Use of Hemostatic Matrix for Hemostasis of the Cavernous Sinus during Endoscopic Endonasal Pituitary and Suprasellar Tumor Surgery

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ABSTRACT

The endoscopic endonasal approach offers a wide, panoramic exposure of the sellar floor, planum, and clivus. The ability to expose fully the tumor margins, through lateral extension of cavernous sinuses, increases the exposure and ability to resect the tumor but increases the risk of bleeding. The authors describe achieving hemostasis using a hemostatic matrix, FloSeal (Baxter Biosciences, Vienna, Austria) sealant, during endoscopic endonasal tumor removal, specifically for pituitary and suprasellar tumors. Thirty-nine cases (33 pituitary adenomas, 4 craniopharyngiomas, 1 clival plasmacytoma, and 1 planum meningioma) are described using this technique. FloSeal was injected directly to the site of bleeding, and a cottonoid was used for further tamponade, immediately achieving hemostasis with no hemorrhagic complications in any of the patients. Surgery could be immediately pursued without any delay. This simple nuance can be used as a safe method in cavernous sinus hemostasis during endoscopic endonasal surgery and may decrease operative time.

KEYWORDS: Cavernous sinus, FloSeal, endoscopic endonasal, hemostasis

The introduction of endoscopic technique in the field of neurosurgery has opened up a wide variety of novel approaches to skull base surgery. In this review of endoscopic endonasal approach to sellar and suprasellar lesions, a technical nuance to achieve hemostasis during the dissection of the cavernous sinus is described.

SURGICAL TECHNIQUE

The surgical technique has been extensively described elsewhere.¹⁻³ The patient's head is affixed in a Mayfield Skull Clamp (Integra Life Sciences, Plainsboro, NJ)

holder with slight extension and rotation of the head toward the right. Neuronavigation (BrainLab, Feldkirchen, Germany) is also positioned, and the patient is registered. Cottonoids saturated with 1:1000 of lidocaine and epinephrine are placed bilaterally in the nostrils for a few minutes. Blood pressure and heart rate are closely monitored during this time. Both nostrils are then inspected with the endoscope to evaluate which middle turbinate's removal would provide the best visualization and allow room for manipulation of the endoscope and instruments. The middle turbinate is then removed to visualize the septum, and the area for the

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Skull Base 2011;21:189-192. Copyright © 2011 by Thieme

Medical Publishers, Inc., 333 Seventh Avenue, New York, NY 10001, USA. Tel: +1(212) 584-4662.

Received: June 12, 2010. Accepted after revision: January 3, 2011.

Published online: March 24, 2011.

DOI: <http://dx.doi.org/10.1055/s-0031-1275632>.

ISSN 1531-5010.

septectomy is identified. A posterior nasal septectomy enables a binasal bimanual approach. When the ostium of the sphenoid is identified, a large sphenoidotomy with opening of the lateral recesses and drilling of the septa is performed. The keel of the sphenoid is drilled down to visualize the clivus. It is important to identify the normal bony landmarks: tuberculum sellae, the medial optico-carotid recesses, planum sphenoidale, the carotid protuberance, and the clivus. The bone over the tuberculum sellae is removed to expose the dura from the right to the left cavernous sinus and from the planum to the clivus. If necessary, further bony resection and dural exposure are performed for expanded approaches. The dura is then opened as described previously.² During the lateral exposure, one might confront the cavernous sinus and the probable bleeding that occurs when achieving such a wide exposure of the dural elements (Fig. 1).

Also in expanded approaches, bleeding might occur from the superior or inferior cavernous sinus despite prior coagulation and section. If venous bleeding is encountered, FloSeal (Baxter Biosciences, Vienna, Austria) is injected directly to the site of bleeding (Fig. 2). It is allowed to swell and expand into the anatomy of our dissection, and a 1 × 1-cm cottonoid is then placed over the matrix to further advance the FloSeal into the cavernous sinus and to provide additional tamponade (Fig. 3). With this technique, hemostasis is achieved within seconds of application (Fig. 4), allowing for progression of surgery as well as decreasing intraoperative blood loss.

RESULTS

This technique was used in 39 consecutive patients (33 pituitary adenomas, 4 craniopharyngiomas, 1 clival

Figure 2 FloSeal (Baxter Biosciences, Vienna, Austria) application to the site of bleeding.

plasmacytoma, and 1 planum meningioma). Thirty-one patients had macroadenomas, and five had functional adenomas. All 39 patients received preoperative magnetic resonance imaging (MRI) and endocrine studies to evaluate the hormone function. MRI confirmed cavernous sinus invasion in five of these lesions. Although resection of the intracavernous part was not among the objectives of surgery, the need for a wide lateral exposure was deemed necessary to enable complete removal of the sellar and suprasellar part of the lesion.

Postoperatively, each patient received MRI, and endocrine/hormone levels, serial basic metabolic panels, and urine-specific gravity were monitored, along with strict intake and output. Complete resection of the lesion

Figure 1 Venous bleeding from cavernous sinus (CS) during right lateral exposure.

Figure 3 Small cottonoid application over FloSeal (Baxter Biosciences, Vienna, Austria).

