Chapter 2 – Epistaxis

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Epistaxis is one of the most common urgent problems that otolaryngologists are asked to treat. Minor epistaxis usually originates from the anterior nasal septum and is often the result of minor trauma to the septal mucosa. In children, it is often the result of nose picking, whereas in adults, nosebleeds result from desiccation of the mucosa associated with the dry air of the winter months. Minor epistaxis is generally anterior in origin but may also originate from the superior nasal cavity (anterior ethmoid artery [AEA]) and posterior nasal cavity. Conservative measures such as direct pressure (pinching the nose, nasal packing) and chemical cautery are usually successful in controlling this type of hemorrhage, and surgical intervention is rarely necessary.

Major epistaxis lacks a precise definition but it is characterized as being difficult for patients to control, frequently results in a trip to the emergency department, and can be life-threatening. The vast majority of major epistaxis is idiopathic, but a careful history will often yield some risk factors such as the use of antiplatelet medications. Major epistaxis is generally posterior in origin and originates from branches of the sphenopalatine artery, and it may pose a risk to the patient's airway. Patients with severe posterior epistaxis are typically older and have medical comorbid conditions. Care of these patients can be divided into acute management and definitive management. Acutely, an attempt is made to identify the source of the bleeding, and some form of nasal packing is placed to provide temporary control. Treatment options for definitive management include placement of an anterior and posterior nasal pack, hot-water irrigation of the nasal cavity,[1–3] angiographic embolization of the external carotid artery, and surgery.[4] Surgical options include electrocautery and ligation of nasal vessels. Surgical ligation of the terminal vessels (sphenopalatine artery [SPA] and ethmoidal arteries) is superior to ligation of the external carotid artery or internal maxillary artery (IMA) because of decreased morbidity and increased effectiveness.[5,6]

Certain patients deserve special consideration, including those with hereditary hemorrhagic telangiectasia, sinonasal neoplasms, and postsurgical or post-traumatic hemorrhage. An orderly plan of therapy or a treatment algorithm will assist in the management of patients with epistaxis, whatever the cause. This chapter focuses on the surgical management of severe epistaxis.

ANATOMY

The nasal mucosa has a rich arborizing network of submucosal vessels. The anterior septal plexus, termed Little's area or Kiesselbach's plexus, is a confluence of small vessels from the AEA, SPA, and facial artery (Fig. 2-1). The mucosa of the superior aspect of the nasal cavity is supplied by the ethmoidal arteries. Although they are typically labeled the anterior and posterior ethmoid arteries, there may be more than two vessels. These vessels originate from the ophthalmic artery, a branch of the internal carotid artery (Fig. 2-2). They traverse the orbital tissues, enter the nasal cavity through bony foramina along the frontoethmoidal suture line to supply the mucosa of the superior nasal cavity, and reenter the cranial cavity at the lateral margin of the cribriform plate. The AEA is larger than the posterior ethmoid artery (PEA) in most cases and is the most clinically significant. The AEA enters the nasal cavity a little less than 2 cm (average, 14 to 18 mm) posterior to the nasolacrimal suture line. It is situated at the posterior margin of the nasofrontal recess and is generally visible beneath the surface of the mucosa. In some cases it is easily identifiable in a prominent ridge or septation containing the vessel. With the aid of image guidance technology, the vessel can be localized intraoperatively in a coronal plane that is tangential to the posterior surface of the globe. The PEA lies about 1 cm (average, 9 to 13 mm) posterior to the AEA and may lie as little as 2 to 3 mm anterior to the optic canal (average, 4 to 7 mm). It crosses the skull base anterior to the sphenoid sinus and helps demarcate the posterior margin of the cribriform plate.

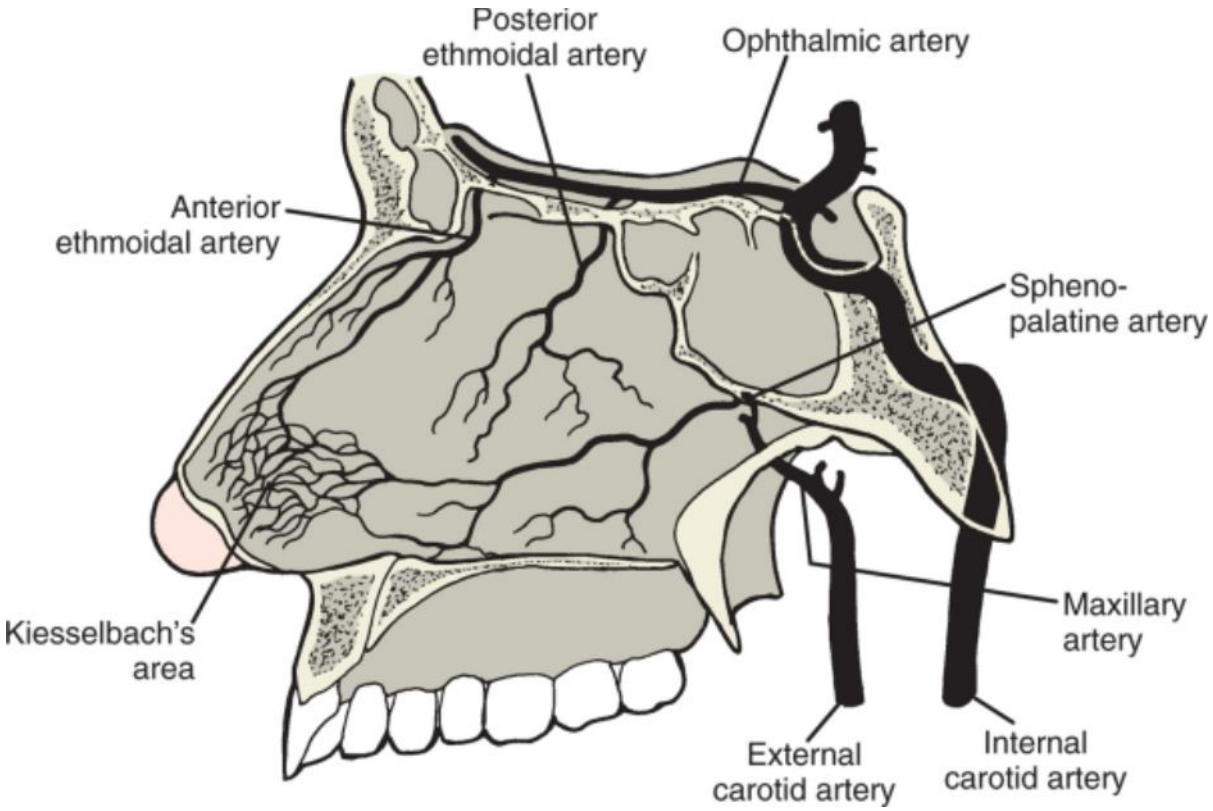

Figure 2-1 Vascular supply of the nasal septum.

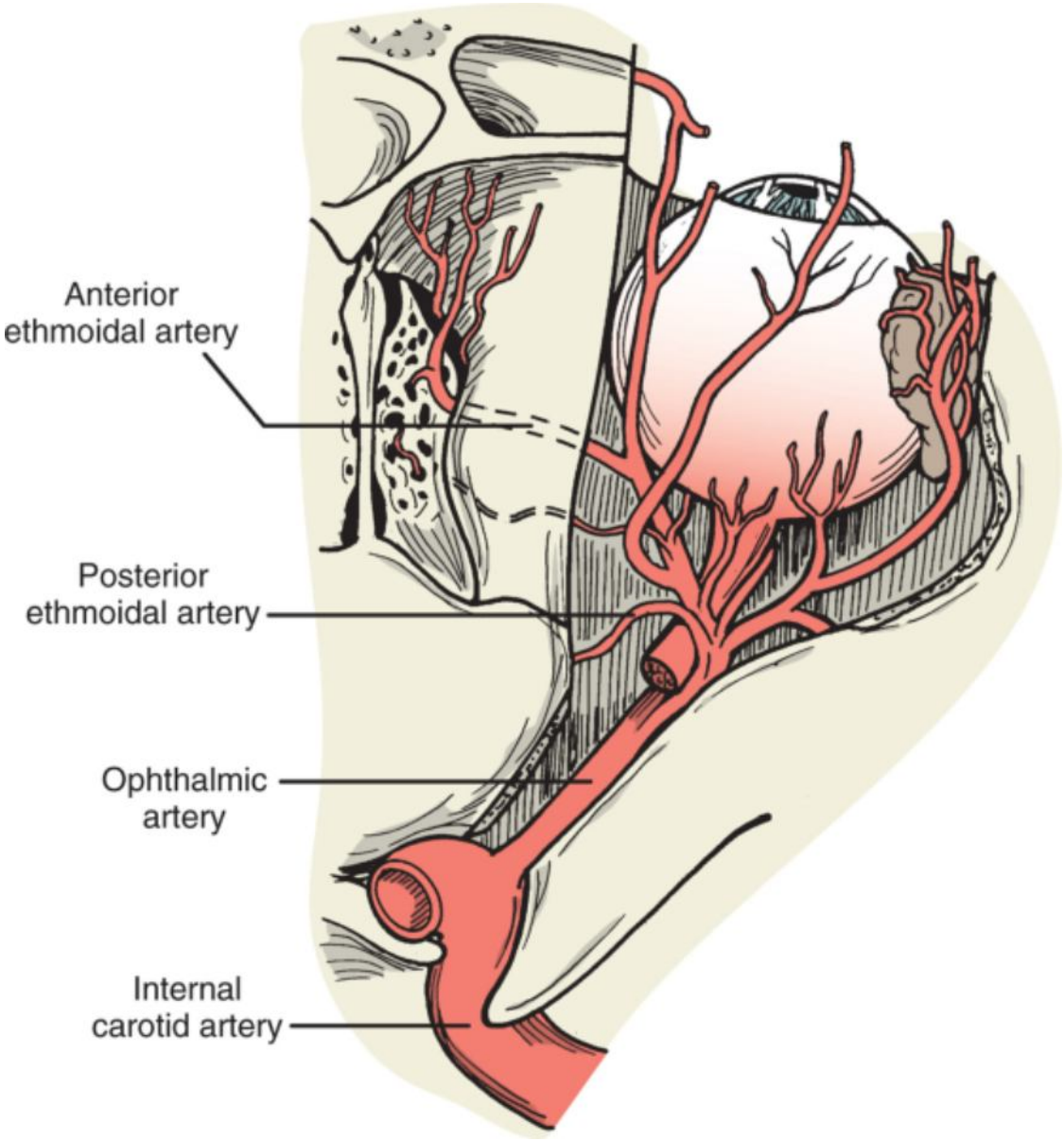

Figure 2-2 Anterior and posterior ethmoid artery branches of the ophthalmic artery.

