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Original Article

Bespoke GelFoam Wafers: A Practical and Inexpensive Alternative to Oxycel for Hemostasis during Neurosurgery

Santosh Prabhu, Sujata Prabhu[1]

Departments of Neurosurgery and [1]Neuroanesthesia, Western India Institute of Neurosciences, Kolhapur, Maharashtra, India

Abstract

Background: Since the beginning of neurosurgery, intraoperative parenchymal bleeding has been a major problem. Achievement of hemostasis is the endpoint of any cranial or spinal neurosurgical exercise and is mandatory to avoid postoperative hematomas which mar the ultimate outcome of the surgery. Several biosurgical agents are used to achieve this goal. Agents such as oxidized cellulose, gelatin foam, fibrillar collagen, fibrin sealants, and antifibrinolytic agents are used, each having a different mechanism of action. **Materials and Methods:** The authors describe a simple technique for substituting oxidized regenerated cellulose (Surgicel) for lining the surgical cavities after excising brain lesions, with customized gelfoam wafers fashioned on the surgical trolley. This has been used in over 8000 cases with excellent hemostatic results over the last 25 years. No complications are noted with use of these wafers. **Results:** In a randomized trial done by us, similar hemostatic effect was found between oxycel and the gelfoam wafers described by us with satisfactory outcomes of surgeries. No previous use of such custom-fashioned wafers has been described for neurosurgical hemostasis in the literature.

Keywords: *Bespoke, gelfoam, hemostasis, oxidized cellulose*

Introduction

Achieving satisfactory hemostasis is a mandatory goal of every neurosurgical operation.

Normally, hemostasis is a natural process resulting from vasoconstriction, platelet aggregation, and utilization of coagulation factors finally producing a coagulum.

In addition, methods such as oxycel and gelfoam application are used to hasten hemostasis.

We describe a simple method of fashioning thin wafers from gelfoam to substitute expensive oxycel sheets. This has been used in over 8000 cases in the last 25 years with excellent results in a randomized trial.

Materials and Methods

Regular gelatin sponge (Gelfoam/Abgel/Spongostan) is universally available in India as a slab of the following dimensions: 80 mm × 50 mm × 10 mm. This material is too thick to use for lining the cavity as it is known to absorb about 35 times its weight in blood and can swell up to several times its size, which may then itself cause compressive mass effect on the surrounding brain. Hence, surgicel is the preferred agent for lining cavities at most neurosurgical centers, as it does not swell and acts, in addition to providing a mechanical trellis (though inferior to gelfoam) by producing acid hematin due to its acidic pH, which topically coagulates the bleeders.

The authors have been using very thin wafers of gelfoam fashioned on the operation theater sterile trolley using an autoclaved skin grafting blade, a surgical No 23 or No 15 blade (if very thin slice required), or even an autoclaved knife with serrated cutting edge. These are used to slice through this 10-mm thick slab to create thin pellicles of gelfoam using a sawing motion [Figure 1]. This thin slice can then be shaped to the desired size as required with a scissors [Figure 2] and then applied to line the cavity [Figures 3 and 4] or raw brain surface [Figure 5] without soaking in saline. We have used this in over 8000 surgeries both, cranial and spinal, over the last 25 years, with excellent results [Table 1].

The thickness of the waters can be varied by the creator, to make them very thin for use in the brain stem or intramedullary

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Address for correspondence:
Dr. Santosh Prabhu, Department of Neurosurgery, Western India Institute of Neurosciences, 183/B, Nagala Park, Kolhapur - 416 002, Maharashtra, India.
E-mail: sprabhuneuro@gmail.com

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lesions in the spinal cord and thicker, for use in oozing cavities. Thus, the thickness of these pellicles can be customized to suit the area where it is being used and also depending on the oozing that is occurring or is anticipated [Figure 6]. For example, after excising an arteriovenous malformations with a large nidus, a thicker slice is used to prevent breakthrough bleeding. The slice thickness can be thus tailored during surgery to suit the exact anatomical location where it is to be applied and the situation at hand demanding hemostasis. These wafers are also very easy to handle during surgery, unlike surgicel which has a tendency to form a roll, thereby making its application difficult. If the situation demands, these wafers