Figure 4 Final exposure before dural opening. C, clinoid; CS, cavernous sinus; P, planum.

was confirmed in 31 patients. Residual tumor in the remaining cases was due to cavernous sinus invasion in five patients, calcified and adherent nature of the tumor in two patients, and radiosensitive nature of the tumor with intentional residual in one patient. Because of the wide exposure that we were able to achieve with the endoscopic approach, each lesion could be fully visualized and optimally resected with no hemorrhagic complication. The bleeding from the cavernous sinus was strictly venous, and carotid injury was not present in any cases. Intraoperative bleeding was 110 mL on average for pituitary adenoma cases and 370 mL for expanded skull base cases.

Three patients suffering from functional adenomas were cured following surgery. There were two growth hormone (GH) adenomas and one medically resistant prolactinoma. The two GH adenoma patients were noted to have GH levels less than 1, normalized insulin-like growth factor-1 (IGF1) and a normal oral glucose tolerance test at 6 weeks postoperatively. The prolactinoma patient was noted to have a prolactin level less than 2, immediately and weeks postoperatively, with no need for further medication. Two patients with GH adenomas underwent complementary treatments, as their residual tumors in the cavernous sinus had persistent activity as indicated by persistently high IGF1. Six of these patients suffered from panhypopituitarism preoperatively and continued their hormone replacement after the surgery. There were three new endocrine abnormalities in one or more hypothalamopituitary axes. Five patients were diagnosed with diabetes insipidus postoperatively, which was transient in all. Lumbar drains were placed in four of these patients for postoperative cerebrospinal fluid leaks, which subsided after 3 to 5 days of drainage. Eight of these

patients showed chiasmic compression on MRI preoperatively with visual field deficits confirmed by Humphrey (Carl Zeiss Meditec, Inc., Dublin, CA) visual field testing. Six of eight of these patients who reported better visual acuity after tumor removal had either minor visual field deficits or no visual field deficits. There were no other neurological deficits or mortality in this group.

DISCUSSION

FloSeal is a combination of human-derived thrombin and bovine-derived gelatin matrix. The matrix is prepared immediately before use, whereby the two components are methodically mixed with the provided accessories and injected directly to the site of bleeding.⁴ It is known to work by utilizing the patient's own circulating fibrinogen and does not rely on platelet activation.⁵ The matrix has been widely used and studied throughout several surgical specialties due to its effectiveness. Our patient population consisted of 39 patients, 33 of whom had pituitary adenomas. The effectiveness of this technique was pronounced and reproducible in each case. It was felt that lateral exposure would be required to guarantee optimal access to each lesion, therefore increasing the likelihood of complete tumor removal. The object was to proceed with the exposure in a quick, yet efficient manner allowing for the majority of operating time to be devoted to tumor removal. Due to the precarious nature of the dural structures around the cavernous sinus, this specific exposure frequently can delay progression and lengthen these cases significantly in case of bleeding. The use of this hemostatic matrix allowed for rapid hemostasis at the time of oozing/bleeding and could be used repeatedly throughout the procedure if needed. The amount of bleeding was appropriate for this type of enlarged exposure as stated in the results section. With this technique, the surgery proceeded in a manner that allowed control of the expected oozing from this venous structure in addition to providing optimal visualization to continue with the intricate exposure.

Surgicel (Ethicon Inc., Somerville, NJ) has also been used to pack the cavernous sinus to achieve hemostasis.⁶ This technique is commonly used with an acceptable response. One article described packing of the cavernous sinus in conjunction with using custom-made 45-degree right-angled or left-angled bipolar forceps. In this technique, two modalities, Surgicel plus the use of a bipolar forceps (which may not be readily available in all institutions), are used with sufficient efficacy.⁷ Other methods for taming the bleeding associated with the anterior cavernous sinus have been described in the literature. One of the more traditionally used techniques has been described with the use of

thrombin-soaked Gelfoam (Pfizer, New York, NY) to pack the cavernous sinus.⁸ This method was found to be effective; however, it can become time-consuming and prolonged if there is profuse bleeding from the cavernous sinus, which can compromise visualization of the anatomy. This can place the patient at risk for increased blood loss and further complications. Furthermore, when a lateral exposure is a vital portion of tumor removal, using the technique of packing with either Surgicel or Gelfoam can ultimately impede the view during the removal of bony structures. More importantly, the packing can be removed while using Ferris-Smith-Kerrison rongeurs, which can potentially incite an unwanted and large amount of bleeding.

Fibrin glue such as Tisseel (Baxter Healthcare Corp., Deerfield, IL) has been described in achieving hemostasis in this region. This was found to be effective in cases of mild to moderate bleeding. However, in excessive bleeding, it was only useful if the cavernous sinus was packed either with Gelfoam or Surgicel before the use of glue.⁹

CONCLUSION

We believe that the technique described herewith has some superiority to other known techniques due to its rapidity and effectiveness. The use of FloSeal provides a quick and effective method of hemostasis in the cavernous sinus while creating a laterally expanded exposure for adequate dissection and removal of sellar and suprasellar lesions.

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