The predominant blood supply to the nasal cavity comes from branches of the IMA, a major branch of the external carotid artery (Fig. 2-3). The IMA enters the pterygopalatine fossa or pterygomaxillary space laterally and branches into multiple vessels supplying the nasal cavity, oral cavity, and surrounding soft tissues. Within the pterygopalatine fossa, branches of the IMA can have a simple or complex branching pattern, thus making identification of the individual vessels nearly impossible. The SPA is the terminal branch of the IMA and is the major blood supply to the mucosa of the posterior nasal cavity.[7] It enters the nasal cavity at the sphenopalatine foramen. The sphenopalatine foramen is located at the superior aspect of the vertical plate of the palatine bone, which forms the medial boundary of the pterygopalatine fossa.[8] The foramen can be found at the posterior-superior-medial corner of the maxillary sinus, just deep to the attachment of the middle turbinate (Fig. 2-4). The SPA branches into lateral nasal branches and posterior septal branches to supply the mucosa of the lateral nasal wall and posterior nasal septum, respectively. The posterior nasal branch is frequently termed the posterior nasal artery, and this terminology will be used throughout this chapter. This branching of the SPA occurs proximal to the sphenopalatine foramen in 42% of cadaver specimens and results in separate bony foramina.[7] The lateral nasal branches travel along the turbinates in a posterior-to-anterior direction. The posterior nasal artery courses across the inferior aspect of the front wall of the sphenoid sinus and is susceptible to injury when a large sphenoidotomy is performed (Fig. 2-5).

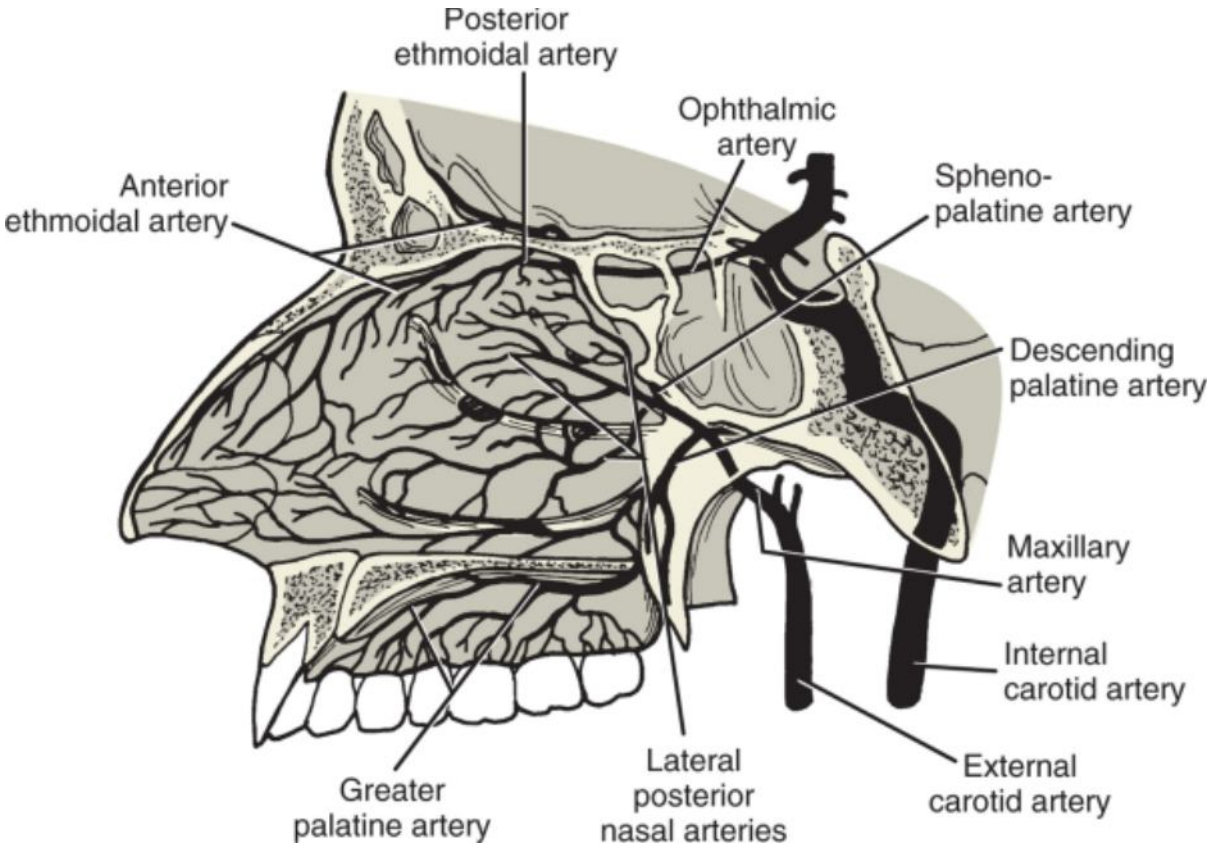

Figure 2-3 Vascular supply of the lateral nasal wall.

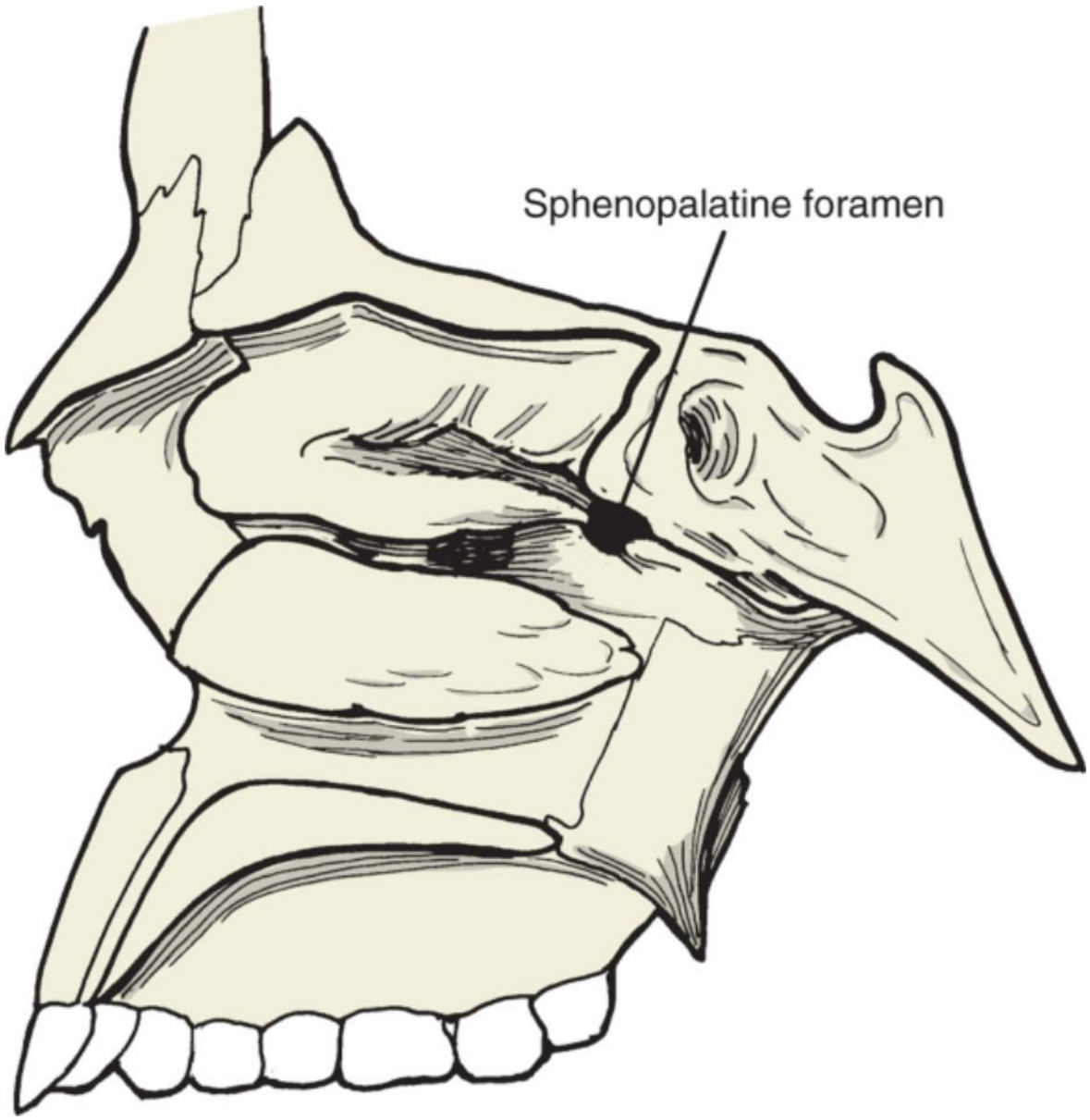

Figure 2-4 Relationship of the sphenopalatine foramen to the posterior attachment of the middle turbinate.

