Minimal craniotomy and matrix hemostatic sealant for the treatment of spontaneous supratentorial intracerebral hemorrhage

Technical note

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The authors describe a minimally invasive technical note for the surgical treatment of primary intracerebral hematoma. Thirty-one patients with supratentorial intracerebral hematomas and no underlying vascular anomalies or bleeding disorders underwent treatment with a single linear skin incision followed by a 3-cm craniotomy. After evacuation of the hematoma, a matrix hemostatic sealant (FloSeal) was injected into the surgical cavity, and immediate hemostasis was achieved in all cases. A second operation was necessary in only 1 case. In this preliminary experience, a small craniotomy combined with FloSeal helped to control operative bleeding, reducing brain exposure and damage to the surrounding tissue while reducing the length of the surgery. (DOI: 10.3171/2008.8.JNS17642)

KEY WORDS • hemostasis • hemostatic sealant • intracerebral hemorrhage • spontaneous hematoma

SURGICAL treatment of spontaneous ICH has been widely debated in recent times; the authors of the most important multicenter study demonstrated that hardly any advantage is obtained with early evacuation of deep hematomas compared to medical treatment. Lobar hematomas, on the contrary, may benefit from surgical management. After clot evacuation, there may be bleeding from the ICH walls. This can usually be controlled with additional bipolar cautery and the use of hemostatic agents, but enlargement of the corticectomy and working channel may be necessary. FloSeal Matrix Hemostatic Sealant (Baxter) has gelatin matrix and thrombin components that are mixed together at the time of use: both components promote hemostasis and synergistically facilitate the formation of a clot at the bleeding site. We present our experience in the treatment of patients with supratentorial ICHs who underwent early minimal craniotomy, corticectomy, and evacuation of the hematoma, followed by application of FloSeal. This agent is well known and has been on the market for years, although no publication has referred specifically to this application.

Abbreviation used in this paper: ICH = intracerebral hematoma.

Methods

Our surgical approach was individualized on the basis of the shortest trajectory to the hematoma, passing through noneloquent regions of the cortex. In the presence of a lobar hematoma, the craniotomy was made over the affected lobe, and in basal ganglia hematomas, a frontal craniotomy was performed anterior to the coronal and lateral to the sagittal suture, depending on the location of the clot. The intention of surgery was to achieve complete removal of the hematoma. In all cases general anesthesia was administered and a linear, 7-cm-long incision was made, which allowed for a rapid surgical opening and closure. Skin hemostasis was secured by tamponade with a self-retaining retractor (Fig. 1). A high-speed drill was used to create a 3-cm-diameter craniotomy, and the dura mater was opened in a cruciate fashion. The brain was tense in all cases, and bulged out of the craniotomy. A transcortical approach (~ 1.5 cm), with suction and bipolar cautery was performed. Rapid decompression, suction of the hematoma without brain retraction, and complete or nearly complete clot evacuation was performed in all cases (Fig. 2). After evacuation, FloSeal hemostatic matrix was applied directly into the operative cavity with a needle; the granular hemostatic agent adapted to the cav-
ity walls, and conformed to any irregular geometry. Cottonoid was used for gentle compression of the hemostatic agent. Immediate hemostasis was observed in all cases. The cottonoid and hemostatic matrix were removed after 3 minutes with gentle, copious irrigation with warm normal saline, and adequate hemostasis was confirmed (Fig. 3). The dura was closed, the bone flap replaced, and the scalp closed in 2 layers.

Discussion

In the US and Europe, 10–15% of all strokes are caused by intracerebral hemorrhage. The efficacy of surgical therapy for ICH is still a matter of debate. One factor that strengthens the case for surgery is that early hematoma growth causing further neurological deterioration occurs in one-third of patients who present with ICHs. Clot removal may be beneficial because it reduces the neurotoxic edema caused by high levels of thrombin and blood degradation products. Another benefit to hematoma evacuation is a direct reduction in intracranial pressure. Quick decompression of the hematoma was achieved in all patients, and in no case was there immediate clinical deterioration from edema or residual hematoma.