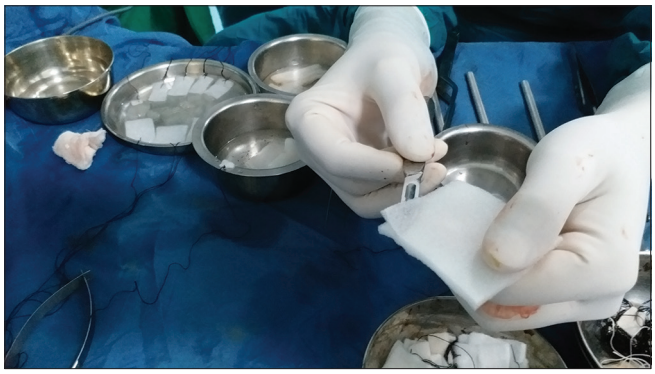

Figure 1: Wafer fashioning with No 23 surgical blade

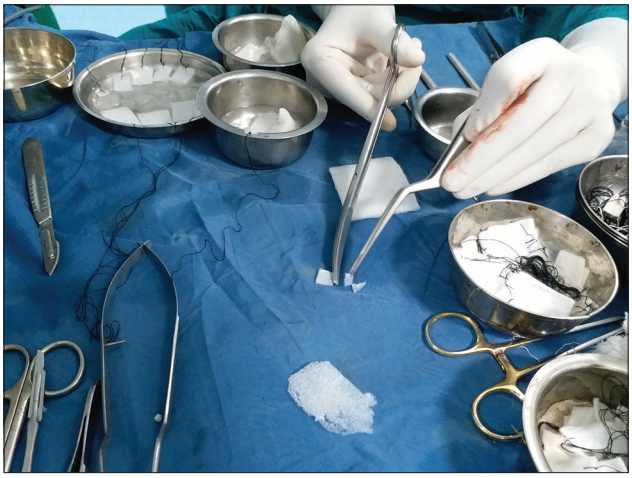

Figure 2: Wafer cut to the desired size

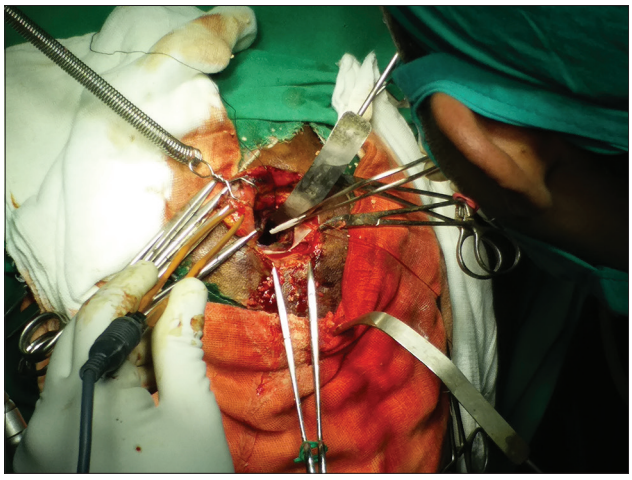

Figure 3: Wafer being applied to surgical cavity

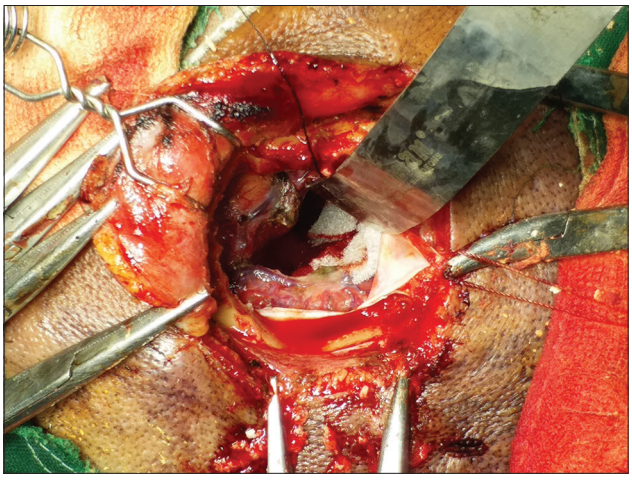

Figure 4: Wafer-lined surgical cavity

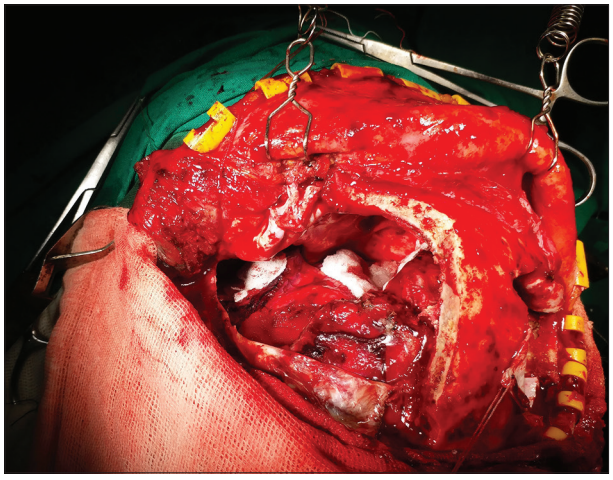

Figure 5: Wafers lining the brain surface after lobectomy

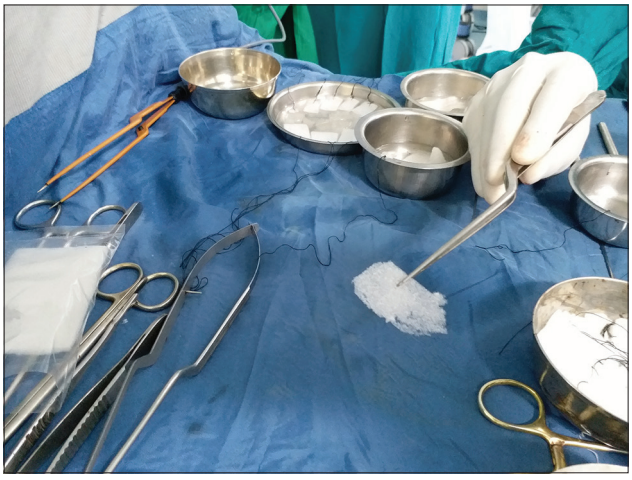

Figure 6: Wafer ready for application

can be soaked in thrombin and applied to further augment its hemostatic action.

Very thin wafers can also be applied to protect anastomosis and vascular repair suture lines, for covering dura after suturing it, to retain bone dust in place while replacing bone flaps and also to cover implants in cranial and spinal surgeries [Table 2].

Results

We used simple randomization to allocate cases to surgicel group versus gelfoam wafer group [Table 1].

We compared our data of patients in whom surgicel was used for hemostasis with the ones in which these customized wafers were used. There was identical hemostatic ability when compared on the rebleed rates on routine postoperative scans done on the 1st postoperative day at our center. Furthermore, there was no difference in the reexploration rates for rebleeding and overall clinical out comes and infection rates in both the groups.

Discussion

In the event of hemorrhage, hemostasis is naturally carried out by vasal contraction, platelet aggregation, and consumption of coagulation factors which end up as a clot formation. Usually, during an operation, it is not possible to wait for the natural hemostatic process to occur, and therefore, additive methods to obtain a stable coagulum have to be used.[1,2] In fact, for the last 6 decades, the commonly used materials have not changed much. Continuous evolution of new materials in chemical hemostasis may cause confusion among surgeons.

Table 1: Breakup of cases in which gelfoam wafers used

	Gelfoam wafer	Surgicel
Tumors	1850	425
IC hematoma	627	122
AVM's	36	42
Aneurysms	86	18
Spine	3825	1248
Others trauma etc.	2236	456
Number of cases	8660	2311
Total	10,971	

IC – Intracranial, AVM's – Arteriovenous malformations

Table 2: Indications for using gelfoam wafers

Application
Hemostasis
Dural epidural bone
Parenchymal
Skull base
Dural reconstruction
Posttraumatic
Skull base
Spine
Convexity
Special indications
Vascular anastomosis and repair
Implant fixation