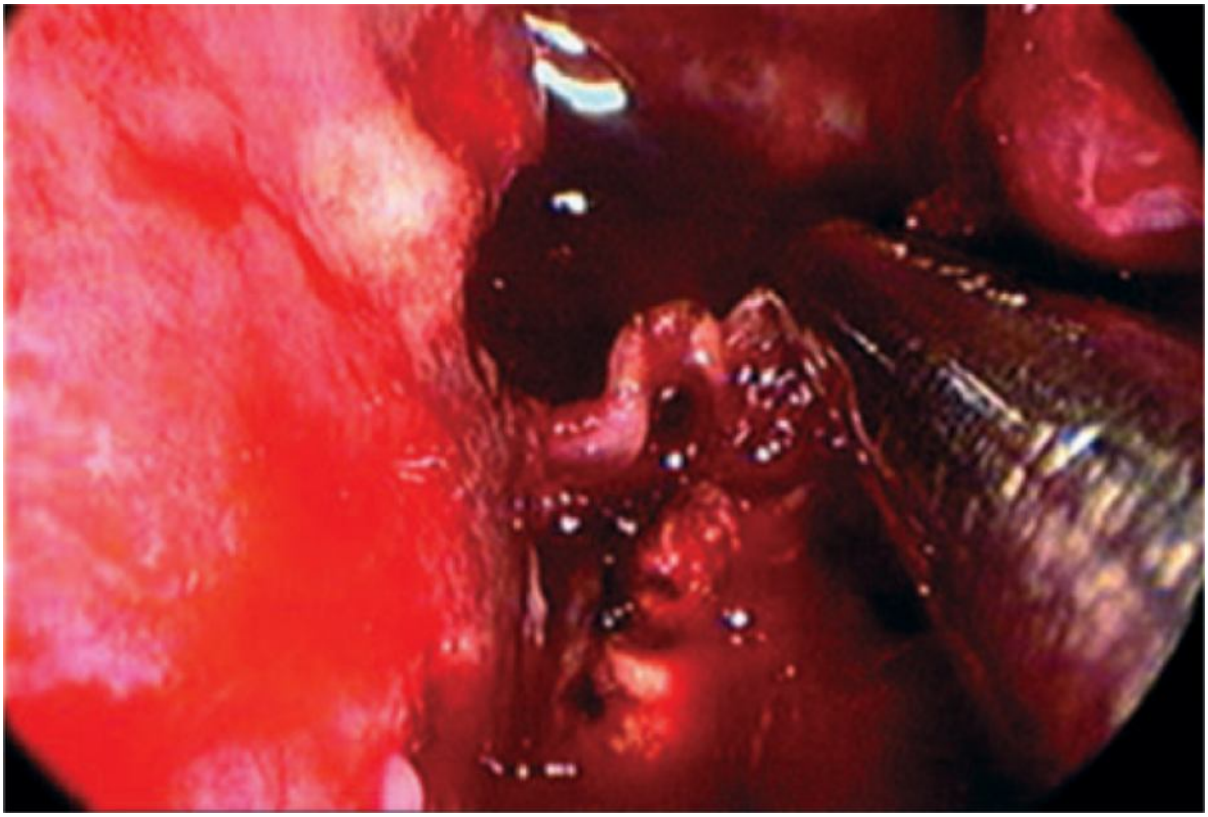

Figure 2-5 Endoscopic view of the left posterior nasal artery at the inferior margin of the sphenoidotomy.

PATIENT SELECTION

There is wide variation in the management of severe epistaxis, including nasal packing, hot-water irrigation of the nasal cavity, angiography with embolization, and surgery. The choice of a treatment modality depends on the cause of the epistaxis, its location, the experience of the otolaryngologist, the presence of medical comorbid conditions, patient preference, the availability of resources, and cost considerations. Most patients are managed acutely with nasal packing. Historically, this was accomplished with anterior and posterior nasal gauze packs that were left in place for up to 5 days. Currently, most physicians prefer to use a balloon catheter because of ease of insertion and improved patient comfort.

An alternative to nasal packing is hot-water irrigation of the nasal cavity. The nasal cavity is irrigated with hot water (50° C) through a double-lumen catheter with a distal balloon to prevent aspiration. Clinical trials have shown this technique to be as effective as nasalpacking with less pain and trauma to nasal tissues. Possible mechanisms of action include vasodilatation with decreased blood flow, tissue edema with compression of vessels, and activation of the clotting process. Hot-water irrigation is more often used as an adjunct to other methods of treating epistaxis.

Angiography with embolization is an effective treatment of epistaxis but has several major limitations. Embolization is limited to branches of the external carotid circulation (IMA, facial artery) because the ethmoid arteries cannot be embolized without causing blindness. Despite the fact that angiography with embolization is safe when performed by experienced interventional radiologists, the potential complications are significant and include visual loss, facial paralysis, carotid dissection, and stroke. Surveys have demonstrated that this type of angiography is not available at most institutions, especially those in rural settings. Indications for angiography with embolization include patients who are poor surgical candidates, epistaxis from tumors, patient preference, and possibly children.

Surgical options include endoscopic electrocautery and ligation of vessels supplying the mucosa of the nasal cavity. The medical literature suggests that they are equivalent therapies. The source of the bleeding is frequently not apparent at surgery, however, and access to the bleeding site may be limited. For these reasons, we prefer surgical ligation in most patients. For many years the “gold standard” of surgery was transantral ligation of branches of the IMA and external ligation of the AEA and sometimes the PEA. Transantral ligation may be associated with significant morbidity, such as pain, dehiscence of the oral incision, and infraorbital nerve hypoesthesia, and may fail because of difficulty identifying all branches of the IMA in the pterygopalatine space. Ligation of the terminal vessels avoids the additional morbidity and is less likely to fail. The new standard of care is endoscopic (or microscopic) ligation of the SPA at the point where it enters the nasal cavity.

Indications for surgical ligation include failure of medical therapy, a history of recurrent epistaxis, inability to place nasal packing because of an anatomic deformity (severely deviated nasal septum), and a contraindication to embolization. Contraindications to embolization include carotid atherosclerosis, previous ligation of the external carotid artery, and bleeding from the AEA (internal carotid artery circulation). Anterior and posterior nasal packing is extremely uncomfortable for patients and may be associated with significant cardiopulmonary problems and death, especially in patients with medical comorbid conditions. Given a choice, most patients will choose a surgical procedure over multiple days with nasal packing. Thus, surgical ligation may be indicated in all patients requiring hospitalization for severe epistaxis.

Another consideration that may influence the choice of therapy is the cost of care. At our institution, prompt surgical ligation is approximately half the cost of embolization. The most expensive therapy is posterior nasal packing in an intensive care setting, especially if the epistaxis recurs after removal of the packing. Contraindications to surgical ligation include medical comorbid disease that precludes general anesthesia and underlying coagulopathy. Attempts should be made to treat a coagulopathy first, but surgical ligation may still be beneficial in these patients and can be performed safely. Failure of previous surgical ligation may also be a contraindication, depending on the vessels ligated and the surgical technique.

Concurrent ligation of the SPA and AEA is performed in the majority of cases. The PEA is rarely, if ever, a source of epistaxis and is not ligated because of its proximity to the optic nerve. Many patients are referred after initial management of the epistaxis. The patient's history may be unreliable, and packing is usually placed without identification of the source of bleeding. When the packing is removed in the operating room, either there is no bleeding or minor mucosal bleeding is noted from multiple sites. Even if the initial epistaxis is from the territory of one vessel, there may be secondary mucosal trauma from packing that affects the distribution of another vessel. Other reasons for concurrent ligation of the SPA and AEA include the need for definitive treatment of patients referred from rural communities with limited resources and the low morbidity associated with ligation of an additional vessel.

An algorithm can be developed to guide the management of patients with severe epistaxis (Fig. 2-6). In patients who have a coagulopathy, epistaxis is first controlled with nasal packing and then treated medically. Sometimes, a previously unrecognized coagulopathy is discovered. If the patient is a candidate for surgery, the AEA or SPA is individually ligated if the source is known. If the source is unknown, both vessels are ligated. Surgical failures are treated by embolization or ligation of the other vessel.

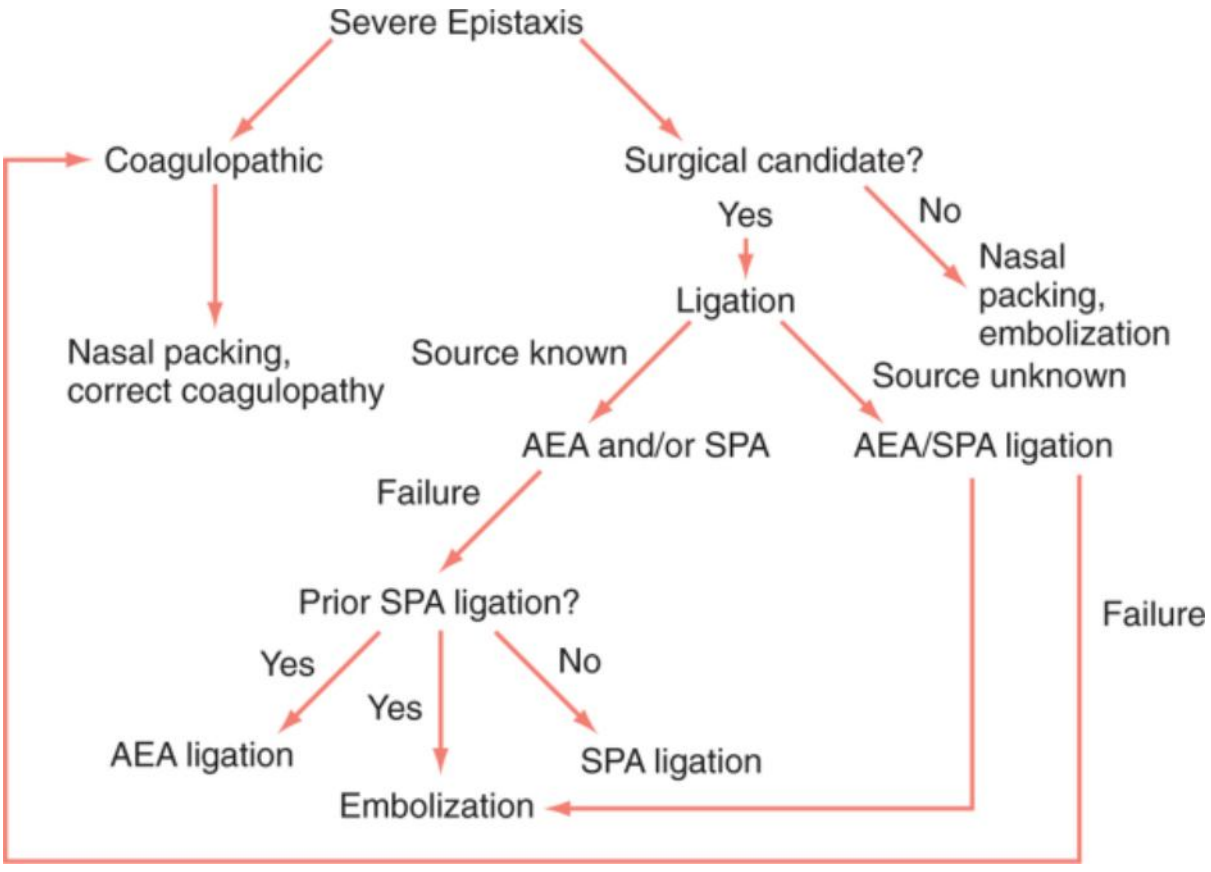

Figure 2-6 Treatment algorithm for the management of severe epistaxis. AEA, anterior ethmoid artery; SPA, sphenopalatine artery.

