your patients covered up. Keep the room warm enough, because if you're doing a long surgery and the patient becomes hypothermic, you may start to have bleeding problems.

There are a number of hemostatic materials that we can use for hemostasis as noted here. Here you see examples of Surgicel, Fibrillar, Avitene, tissue glue, powdered gelatin, as well as a material called Syvek that is made from plankton.

But of these, one of our favorite products is using the powdered gelatin, this is great for bleeding from veins or from the surface of the bone. And so there are two products that are available commercially, Flowseal and Surgiflo. And you can inject these right at the site of the bleeding. So here's an example of a cavernous sinus bleeding. And so we inject the material right into the cavernous sinus, it gives you immediate hemostasis.

So this can be used for veins that are bleeding on the surface of the bone, or just if you're in a soft tissue and you can squirt this right on the soft tissues, apply a little pressure, it can be very effective.

There are some precautions you need to note, however. You don't want to over-inject the cavernous sinus. If you put too much material in the cavernous sinus, it can swell and causes sixth nerve palsy. Also, be very careful that you're not injecting an artery. So if you have a carotid artery injury or any other arterial injury, you need to recognize the difference between arterial and venous bleeding. If you inject the artery, this material will embolize and you will include the vessel and risk causing a stroke.

In fact, there are examples in transcranial surgery where this has occurred, causing problems. There are no reports of this problem during endoscopic surgery, fortunately.

We can all also use antifibrinolytics to enhance hemostasis. Tranexamic acid can be administered intravenously at the beginning of surgery. So if we know we're going to deal with a bloody situation, if we have a highly vascular tumor such as an angiofibroma, we will consider giving a dose of this drug at the beginning of the surgery.

It's very important that you have the right tools, and every endoscopic sinus surgeon should have an endoscopic bipolar set. These come in different configurations with different interchangeable tips for different types of situations. And a number of companies make these devices now, and so every surgeon should really ask their OR to invest in these tools. It allows you to provide very precise electrocautery without the risk of thermal spread to normal structures.

There are other instruments that may be useful. Here's an example of the Aquamantys, which is a fixed bipolar electrocautery. So these are fairly large tips, so they're good for surface mucosal cauterization in the nasal cavity, and also good for debulking tumors, getting hemostasis on the surface of the tumor.

Sometimes you need to address specific vessels in the nose. It's important to understand the vascular anatomy of the nasal cavity, the contributions from the ethmoidal arteries and the sphenopalatine artery, and even the facial artery.

The posterior nasal artery is a branch of the sphenopalatine artery that crosses the front of the sphenoid sinus. And so if you're doing a sphenoidotomy, this branch is often injured, and this can bleed quite profusely. It is easily controlled with monopolar or bipolar or electrocautery, but it's very important to recognize that it is bleeding.

Sometimes there's an injury and you don't notice it right away and there's bleeding occurring in the background throughout the surgery, and so this can result in excessive blood loss during the surgery if you don't pay attention.

This sphenopalatine artery exits the sphenopalatine foramen at the posterior superior corner the maxillary sinus, and so it's important to understand this anatomy. Most of the time, it branches into two branches, and this may exit through one foramen or two foramina.

And so in patients with severe epistaxis, we may consider ligation of this vessel. So here's an example of the right sphenopalatine artery ligation. But we may also consider doing this preemptively in patients where the artery is feeding a tumor or as part of the surgical approach.

So here, you see we're exposing the sphenopalatine foramen. Now we're moving bone over the sphenopalatine artery so that we can gain access to the proximal trunk before it has a chance to divide.

And then once we have full exposure, then we can place some Hemoclips across the vessel. Typically I like to clip the main trunk of the vessel, and then put a clip on each of the distal branches as well. So this is my preferred treatment for patients who present with severe posterior epistaxis.

There is some evidence that a combination of clipping of the vessel as well as bipolar electrocautery achieves the best results. There's always a risk that the Hemoclips may fall off of the vessel or they may not be properly attached, and so it's probably a good idea to burn the vessel. I prefer not to cut the vessel unless it's required for the surgical approach.

The anterior ethmoidal artery may also be a source for bleeding, and sometimes it's important to devascularize the tumor by sacrificing this artery. This artery may be approached internasally. And so here's a view looking up at the skull base, and you can see the anterior and the posterior ethmoidal arteries.