The outcome of a delicately done neurosurgical operation can be ruined by a devastating postoperative hemorrhage in the operated area. Hence, hemostasis achievement is an important end point after excising any pathology in the brain. The surgeon has thermal, mechanical, and biochemical methods in his armamentarium to achieve satisfactory hemostasis. Since ancient Egyptian times, thermal methods have been used. Galen used it as the principle technique till Pare` reintroduced mechanical method of ligaturing of vessels in 16th century. In 1920s, Bovie and Cushing introduced electrocoagulation bringing thermal methodology again to prominence where it has remained even today. Victor Horsley introduced Bone wax for bone bleeding. Unfortunately, these methods have huge disadvantages in sensitive areas, particularly in arresting parenchymal ooze. Biochemical hemostasis started by Hippocrates, consisted of using caustic agents such as copper sulfate; these however caused uncontrolled destruction of all protein elements, besides the hemostasis was also poor and unreliable, hence they never succeeded in neurosurgery.[3]

Thus, the surgeon has to rely on meticulous surgical technique by maintaining the correct plane of cleavage between the tumor and surrounding normal brain and coagulating and cutting the supplying arteries and draining veins, as important surgical steps, toward achieving this goal. Once the pathology is excised, capillary bleeders in the tumor bed are carefully coagulated using bipolar cautery. After this, a hydrogen peroxide application is often done to further reinforce this hemostasis and then ultimately, the cavity is typically lined with oxidized cellulose (OC) (Surgicel) cut to desired size. Several biosurgical agents are used to achieve this goal.[4]

OC was introduced in 1942, whereas oxidized regenerated cellulose was developed in 1960 and is manufactured from wood pulp, which contains about 50% cellulose by mass. To prepare purified cellulose, it is decomposed and then recomposed into regenerated cellulose.[5-7]

Gelatin foam (GF) was introduced as a hemostatic agent in 1945 and has been marketed by several sellers since 1952.[8]

AbGel (Absorbable Gelatin) Sponge USP is nontoxic, nonallergenic, nonimmunogenic, and nonpyrogenic. It is manufactured from highly purified neutral GF of uniform fine porosity which guarantees a good hemostasis. The mechanism of action of surface-mediated hemostatic devices is supportive and mechanical.[6] Surface-acting devices, when applied directly to bleeding surfaces, arrest bleeding by the formation of an artificial clot and by producing a mechanical matrix that facilitates clotting.[9]

Jenkins *et al*.[10] have theorized that the clotting effect of gelfoam may be due to the release of thromboplastin from platelets, occurring when platelets entering the sponge become damaged by contact with the walls of its myriad interstices. Thromboplastin interacts with prothrombin and calcium to produce thrombin, and this sequence of events initiates the clotting reaction. It is suggested that the physiologic formation of thrombin in the sponge is sufficient to produce formation of a clot by its action on the fibrinogen in blood.[11] The spongy physical properties of the gelatin sponge hasten clot formation and provide structural support for the forming clot.[9,11] The uniform porosity of gelfoam guarantees a favorable hemostasis. It has been found to get completely absorbed *in vivo*, within 3–5 weeks.[12]

Following are the characteristics of gelfoam:

- Hemostasis in 2–4 min
- Absorbs 35 times its own weight in blood and fluids
- Completely absorbed within 4 weeks
- pH-neutral
- 100% biodegradable
- Can be used dry or impregnated.

There are several biosurgical agents used by neurosurgeons as per their preferences and individual experiences, to achieve satisfactory hemostasis after excising brain lesions.

Oxycel is the commonly used agent; however, it is expensive and sometimes difficult to procure in smaller centers located in the peripheral areas. Gelfoam, on the other hand, is universally available and substantially cheaper.

Our bespoke gelfoam wafers can be fashioned easily during surgery and can be customized as per the needs of that particular surgery. The remaining gelfoam can then be used to cover the dura and for epidural hemostasis also. No difference in postoperative bleeding rates, infections, or any other complications has been noted in this large series.

Conclusion

To the best of our knowledge, such bespoke wafers have never been used before in neurosurgery and are safe, efficacious, and cost-effective means to achieve excellent hemostasis postoperatively in a variety of neurosurgical operations with no complications.

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Conflicts of interest

There are no conflicts of interest.

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