PREOPERATIVE EVALUATION

Preoperative evaluation of patients includes a careful history to identify potential risk factors for epistaxis, such as coagulopathy, nasal trauma, and other comorbid conditions for which they are taking anticoagulant medications. In particular, patients should be questioned about the use of medications with antiplatelet effects, such as nonsteroidal anti-inflammatory drugs. Patients may not be aware that ethanol, vitamin E, and alternative medicines such as the “3 G's” (garlic, ginseng, and gingko) also have antiplatelet effects. Attempts to determine the source of the bleeding from the history (laterality, anterior versus posterior, amount) are probably of limited value. Associated symptoms such as nasal obstruction, facial hypoesthesia, and diplopia may indicate that the epistaxis is secondary to an undiagnosed sinonasal neoplasm. The presence of medical comorbid diseases may influence the choice of therapy.

Unless the severity of the bleeding precludes intranasal examination, the nasal cavity should be decongested and examined endoscopically in an attempt to identify the source of the bleeding and rule out other pathology. The vascular territories of the nasal vessels should all be evaluated to identify active bleeding or adherent clots. Gentle removal of a clot may be necessary to reproduce the bleeding. Other abnormalities such as a deviated nasal septum, nasal polyps, rhinosinusitis, septal perforation, or neoplasm should be recognized.

In the absence of associated symptoms, a sinus radiograph is not necessary. If the history is unusual, associated symptoms are present, or the physical examination is abnormal, a computed tomography (CT) scan of the sinuses should be obtained. Hematologic tests of coagulation are not necessary unless the patient has a history of recurrent bleeding or bruising.

PREOPERATIVE PLANNING

Informed consent includes a discussion of alternative treatments and their relative advantages and disadvantages. Patients are counseled that surgery is probably the most effective therapy because of its high success rate and ability to deal with both the AEA and SPA. Additional advantages include decreased morbidity and shorter hospitalization. Potential risks of surgery are the same as for endoscopic sinus surgery (hemorrhage, orbital injury, cerebrospinal fluid leak), with the addition of possible injury to the descending palatine nerve (palatal hypoesthesia) and vidian nerve (decreased tearing).

Although preoperative imaging is not essential, a CT scan with image guidance may be helpful for localization of anatomic structures intraoperatively. General anesthesia is used for patient comfort and prevention of aspiration.

Consultation with medical colleagues may be necessary in patients who have major comorbid diseases. Patients with a known coagulopathy or a history suggestive of such should be seen in consultation by a hematologist.

SURGICAL APPROACHES

The nasal packing is removed after induction of general anesthesia and is replaced with cottonoids soaked in oxymetazoline. Continued bleeding is rarely a problem. If external ligation of the AEA is planned, temporary tarsorrhaphy sutures are placed and the surgical site is infiltrated with local anesthetic. The AEA ligation is performed first in such cases because it is “cleaner” than the nasal cavity, allows monitoring of the orbit during surgery for the development of an orbital hematoma, and may decrease intranasal bleeding during the endoscopic SPA ligation. If endonasal ligation of the AEA is performed, it is carried out after ligation of the SPA.

External Ligation of the Anterior Ethmoid Artery

A 1-cm curvilinear incision is made lateral to the nasal dorsum, equidistant between the dorsum and the medial canthus (Fig. 2-7). A smaller incision avoids cicatrix contracture postoperatively and ensures a good cosmetic result (Fig. 2-8). The inferior limit of the incision is the axial plane of the medial canthus because the frontoethmoidal suture line lies above the medial canthus. The incision extends through the soft tissues and periosteum. Bleeding from a branch of the facial vein may require ligation. The periosteum is elevated from the bone and medial orbital wall with a Cottle elevator along the frontoethmoidal suture line. The inferior limit of the exposure is the lacrimal sac. The frontoethmoidal suture line is identified at the superior aspect of the lacrimal bone and followed posteriorly until the AEA is identified. The orbital tissues are retracted with a narrow malleable ribbon and the AEA is identified in the frontoethmoidal suture line (Fig. 2-9). The periosteum is elevated above and below the AEA to create enough room to apply a hemoclip. Herniation of orbital fat often occurs at the site of the vessel. A 4-mm nasal endoscope is inserted into the wound to verify the vessel, and two medium-sized hemoclips are placed securely on the artery (Fig. 2-10). The AEA is not transected because of the risk of retraction into orbital tissues. If ligation of the SPA is planned, the wound is temporarily packed with moist cottonoids to prevent the development of a hematoma. At the end of surgery the wound is irrigated and closed with 4-0 polyglycolic acid sutures and a running 5-0 plain “fast-absorbing” catgut suture. One-eighth-inch Steri-Strips are placed longitudinally over the incision for a dressing.

Figure 2-7 Surgical approach for external ligation of the anterior ethmoid artery.

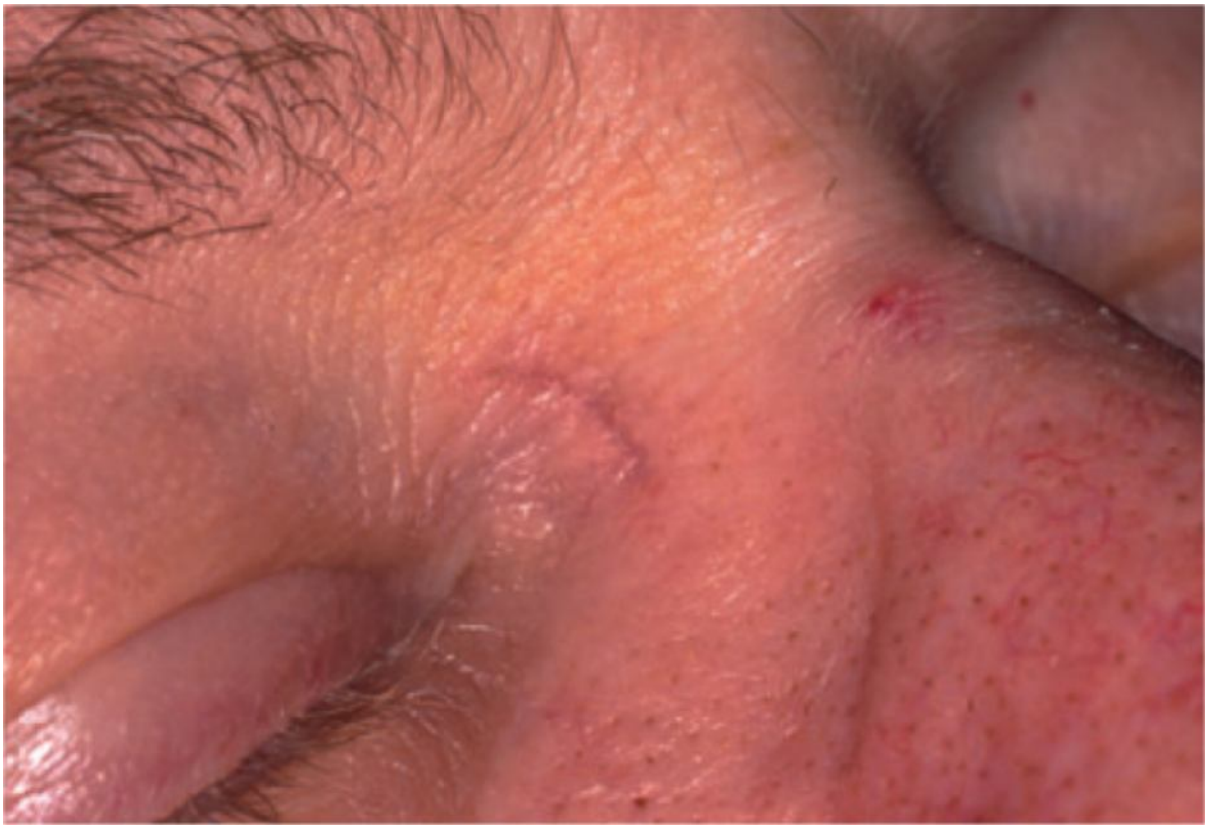

Figure 2-8 Healed scar without contracture after external ligation of the anterior ethmoid artery.