So this can be cauterized along its course, or even cauterized or clipped on the orbital side of the vessel. So here's an example of cauterization that the skull base of the anterior ethmoidal artery, once again, using one of these special bipolar electrocautery devices.

Or you can do an external anterior ethmoidal artery ligation. And so here's an example of using a very small incision on the lateral surface of the nose equidistant between the nasal dorsum and the medial cathus.

And with the use of an endoscope, we really can minimize our exposure and have excellent visualization of the artery as it crosses from the orbit to the nasal cavity, and we can cauterize or just place Hemoclips on the vessel. Once again, I prefer not to transect the vessel so that there's no risk of bleeding into the orbital tissues. With the use of the endoscope, we can have a very small cosmetically favorable incision.

And here's a video showing the same procedure, retracting the orbital contents, and then passing the Hemoclip down and placing it securely on the vessel.

So if I'm treating a patient who needs both a ligation of the anterior ethmoid and the sphenopalatine artery at the same time, I prefer to ligate the anterior ethmoidal artery first.

And someone who has sort of unexpected excessive bleeding, you may consider an underlying coagulopathy that hasn't been diagnosed previously. Patient could have Von Willebrand's disease, but also a prolonged surgery with a lot of blood loss can result in coagulopathy. And don't forget, the effects of hypothermia on patients during the long surgery. This can be treated effectively with fresh frozen plasma.

So they're looking at the literature once again. You can achieve very good results by combining all of these techniques, using intravenous anesthesia, preoperative steroids, especially in patients with polyposis, and using a topical vasoconstrictors as well as a local injection of vasoconstricting medicines.

So now let's switch topics a little bit and talk about specific strategies for treating vascular tumors. There are a number of different vascular tumors that you may encounter as noted here. Meningiomas, sinonasal malignancies, angiofibromas the most common vascular tumors that we would treat.

And so one strategy is to do as much as you can around the periphery of the tumor. So here's an example of an adenocarcinoma in the nasal cavity. We don't know the site of attachment yet, so we start working around the periphery of the tumor. This is a situation where you might consider using the Aquamantys bipolar electrocautery to cauterize and debulk your tumor.

But our goal here is to work with two hands-- this is a two-surgeon team surgery-- and identify the site of attachment of the tumor, cauterize the surface of the tumor, transect it at-- or revulse it at its attachment so that you can quickly get to the site of the vascular supply.

So we're coming across that attachment. So rather than take this tumor out piecemeal, we're taking the bulk of it out in one piece. And so now we can effectively get to the origin of the tumor, and it's very effectively-- or very easy to control bleeding from the tumor, and then complete our resection to get clear margins.

Well what about angiofibromas? A small angiofibroma such as the one you see here is really not much of a challenge. You can do a preoperative embolization and effectively devascularize the tumor, or if you're in an environment where that's not feasible, you could simply expose the target palatine space and cauterize or clip the branches of the internal maxillary artery to devascularize this tumor before you can manipulate the tumor.

Well what about a large tumor such as this angiofibroma? This is certainly much more challenging, there's intracranial extension. You can anticipate that this tumor is going to have a blood supply from the internal carotid artery. So we routinely embolize the external carotid artery, but that doesn't always get rid of all the blood supply as you can see here. So here's residual blood supply from the internal carotid artery.

And so you could consider embolization of the branches coming off the internal carotid artery, but this carries some risk of stroke, and so we generally prefer not to do that.

A number embolic agents have been used for sealing off the blood supply. You can see that they're both temporary and permanent agents. For permanent agents, you can use particles, coils, or liquid agents.

One that we particularly like to use is called Onyx. It's a liquid agent. And the nice thing about the liquid agents is they have very good penetration of the tissues, and so it's getting down to the end vessels and gives a much more effective devascularization of the tumor. However, if used excessively, there is a greater risk of tissue necrosis with these agents.

So here's an example of an angiofibroma with intracranial extension. You can see pre- and post-embolization of the external carotid system. And you can see, there's still a significant residual blood supply coming off of the internal carotid artery near the cavernous sinus.

