



# Case Report of a Novel Technique for Repair of the Vertebral Artery During Cranial Surgery

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## ABSTRACT

Surgery of complex cranial base lesions carries a high risk of damage to main vessels, often resulting in life-changing or even life-threatening injuries. We describe a rapid, effective, and noninvasive application of a collagen-based hemostatic patch to repair the vertebral artery during cranial surgery. A 61-year-old male patient underwent retrosigmoid craniotomy to remove a foramen magnum meningioma that encased the vertebral artery. A linear incision was made behind the ear and standard retrosigmoid craniotomy was performed with preservation of the transverse and sigmoid sinuses. The dura was opened in a Y-shaped fashion and the cerebellum was retracted with

cerebrospinal fluid being released. Removing the exposed tumor from the artery resulted in a small arterial bleed. Two pieces of an N-hydroxysuccinimide-functionalized polyethylene glycol-coated collagen patch (Hemopatch<sup>®</sup>, Baxter Healthcare Ltd.) were applied sequentially and were pressed to the bleed site for 2 min each. Hemostasis of the vertebral artery was achieved at the patient's regular blood pressure. There was no postoperative bleeding, dissection or pseudoaneurysm. The patient recovered gradually with several cranial nerve deficits. There was no brain stem stroke. Twelve months on, the patient has made an excellent recovery from surgery, is independently mobile and has minimal cranial nerve deficits. Application of the collagen-based hemostatic patch proved to be an efficient, safe, and noninvasive technique that achieved rapid hemostasis, confirming its effectiveness in complicated surgery, where risk of hemorrhage can be critical for the surgery outcome.

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## INTRODUCTION

Inadvertent or unintended tearing of tissue is sometimes unavoidable during complicated surgical procedures, and complications such as leakage of body fluids can be life-threatening. Conventional measures such as suturing tears take time, involve cross-clamping of the vessels (which can lead to ischemia), and hemostasis may take longer to achieve, so they may not be effective in cases where leakage can severely complicate and worsen an otherwise successful surgery outcome. In an attempt to address these problems, a number of hemostatic sealants have been developed that can be used during surgery to prevent a massive leakage of fluid and to induce hemostasis of the tissue. A polyethylene glycol-coated, collagen-based, sealing hemostatic patch (Hemopatch<sup>®</sup>, Baxter Healthcare Ltd.) has been designed to stop bleeding during surgical procedures and to simultaneously induce hemostasis [1, 2]. This collagen-based hemostatic patch was safe and performed well against other sealing hemostats when tested in vivo using various surgical models [3–9], and in a range of surgeries in patients [10–17]. This case report is the first to describe the use of the collagen-based hemostatic patch for repair of vascular injury in a neurosurgical case involving the removal of meningioma in the foramen magnum.

## CASE REPORT

Informed consent was obtained from the patient before his participation in the study, and written informed consent for publication of the patient's clinical details was obtained.

A 61-year-old male patient had a meningioma in the foramen magnum running anterior to the brainstem and pons and encasing the vertebral artery of the left side. The patient did not have any cranial nerve deficits on presentation. He had increasingly worsening gait and balance, and some problems with swallowing (bulbar problems due to the location of the meningioma). On examination, cerebellar signs were present, including a positive Romberg's sign, but there were no positive findings on

cranial examination or examination of the peripheral sensorimotor system.

A left-sided retromastoid craniotomy was performed, and debulking of the foramen magnum meningioma was attempted. A Mayfield 3-pin head clamp was fixed with the patient in a lateral position. A linear incision was made behind the ear, and standard retrosigmoid craniotomy was performed with preservation of the transverse and sigmoid sinuses. The dura was opened in a Y-shaped fashion and the cerebellum was retracted with cerebrospinal fluid being released. The tumor was exposed gradually with fixed retraction, and was partially debulked. Further debulking was carried out more medially to expose the vertebral artery. The attempt to peel off the tumor from the vertebral artery resulted in a small bleed from the artery. The collagen-based hemostatic patch was used to seal the hole as an onlay, applying pressure for 2 min. Another piece of the patch was used for further security and the artery was checked for hemostasis. Some further debulking was carried out between the cranial nerves. Hemostasis was achieved at 140 mmHg systolic blood pressure; the patient's regular blood pressure. The dura was closed with 3-0 vicryl and hemostatic patch onlay. Skull bones were fixed with Leibinger mini-plates. The incision was closed in layers, with the skin held together with clips. The surgery and application of the hemostatic patch are shown in the video provided in the "Discussion."