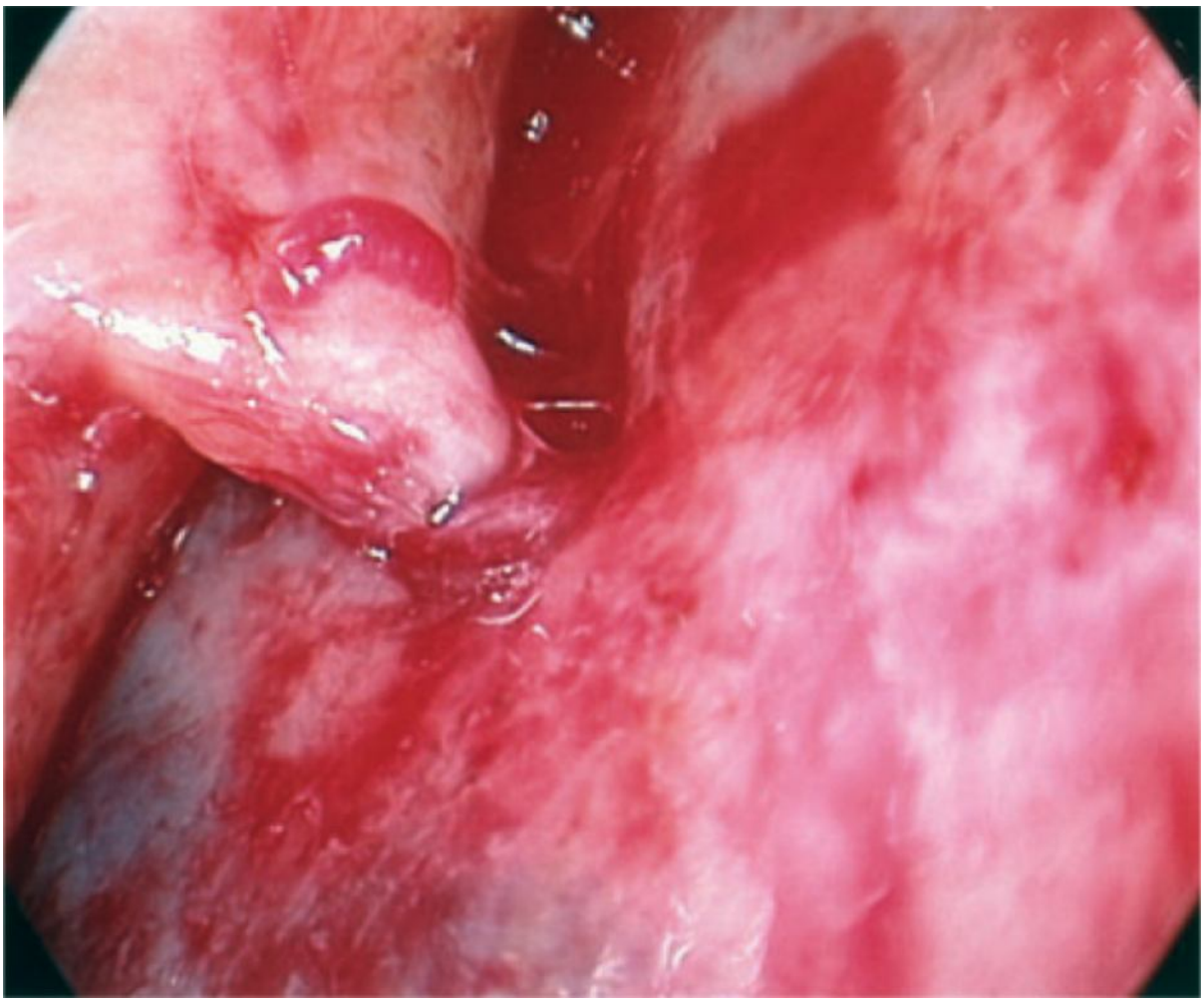

Figure 2-9 Endoscopic view of the anterior ethmoid artery (external approach).

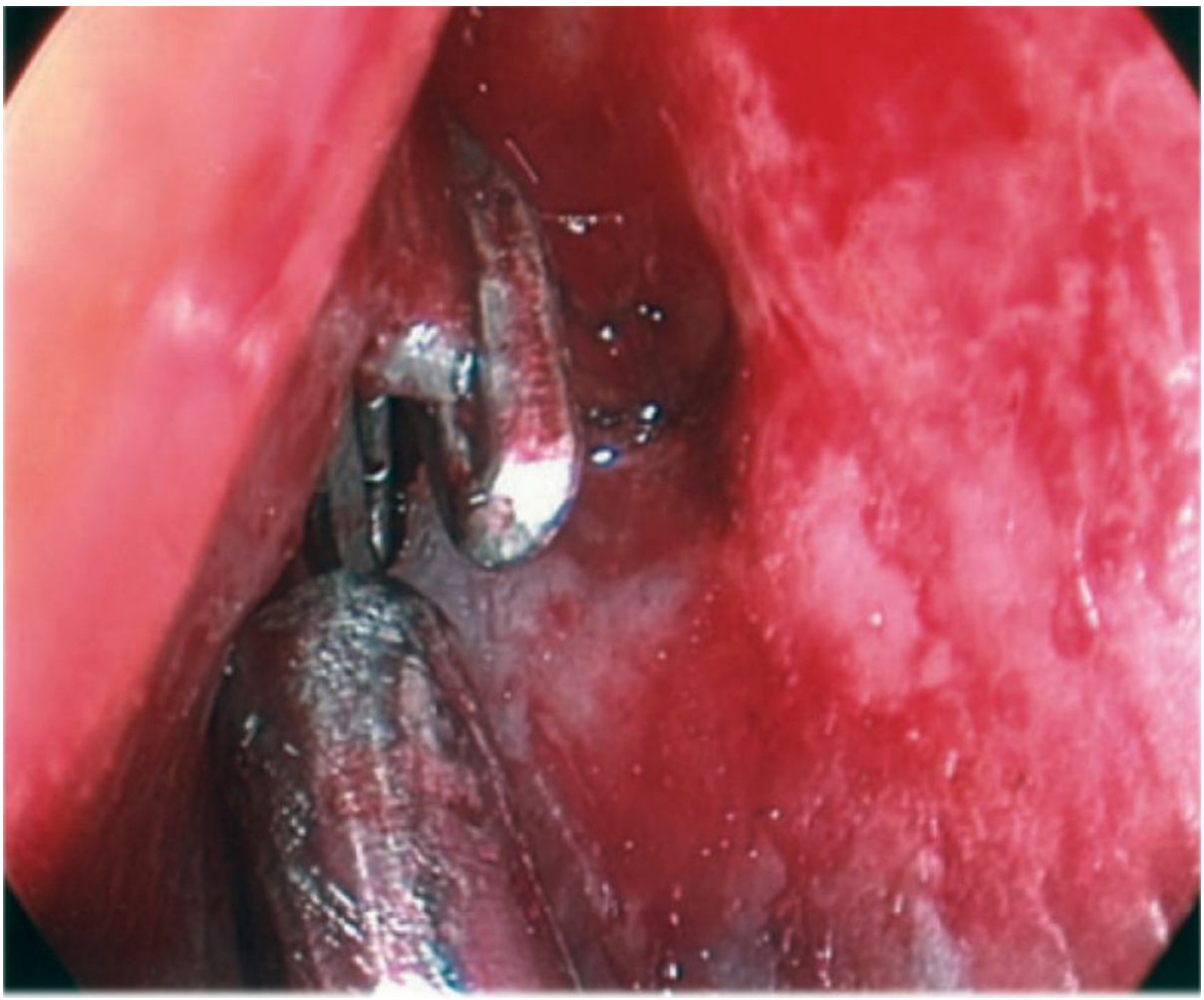

Figure 2-10 Endoscopic view of the anterior ethmoid artery after the placement of hemoclips (external approach).

Endoscopic Ligation of the Sphenopalatine Artery[4,9]

After the nasal cavity is decongested, endoscopic examination is performed. If the bleeding is brisk, the site is temporarily controlled with monopolar electrocautery. The uncinate process is removed with a backbiter to create a large antrostomy. The antrostomy is enlargedinferiorly to the level of attachment of the inferior turbinate and posteriorly to the posterior wall of the maxillary sinus (Fig. 2-11). A large antrostomy provides additional room for instrumentation and facilitates subperiosteal dissection of the lateral nasal wall. A Cottle elevator is then used to elevate the mucoperiosteum of the lateral nasal wall, starting at the inferoposterior aspect of the antrostomy (Fig. 2-12). By sweeping the instrument in an inferior-to-superior direction, tenting of the SPA at the sphenopalatine foramen can be observed (Fig. 2-13). A small crest of bone (crista ethmoidalis) is observed just inferior and anterior to the foramen. The sphenopalatine foramen is located at the posterosuperior corner of the maxillary sinus. Creation of this large space has several advantages. It avoids direct injury to the SPA during dissection, allows detection of multiple foramina because of proximal branching, and provides room for placement of a suction instrument (third hand).

