TECHNICAL NOTE

Neurologia i Neurochirurgia Polska
Polish Journal of Neurology and Neurosurgery
2022, Volume 56, no. 6, pages: 499–502
DOI: 10.5603/PJNNS.a2022.0074

ISSN: 0028-3843, e-ISSN: 1897-4260

Haemostatic technique in malignant gliomas

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ABSTRACT

Introduction. Haemostasis in brain surgery is mandatory to avoid postoperative re-bleeding and a poor outcome. Postoperative intra-cavity haemorrhage is a frequent complication, especially in surgery of malignant gliomas because of the fragility of pathological vessels.

Material and methods. In this technical note, we describe our 'compression' technique used to achieve haemostasis in adult patients who underwent surgery for supratentorial malignant gliomas (GBM) at our Institute from January 2019 to January 2022. Peri-operative work-up included clinical status, laboratory data and contrast brain CT, performed at 24 hours after surgery, or earlier for patients with neurological worsening.

Results. A total of 82 patients was included in this study, 46 males (57%) and 36 females (43%). A post-operative intra-cavity haemorrhage was documented by postoperative CT-scan in 3/82 patients (3.65%), and the mean surgical time was 3.66 hours. No late bleeding was observed 48 hours after surgery.

Conclusions. We have documented the good results of our technique to achieve haemostasis in patients operated for malignant glioma (GBM). The technique described in this study seems to be safe and useful to avoid post-operative bleeding in the surgery of cerebral GBM.

Key words: glioblastoma, haemostasis, brain tumour, haemostatic agents, intra-axial haemostasis

(*Neurol Neurochir Pol 2022; 56 (6): 499–502*)

Introduction

Adequate haemostasis in cranial and spinal surgery is the key to good results. Haemostasis can be challenging in many surgical procedures, especially in transsphenoidal surgery or in malignant brain tumours [1]. Although bipolar cautery controls bleeding in large vessels, in malignant gliomas (GBM) it can be very difficult to achieve haemostasis especially in cases of subtotal tumour resection. When postoperative re-bleeding occurs, the neurological status of the patient gets worse, requiring reoperation with poor results. Nowadays, to avoid re-bleeding in brain tumours, many intraoperatively haemostatic agents, from peroxide, fibrin glue, oxidised regenerated cellulose, and microfibrillar collagen down to traditional washing with warm water, are used [2]. In this study, we detail the steps of our surgical cavity haemostasis after resection of malignant gliomas; this technique has provided encouraging results in terms of postoperative re-bleeding prevention in malignant glioma excision.

Material and methods

Between January 2019 and January 2022, a total of 82 supratentorial GBM operated with this technique by three neurosurgeons were enrolled in this study. The surgical indication was given according to the MRI study, the neurological status of the patient, his or her age, the tumour location, and the necessity for histopathological examination.

All patients were operated upon under general anaesthesia with the aid of neuronavigation and an operative microscope.

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Received: 5.08.2022 Accepted: 20.09.2022 Early publication date: 2.12.2022

All patients had stopped antiaggregant therapy five days before surgery in cases of home therapy. A postoperative CT-scan of the brain was performed immediately in cases of neurological worsening, or 24 hours after surgery and on the day of the patient's discharge.

The neurological examination was performed daily and the patient was mobilised after three days, or later in a case of neurological deficit. The rehabilitation started three days after surgery then continued at home. Patients with a recurrence of GBM, infections, coagulopathy and other malignant tumours were excluded from this study.

The haemostatic agents used in this study were Floseal® (Baxter Healthcare, Deerfield, IL, USA) (thrombin component), Pahacel® (Altaylar Medical Tibbi Malz — Ankara, Turkey) (oxidised regenerated cellulose) and Cutanplast® (Mascia Burmel SPA Milan, Italy) (absorbable haemostatic gelatin sponge).

To measure the intracranial pressure in the surgical cavity, a Codmann® ICP Express® monitor with a Codmann Microsensor® ICP Transducer were used.

Haemostatic technique

Under general anaesthesia, the patient was positioned in a mayfield headrest and a skin incision was made above the tumour site identified by the neuronavigation system. The bone flap was removed, and after dural incision a proper corticectomy under neuronavigation was performed to reach the tumour mass. GBM was removed with the aid of bipolar forceps, irrigation and dissector under microscope magnification. Finally, in the first step, haemostasis was obtained by irrigation of the surgical cavity with a warm saline solution. The bipolar forceps was used only to coagulate copious bleeding foci of major vessels in the surgical cavity (Figs. 1A and 1B). Then, in the second step, haemostasis was obtained with the use of the 'compression technique'. The surgical cavity was filled with Floseal® and a wet cotton balloon was left in place for one minute to reinforce haemostasis (Figs. 1C and 1D). In the second step, the balloon was removed under gentle irrigation with a warm saline solution and the surgical walls were covered with a small and thin amount of Floseal® reinforced with Pahacel® (Figs. 2A and 2B). A cube of wet Cutanplast® (absorbable haemostatic gelatin sponge) was introduced in the residual cavity to fill it all (Fig. 2C). Finally, the minimal residual space was filled with Pahacel® (Fig. 2D).