And so we felt that this was-- or we realized that this is probably the biggest risk factor for doing surgery on these tumors. The biggest problem is bleeding, and as we mentioned before, that impairs visualization, increases the risk of complications, and limits your ability to remove the entire tumor.

So we developed a new staging system back in 2010 which incorporates the residual vascularity into the staging of the tumor. And so sort of like an upside-down stoplight, you can see that we've progressed from green to yellow to red from early to late-stage tumors, and you can have a very large tumor, stage 3, in the yellow group that has skull base erosion, but if it has no residual vascularity following an embolization, it's not a very challenging tumor to remove.

However, stage 4 and 5 tumors that have residual vascularity are among the most challenging. And we compared this staging system to other staging systems out there, and it had the best correlation with interoperate of blood loss, and also with tumor recurrence and risk of leaving residual tumor.

So what's our strategy with the big tumor as I showed you? First of all, this is team surgery. You really can't tackle a tumor like this on your own working with one hand, you need both hands to operate. We work around the periphery of the tumor as much as possible, sort of dancing around the tumor, exposing the margins, identifying important key landmarks before we tackle the tumor itself.

And then we divide the tumor into vascular segments. So if we have a large bilateral tumor, we'll take one extracranial component at a time before we tackle the intracranial component.

It's important to identify midline structures. This is where all of your important landmarks are located. And then early on, identify where the contributions are coming from the internal carotid artery so that you can cauterize these. And really, one bleeder at a time. You don't want to have multiple bleeding sites going on at the same time, so really take your time to get hemostatis as you work through the tumor.

In some cases, with very large tumors, there's simply too much bleeding, and you'll have to pack things off and stage the surgery. And so always be prepared to do that, and it's a good thing to always discuss with patients beforehand. We don't want to risk dural injury with a lot of bleeding and mixing blood with the CSF, that can cause vasoconstriction and be a life-threatening problem.

So here's an example of a 10-year-old male with a large angiofibroma. And so we do this in stages. And so we took out the bulk of the tumor in the first stage, and then went back in stage two to remove the intracranial component of the tumor.

For such surgeries, we have some additional tools that are very helpful. The harmonic scalpel uses radio frequency to cauterize tissues. And so this is very good for transecting tumors that are too large to remove in one piece.

And so here's an example of us using a harmonic scalpel during an angiofibroma surgery. And so you have to be patient with this device, you just slowly squeeze it across the tumor, and it cauterizes as it cuts through the tumor. You know, especially after embolization, these tumors may be quite firm, and they're simply too big to move through your access point, through the nasal cavity or through the maxillary sinus, and so you need to cut them into smaller pieces.

Some other tools that have been used effectively, one is coblation. I have no personal experience with coblation, but as you can see, there are multiple reports in the literature demonstrating its efficacy. And here's some examples from the literature of the use of coblation.



We also sometimes can minimize the effects of blood loss using a blood-sparing protocol, especially in patients who are transfusion risks or do not allow us to use transfusions. And so we can dilute their own blood beforehand. We can do auto-transfusion, this is especially important in Jehovah's Witnesses, where we can draw off their blood, hemodilute, and as long as we maintain contact with the patient, as long as the blood remains in a circuit that's connected to the patient, they're OK with that.

We can use tranexamic acid, Cell Saver, and use other drugs to boost the recovery from the blood loss.

We talked briefly about staging a surgery. Situations where we consider that are patients where there are multiple vascular territories such as a large angiofibroma, patients who incur excessive blood loss and risk becoming coagulopathic during a surgery, if there's intracranial extension, and simply if there's a very long surgery, we don't want to be doing a critical part of the operation later in the day.

So here is a patient with a angiofibroma that was deemed inoperable and received radiation therapy elsewhere. And so you know this is going to be a challenging tumor. There's intracranial extension, there's going to be fibrosis, there's good blood supply from the internal carotid artery. And because of the difficulty of dissecting this tumor, it really took four surgeries to get this tumor out. Ultimately we were successful in removing the entire tumor.

So I hope this has been useful coverage of practical tips that you can use to minimize bleeding in your patients undergoing endoscopic sinus surgery. Once again, I refer you back to this book, which covers all aspects of hemostasis in otolaryngology, and I'm always available in case you have problem patients that you want to discuss with me. Thank you.