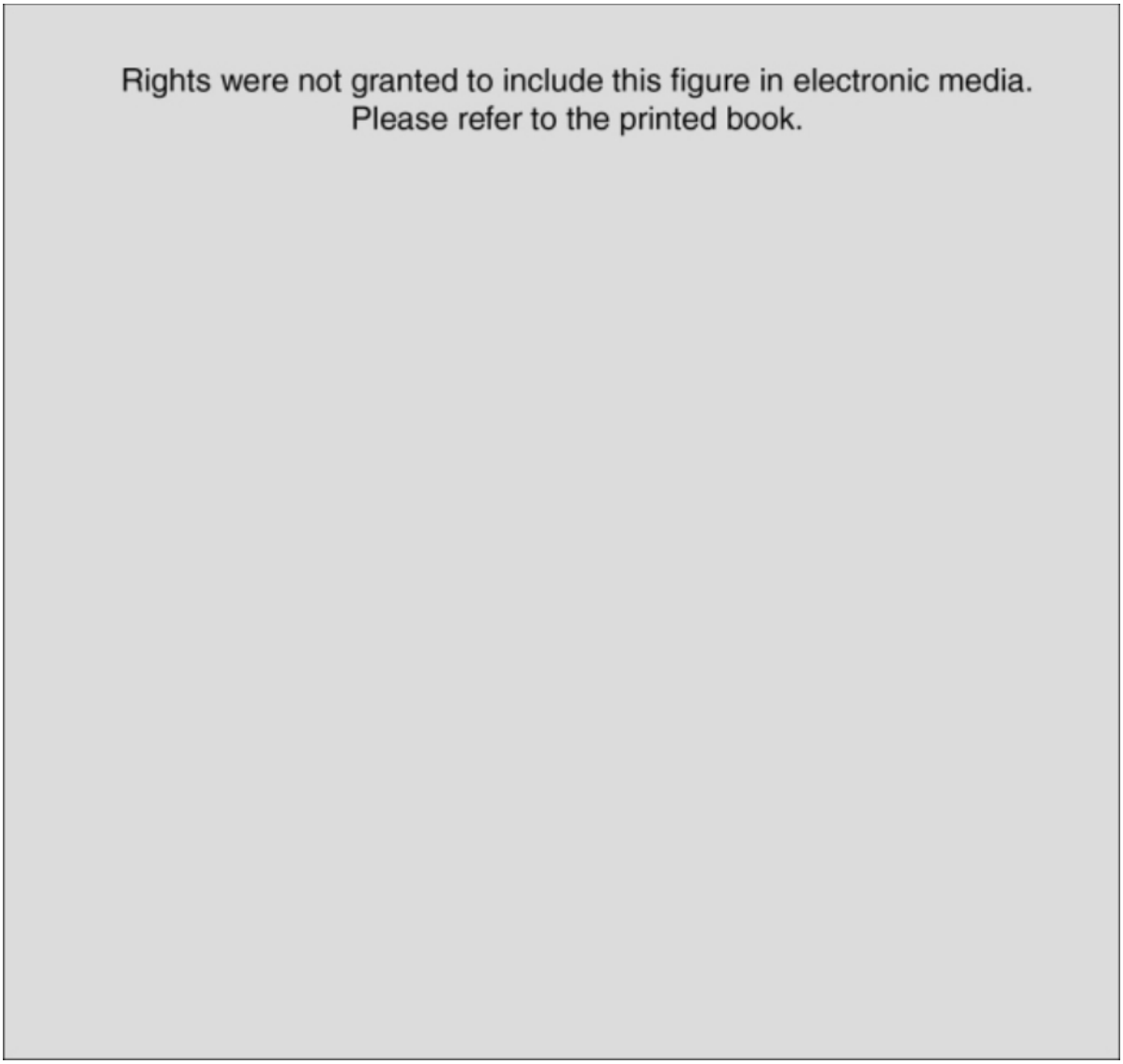

Figure 2-11 After left middle meatal antrostomy, the mucoperiosteum posterior to the antrostomy is elevated from the lateral nasal wall. MT, middle turbinate; PWA, posterior wall antrum.
(Reprinted with permission from Waring M, Padgham N: Osteologic classification of the SP foramen. Laryngoscope 108:125-127, 1998.)

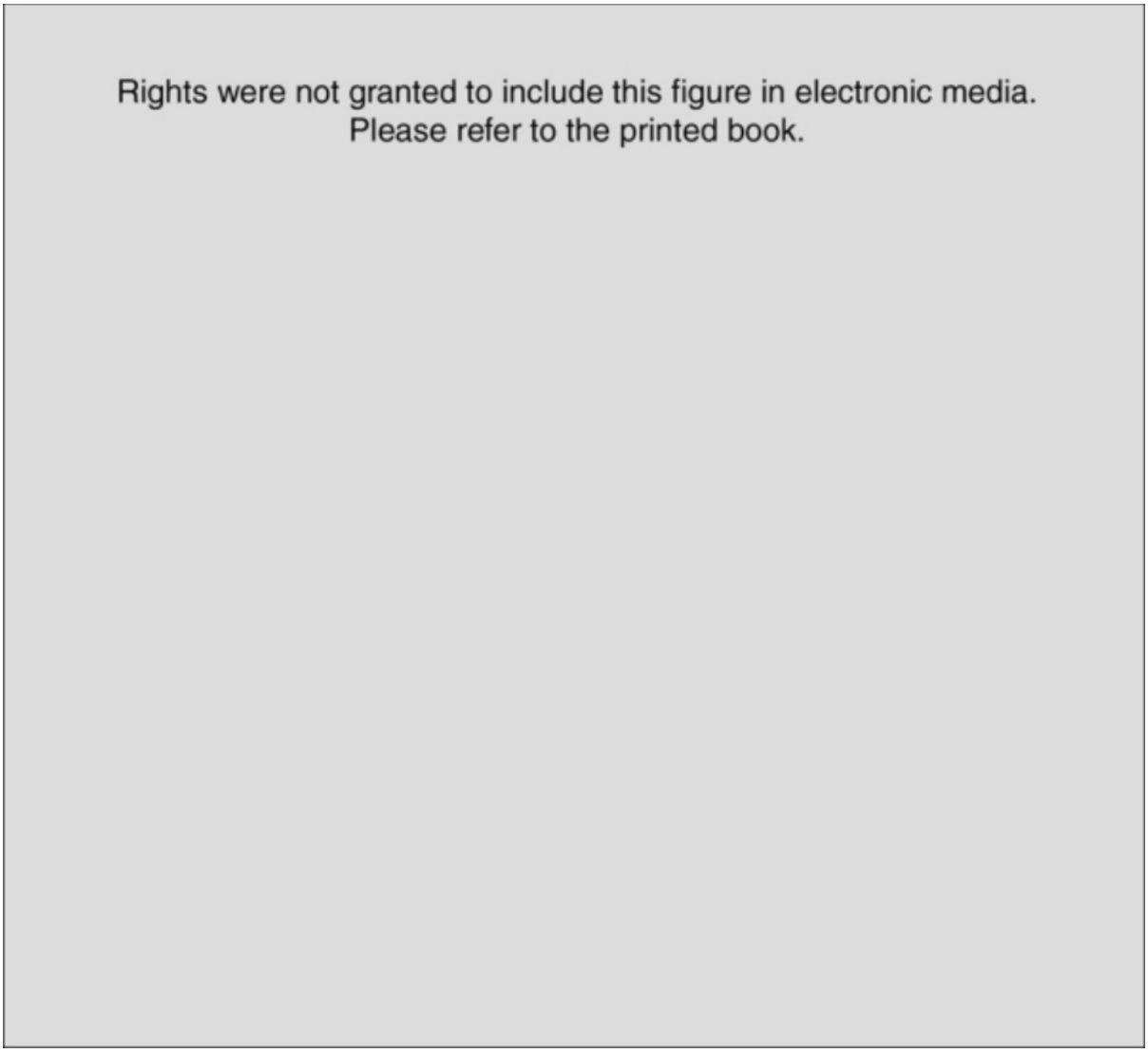

Figure 2-12 The sphenopalatine artery is exposed at the posterosuperior corner of the maxillary sinus.
(Reprinted with permission from Waring M, Padgham N: Osteologic classification of the SP foramen. Laryngoscope 108:125-127, 1998.)

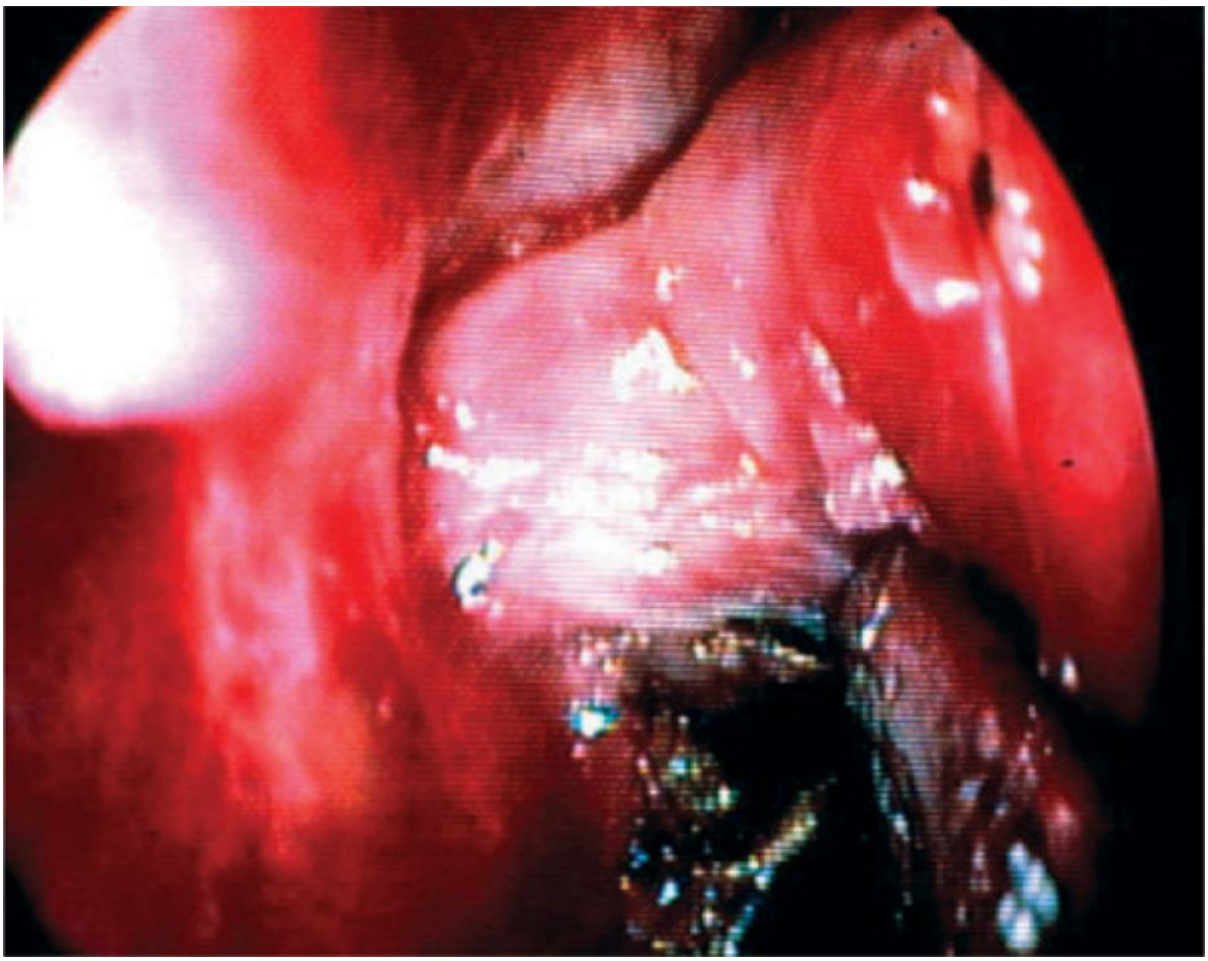

Figure 2-13 Endoscopic view of the right sphenopalatine artery at the point where it exits the foramen.