The dura mater was closed water-tight, the bone flap repositioned with titanium plaques, and a subcutaneous drain was placed before the closure of the muscles and the skin.

Results

The described haemostatic technique was used in 82 patients. A post-operative intra-cavity haemorrhage was documented by a postoperative CT-scan in 3/82 patients (3.65%), and the mean surgical time was 3.66 hours. The patients with intra-cavity bleeding were re-operated after the clinical neurological worsening and postoperative CT-scan images. All three intracavitary haemorrhages occurred within 24 hours after surgery. In the revision surgery, haemostasis was obtained with the same technique.

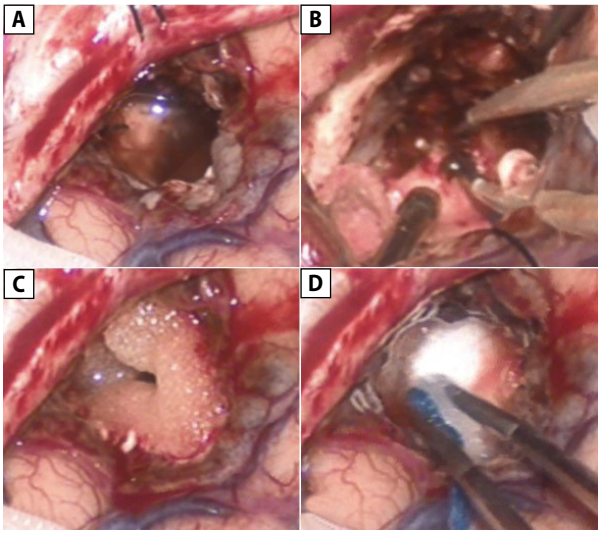

Figure 1. A. Surgical cavity of tumour; **B.** Haemostasis of walls with bipolar forceps; **C and D.** Surgical walls strewn with Floseal® and then entire surgical cavity filled with cottonoid for almost 60 seconds

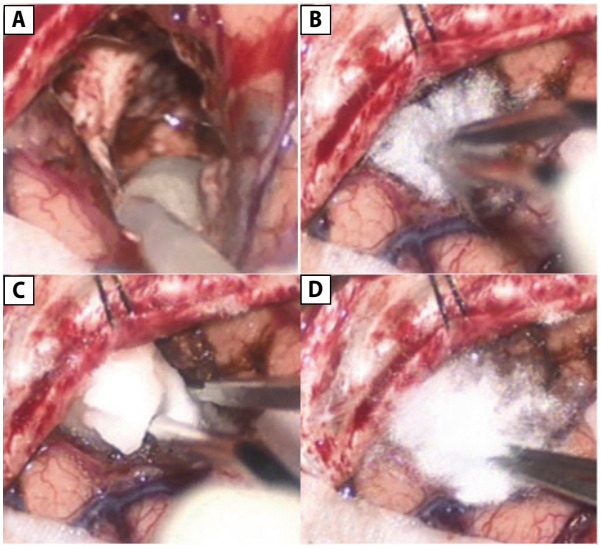

Figure 2. A and B. Surgical cavity strewn with Floseal® and Pahacel® (oxidised regenerated cellulose); **C and D.** Cavity filled with a cube of Cutanplast® (absorbable haemostatic gelatine sponge), then residual cavity sprinkled with Pahacel®

Discussion

In recent years, numerous substances have been introduced into surgical practice to obtain haemostasis in malignant brain tumours [3–5]. Adequate haemostasis in cranial and

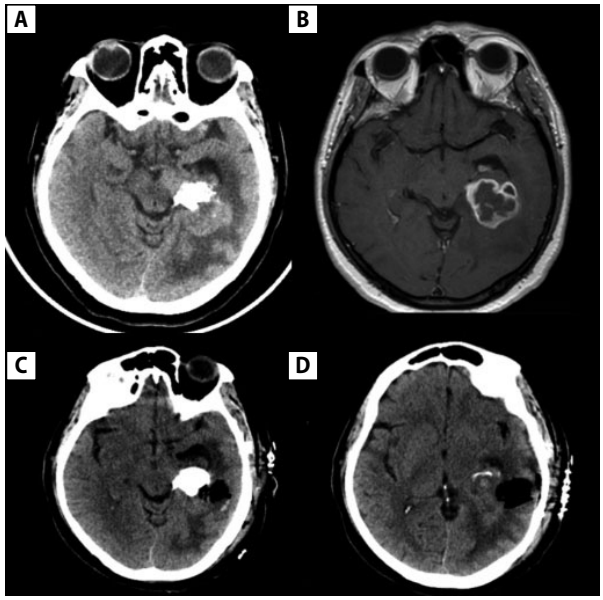

Figure 3. A and B. Pre-operative MRI and CT-scan showing intra-axial tumour with calcific mass; **C and D.** Post-operative CT-scan with surgical cavity and residual calcific portion (malignant glioma) without clots