Surgical Technique Concerns

Numerous approaches to evacuating ICHs arising secondary to hypertension have been described. Minimally invasive techniques combine the benefits of surgical clot removal with minimal additional brain damage and shorter operative times. Stereotactic aspiration with favorable clinical results and no deaths has been reported. Evacuation of deep-seated ICHs after liquefaction of the clot using local instillation of tissue plasminogen activator, has been shown to aggravate secondary tissue injury in terms of edema formation. Although stereotactic surgery is less invasive, a craniotomy provides a wider exposure and better access to the hematoma. Our aim was to reduce operative time and minimize additional brain tissue damage. We performed a small craniotomy and minimal corticectomy, and achieved total or near-total evacuation of the clot in all cases. Less time is spent controlling the bleeding with small craniotomies after a single linear incision, while still allowing wide access to the hematoma. We have used this technique in 19 primary ICHs in lobar regions and 12 in the basal ganglia. No surgery was started > 12 hours after onset, and an 80% reduction in clot volume and ventricular compression was noted on the first postoperative CT scan obtained 12 hours later. In all cases, rapid administration of antifibrinolytic therapy by intravenous administration of 2 g of tranexamic acid over a period of 10 minutes occurred before surgery and again 12 hours postoperatively. This therapy and the maintenance of strict blood pressure control helped to achieve hemostasis. One patient presented 2 days after surgery with neurological deterioration secondary to re-bleeding; the second operation was performed with the same method.

Local Hemostatic Concerns

Local hemostatic agents like microfibrillar collagen, oxidized cellulose, gelatin sponge, or fibrin glue are fre-
Hemostatic sealant for spontaneous ICH

Fig. 2. Illustration of the 3-cm-diameter craniotomy made with a high-speed craniotome (left). Suction of ICH is achieved (right) via a transcortical approach. Arrow indicates bone flap.

Fig. 3. Illustration showing FloSeal hemostatic matrix application with a needle into the operative cavity and a cottonoid insertion for gentle compression of the hemostatic agent (left). Cottonoid and hemostatic matrix are removed with copious irrigation with normal saline (right).

quently used to achieve bleeding control, but these agents may be difficult to apply to the walls of the operative cave through a narrow channel. Bipolar coagulation provides complete hemostasis but is frequently time consuming and leads to a wider corticectomy. In cases of continuous, generalized oozing in deep-seated hematomas, FloSeal may help to complete hemostasis. Both components of FloSeal, gelatin matrix and thrombin, promote hemostasis either with their individual action, either with synergistic interaction, to facilitate the formation of a stable
clot. There is 1 report of the use of this hemostatic agent in pituitary surgery. This technique expeditiously solved the problem of capillary ooze after hematoma evacuation in all cases. Because we injected FloSeal with a syringe tip, the granular nature of the gelatin matrix enabled the material to conform to any irregular operative cave geometry, and the material conformed to the bleeding site, swelling ~ 20% on contact with blood and providing a tamponade effect within the confined space. A cottonoid held the FloSeal in place against the bleeding surface. Excess granular material not incorporated into the hemostatic clot was carefully removed by gentle irrigation. In cases of persistent bleeding, indicated by blood saturation and bleeding through the granules, we reapplied FloSeal through the center of the mass as close as possible to the brain surface; this helped to achieve final hemostasis. No other local hemostatic agent was used in this patient cohort. FloSeal has been demonstrated to be safe and biocompatible compared to other hemostatic agents in use. There is a theoretical danger of aggravating perilesional edema and thereby increasing local thrombin concentrations, but with gentle irrigation and suction we reduced the concentration of intraparenchymal thrombin, leaving a clean operative field. Postoperative head CT scanning in our patients also demonstrated absence of perilesional edema. The safety and biocompatibility after the direct application of FloSeal to neural tissue has been demonstrated in preclinical studies. In this preliminary series, there were no evident adverse effects related to the direct application of this hemostatic agent to the brain.

Disclaimer

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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