Once the subperiosteal pocket is created, a 7F Frazier tip suction is placed in the pocket to keep the field dry and stretch the SPA across the surgical field. The bone of the sphenopalatine foramen superficial to the SPA is removed with a 1-mm Kerrison rongeur (Fig. 2-14). It is important to pass the tip of the rongeur superficial to the vessel so that it is not transected. Removal of bone overlying the pterygopalatine space continues laterally for about 1 cm. This provides enough room for clipping of the SPA proximal to its branching point (Fig. 2-15). Ideally, individual hemoclips are placed on the proximal main trunk, as well as the terminal branches. The exposed vessels are covered with a small piece of absorbable hemostatic material. A nasal tampon is inserted only if there is continued bleeding from surrounding mucosa. Silastic nasal splints are placed on both sides of the septum to prevent postoperative synechiae, especially if there is diffuse mucosal trauma from nasal packing or cautery.

Figure 2-14 The foramen is enlarged with a rongeur to expose the main trunk of the sphenopalatine artery.
(Reprinted with permission from Waring M, Padgham N: Osteologic classification of the SP foramen. Laryngoscope 108:125-127, 1998.)

Figure 2-15 Hemoclips are placed on the main trunk of the sphenopalatine artery proximal to its terminal branches.
(Reprinted with permission from Waring M, Padgham N: Osteologic classification of the SP foramen. Laryngoscope 108:125-127, 1998.)

Endoscopic Ligation of the Anterior Ethmoid Artery[10]

The intranasal approach is an alternative to external AEA ligation. This approach has the advantages of avoiding a facial scar and decreasing the risk of an orbital complication. An anterior ethmoidectomy is performed and the nasofrontal recess is exposed. The AEA can often be visualized crossing the roof of the ethmoid sinus at the posterior aspect of the nasofrontal recess (Fig. 2-16). If the bone is dehiscent, bipolar cauterization of the vessel is performed. Otherwise, the vessel is exposed at its lateral margin. The lamina papyracea is fractured with an elevator adjacent to the AEA, and the fragments are elevated to the plane of the cranial base. The periorbita is elevated from the bone above the plane of the cranial base anterior and posterior to the AEA. A hemoclip is placed on the orbital side of the vessel, or it is cauterized with bipolar electrocautery. The vessel is not transected because it may retract into the orbit and cause an orbital hematoma.

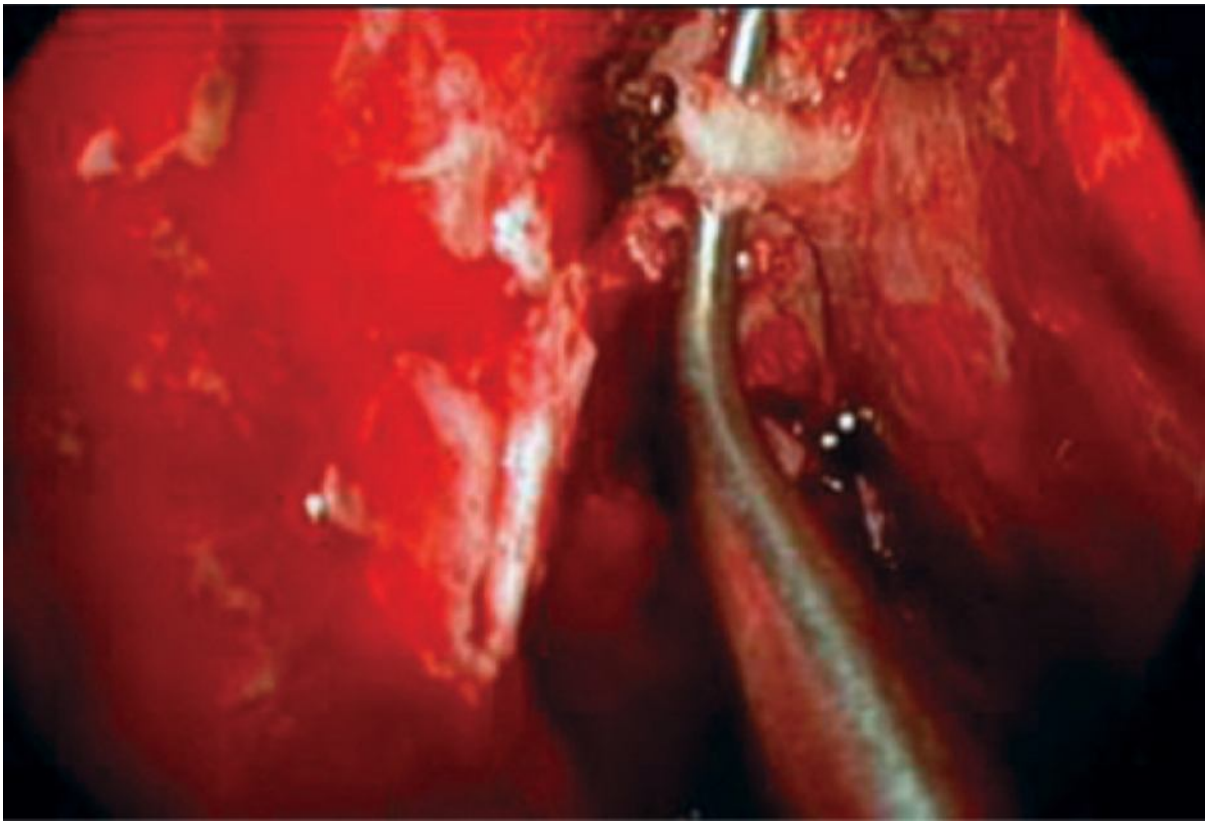

Figure 2-16 Endoscopic view of the anterior ethmoid artery at the point at which it crosses the cranial base.

POSTOPERATIVE CARE

The postoperative care of patients after surgical ligation is not much different from that of any patient undergoing endoscopic sinus surgery. Activities that increase vascular pressure in the head should be avoided and blood pressure controlled if necessary. A decongestant nasal spray is used if minor bleeding persists. Nasal splints are removed in 1 week, and nasal hygiene with saline nasal sprays and rinses is performed until healing is complete. Complete mucosalization over the hemoclips occurs within 1 to 2 months. Rarely, exposed hemoclips can be a source of persistent crusting and may need to be removed (Fig. 2-17).

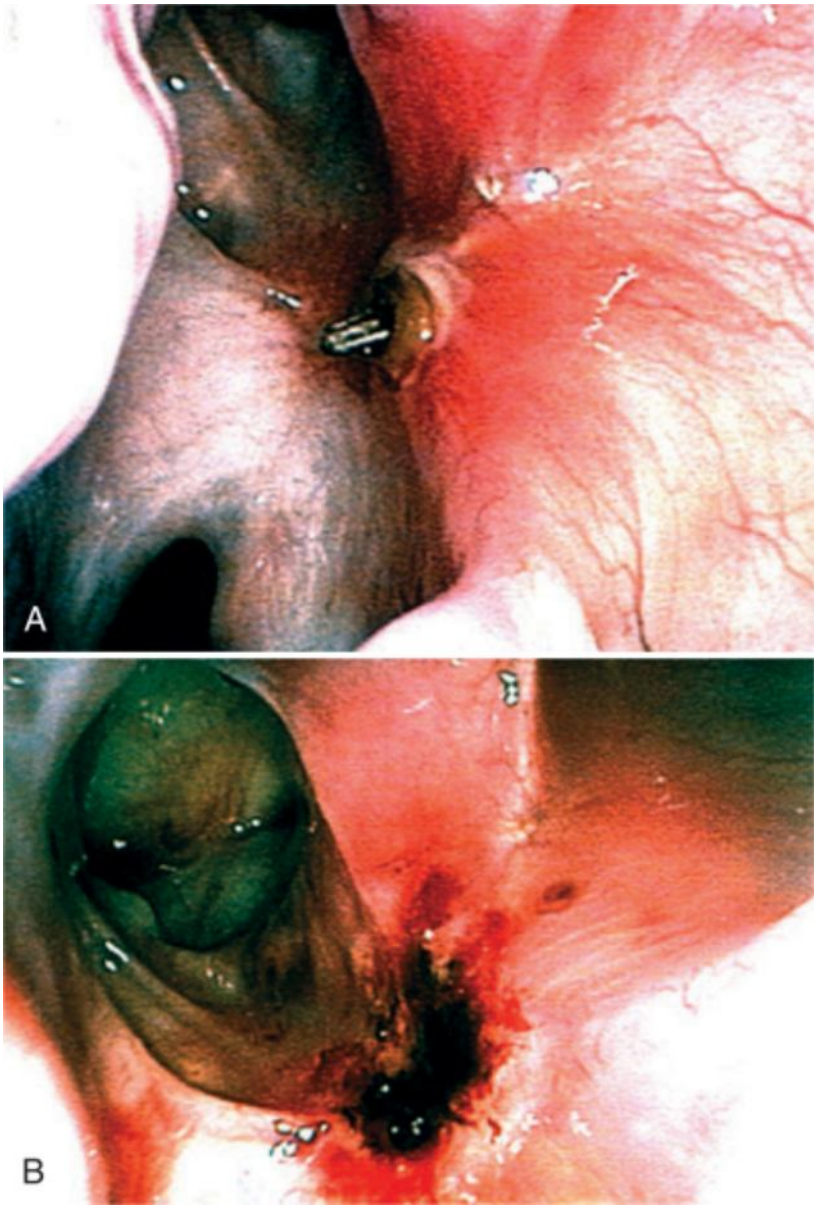

Figure 2-17 Persistent crusting at the site of exposed hemoclips on the sphenopalatine artery (**A**) months after surgery required removal of the hemoclips (**B**).

COMPLICATIONS

In patients whose nasal mucosa has been traumatized by nasal packing and cauterization of the mucosa before referral, necrosis of the septum and septal perforation may occur after ligation of the AEA or SPA. It is possible that the decrease in blood flow from ligation of these vessels may increase the risk for necrosis, especially when bilateral ligation is performed.