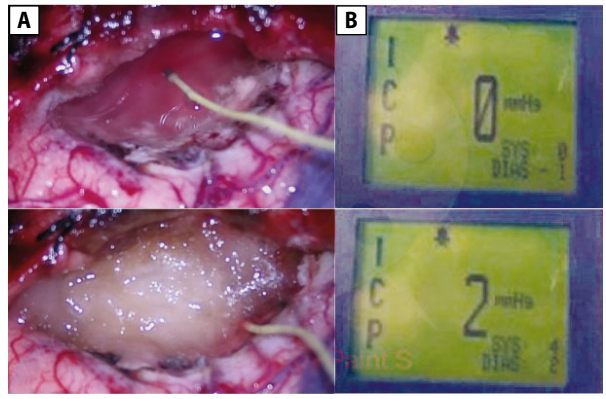

Figure 4. A. Intracranial pressure monitoring (ICP) transducer in surgical cavity filled with saline solution (mmHg = 0); **B.** ICP transducer in interface between cavity wall and haemostatic agents filling surgical cavity (mmHg = 2)

spinal surgery is paramount. In patients operated upon for GBM, the literature reports a postoperative surgical haematoma in c.5% of them, with a high incidence in patients with diabetes mellitus [6]. After brain tumour removal, bleeding from the surgical wall cavity may occur and this is very difficult to control due to the frail and dysplastic neoplastic vessels infiltrating the surrounding brain parenchyma. For this purpose, agents such as oxidised cellulose, gelatin foam, fibrillary collagen, fibrin sealants, and antifibrinolitic agents have been used in recent years.

We here describe a simple technique to achieve haemostasis in the brain surgical cavity after the excision of malignant gliomas (GBM) either total or partial. In this technique, haemostasis was obtained by means of a double mechanism: the use of Floseal® and pressure on the surgical cavity walls by the use of Cutanplast® and Pahacel® (oxidised regenerated cellulose). Floseal® is a gelatin matrix-thrombin solution mixture that is hydrophilic, and it adheres very well to wet brain tissues, forming a layer to coat the surgical wall. After filling the entire surgical cavity with Floseal®, a wet balloon of cottonoid was placed inside to reinforce haemostasis (Figs. 2–3). The second step was the washing out of the tumoural cavity while removing the cottonoid and, when the water was clear enough, the wall was coated with a small amount of first Floseal® and then Pahacel®. Finally, a balloon of Cutanplast® was positioned inside to seal the whole surgical cavity. With this technique, a moderate and constant pressure was obtained on the vessels of the surgical walls (Fig. 4). The insertion of a Codmann Microsensor® ICP Transducer between the balloon of Cutanplast® and the wall of the surgical cavity (Fig. 4B) documented a pressure of about 2 mmHg, strong enough to balance the pressure in the brain surrounding the excised tumour with displastic vessels.

In our experience, this technique grants better results compared to the traditional choice of filling the surgical cavity with a simple saline solution which achieves a pressure of 0 mmHg according to our measurement (Fig 4A). It is understood that the major arteries in the surgical cavity must be coagulated with bipolar forceps. The constant pressure on the surgical walls by the Pahacel® and the balloon of Cutanplast®, plus the use of Floseal®, favour haemostasis, especially in frail and dysplastic tumoural vessels. Thanks to this technique, we observed only three cases (3%) of postoperative bleeding in the surgical cavity. Although in the literature some cases of venous thrombosis have been documented caused by the accidental entry of Floseal® into the dural venous system, in our patients the very small size of the vessels of the surgical wall did not allow the entry of the Floseal® with thrombosis [7].

This technique is useful especially in brain malignant gliomas (GBM) subtotally excised. In these patients, the presence of the tumour residual mass predisposes to postoperative re-bleeding in a high percentage of cases.

The limitations of this study were its retrospective design and the limited number of patients.

Funding: *None.*
Conflicts of interest: *None.*
Ethical approval: *All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional committee and with the latest amendment of the Helsinki Declaration.*
Informed consent: *Informed consent was obtained from all individual participants included in the study.*

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