External Ligation of the Anterior Ethmoid Artery

The skin incision that is used for external ethmoidectomy or dacryocystorhinostomy is too low for external AEA ligation. A longer incision is more curved, will be associated with more scar contracture postoperatively, and will result in an unsightly scar. Because of the curvature of the bone, a short incision may limit the room for instrumentation. Care should be taken to avoid tearing the periorbita because herniation of orbital fat will interfere with visualization. If herniation does occur, the fat should be shrunk with bipolar cauterization. The frontoethmoidal suture line demarcates the level of the skull base. Although a small opening in the ethmoid sinus may occur inferior to this line, fracturing of the bone above the suture line should be avoided because it may result in a cerebrospinal fluid leak or intracranial hemorrhage. Wide elevation of the periorbita is performed so that the tunnel of dissection does not miss the AEA and risk going too deep. The dissection should not disrupt the trochlea superiorly, however, because diplopia may result. The AEA is not transected since the proximal stump of the vessel may retract into the orbit and cause an orbital hematoma.

Endoscopic Ligation of the Anterior Ethmoid Artery

The major risks associated with endoscopic ligation of the AEA include injury to the orbital tissues, development of an orbital hematoma, and creation of a cerebrospinal fluid leak. By dissecting on the orbital side of the cranial base, the risk of a cerebrospinal fluid leak is minimized. Stripping of mucosa from the nasofrontal recess should be avoided because it may result in postoperative scarring and obstruction of the frontal sinus.

Endoscopic Ligation of the Sphenopalatine Artery

Wide exposure of the sphenopalatine foramen is performed to ensure identification of all branches of the SPA and to provide room for instrumentation; otherwise, bleeding from an unclipped branch may persist (Fig. 2-18). Excessive bone removal posterior to the SPA may injure the descending palatine or greater palatine nerve and result in hypoesthesia of the palate. Excessive dissection of the pterygopalatine space can injure other branches of the IMA and give rise to troublesome bleeding. Dissection deep to the arteries can injure branches of the trigeminal nerve and the sphenopalatine ganglion. Loss of vidian nerve function results in decreased tearing, especially emotional tearing. This may pose a problem in patients who already have diminished tearing or when the eye is challenged (windy conditions). Reasons for failure after SPA ligation include an unrecognized site of bleeding (AEA distribution), failure to ligate all the terminal branches of the SPA, dislodged hemoclips, development of collateral circulation (Fig. 2-19), and unrecognized coagulopathy.

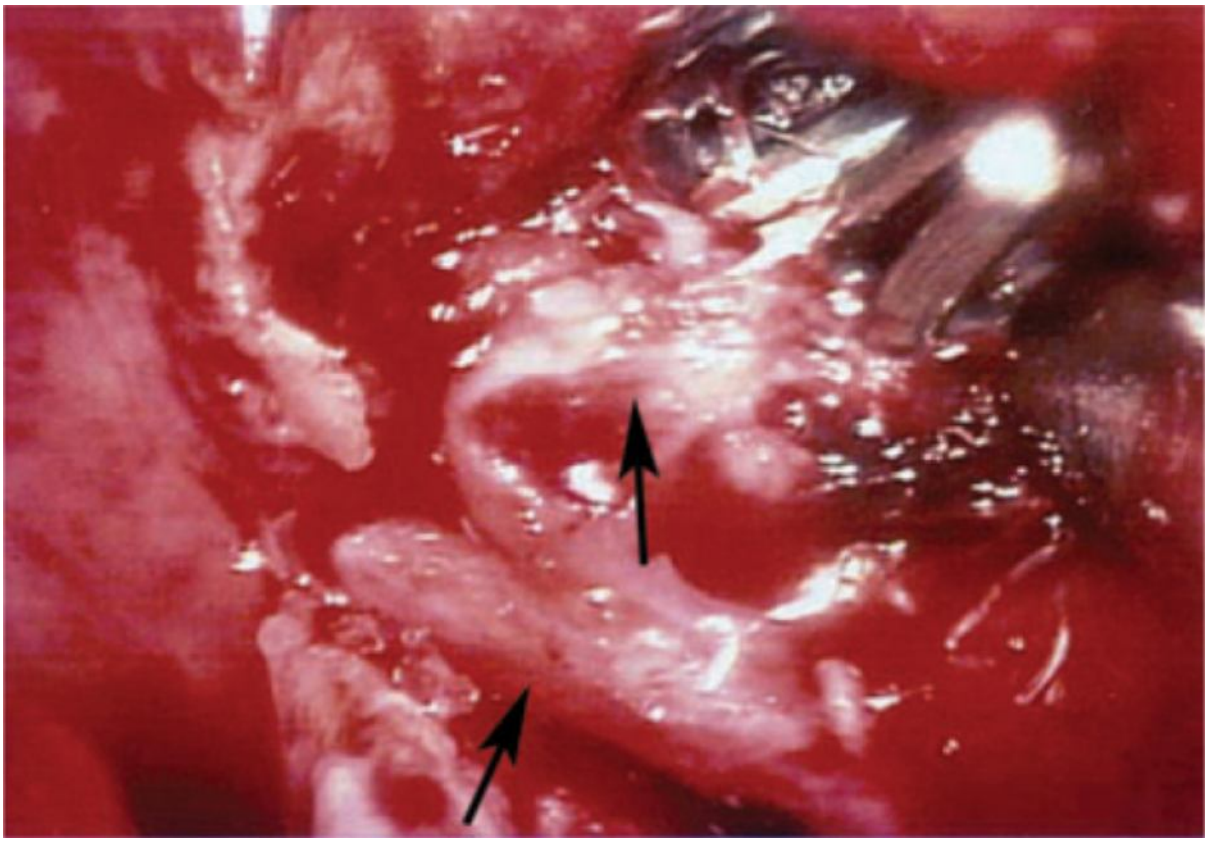

Figure 2-18 Hemoclips were placed on the posterior nasal artery (first surgery), but additional branches of the sphenopalatine artery *(arrows)* were missed (second surgery).

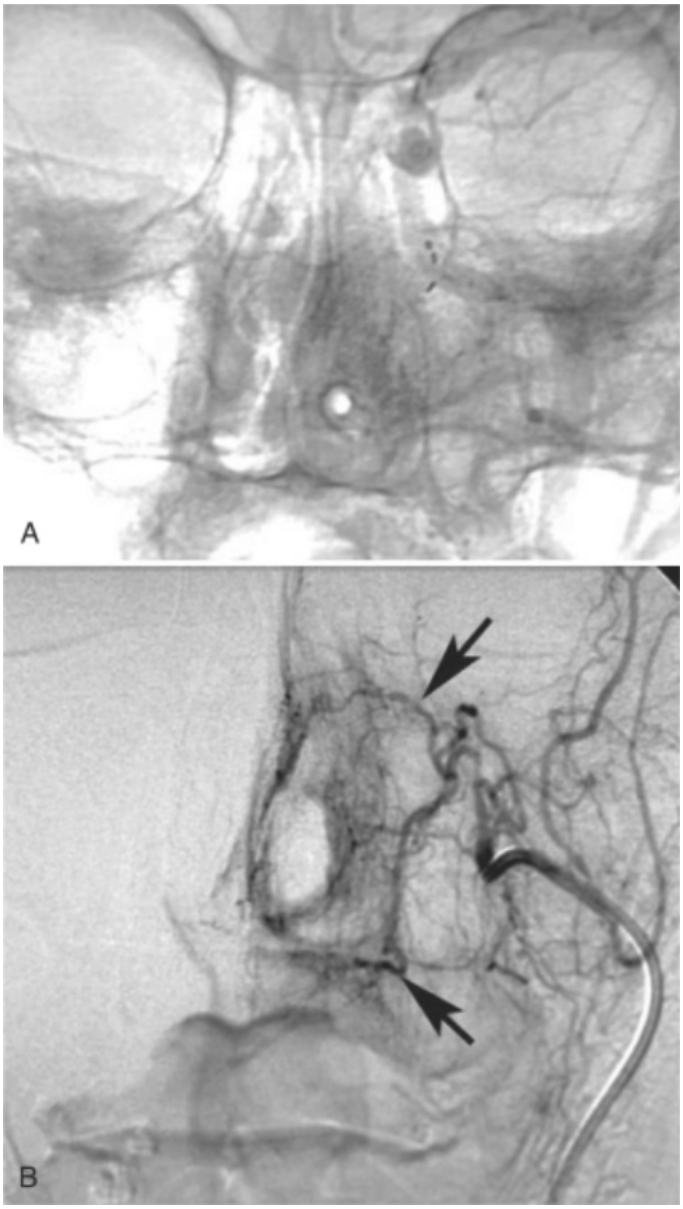

Figure 2-19 **A**, Hemoclips are visible at the site of ligation of the left sphenopalatine artery. **B**, Recurrent epistaxis 6 months after surgery was secondary to collateral circulation *(arrows)*.

SUMMARY

In our experience, surgical ligation offers the most cost-effective and least morbid treatment of severe epistaxis. Concurrent ligation of the AEA and SPA is usually performed to maximize success. Currently, we prefer endoscopic AEA cautery or ligation because it avoids the morbidity of an external approach and is easily performed at the time of SPA ligation. Patients with severe epistaxis can be managed with a stepwise algorithm that reserves nasal packing and embolization for patients who cannot be treated surgically or fail surgical ligation.

PEARLS

- Patients are often unaware that ethanol, vitamin E, and herbal products (garlic, gingko, and ginseng) may cause nasal bleeding.
- The sphenopalatine foramen is located at the posterior attachment of the middle turbinate at the posterosuperior corner of the maxillary sinus.
- The SPA branches proximal to the foramen 42% of the time.
- Placement of a small suction device in the subperiosteal pocket inferior to the sphenopalatine foramen frees up a hand and maintains tension on the SPA during clipping.
- The AEA is located in a coronal plane tangential to the posterior surface of the globe.

PITFALLS

- Transection of the AEA may result in retraction of the AEA into orbital tissues and subsequent orbital hematoma.
- Limited dissection of the lateral nasal wall may miss a branch of the SPA because of proximal branching.
- Placement of a nasal tampon after SPA ligation can dislodge the hemoclips.
- Removal of bone posterior to the SPA can injure the descending palatine nerve.
- Bilateral vessel ligation at the same time may predispose to septal necrosis in patients whose nasal mucosa has been traumatized.