An angiogram was performed to check for dissection or false lumen/pseudoaneurysm in the vertebral artery, but none was found. The patient woke up gradually with several cranial nerve deficits, and had persistent bulbar symptoms in the initial postoperative period. There was no brain stem stroke. The patient did not suffer postoperative hemorrhage, but he suffered lower cranial nerve palsies. Throughout his hospitalization there was no evidence of bleed from the vertebral artery or any leak of cerebrospinal fluid. The patient spent 3 months of neurorehabilitation in hospital and was eventually discharged to an intermediate hospice with significantly improved cranial nerve function. At the time of this report, the patient

**Table 1** Case report timeline

Date <sup>a</sup>	Summary of initial/follow-up visits	Diagnostic testing	Interventions
Mar 2017	Patient had worsening gait and balance, and problems swallowing	Magnetic resonance imaging (MRI) scan performed. A meningioma was discovered in the foramen magnum	Surgery was required
Jun 2017	Retromastoid craniotomy performed. Attempt to peel tumor from artery resulted in a small tear	–	Two pieces of hemostatic patch were used to seal the hole in the vertebral artery
Jun 2017	Patient had lower cranial nerve palsies post surgery	Angiogram, catheter angiogram	No dissection or false lumen/pseudoaneurysm found. No bleed from vertebral artery and no leak of cerebral spinal fluid. Neurorehabilitation for 3 months. Patient discharged Nov 2017
Apr 2018	Clinic visit	–	Noninvasive contrast MRI scheduled
May 2018	Noninvasive contrast MRI performed	–	No abnormalities in the region of the vertebral arteries
Nov 2018	12-month follow-up <sup>b</sup>	Noninvasive contrast MRI performed	No abnormalities in the region of the vertebral arteries. Patient is independently mobile with minimal cranial nerve defects

<sup>a</sup> There was no relevant medical history for this patient

<sup>b</sup> 12 months from date of discharge

was able to move with assistance and had significantly improved cranial nerve function. Twelve months from surgery, the patient is now independently mobile with minimal cranial nerve deficits. This case report is summarized as a timeline in Table 1.

## DISCUSSION

In the present neurosurgical case report, we described the application of a collagen-based patch to a vertebral artery bleed during retromastoid craniotomy for tumor removal, achieving hemostasis after applying pressure for 2 min. We found that the collagen-based patch

provided a rapid, effective, and noninvasive method of hemostasis in this single patient.

The collagen-based hemostatic patch consists of a bovine-derived collagen pad sourced from countries with negligible bovine spongiform encephalopathy risk according to the classification of the World Organization for Animal Health [2]. The collagen-based hemostatic patch has been shown to be equivalent or superior to other sealing hemostats, providing over 98% hemostatic success at 3 min or less [4, 7, 9]. The patch needs no prior preparation and is stored at room temperature [1], allowing rapid availability during surgery. The current case report confirms the patch's utility during surgery, standing alongside critical appraisals of

the patch used in human surgery for hemostasis [10, 12, 13], a shorter mean surgery time [11], and no postoperative complications due to bleeding [15].

Overall, the performance of the collagen-based hemostatic patch for closure of dural defects in cranial surgery was highly satisfactory. When primary repair was not possible due to the dural defect (cranial surgery), the patch provided an excellent dural substitute. The closure was watertight, as tested with a Valsalva maneuver. The neurosurgeon did not need to perform further surgical re-exploration to close these defects, and they considered the collagen-based hemostatic patch to be a safe and effective adjunct. Its use as a vascular adhesive sealant gives it advantage over other available dural substitutes.

## CONCLUSIONS

To the best of our knowledge, this case report highlights the first application of a collagen-based hemostatic patch in neurosurgery, permitting successful hemostasis by a noninvasive technique. The patch could be an important resource in cases where direct cross-clamping and arterial repair is technically challenging and could lead to brain ischemia.

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**Compliance with Ethics Guidelines.** Informed consent was obtained from the patient before his participation in the study. Written informed consent for publication of the patient's clinical details was obtained, and a copy of the consent form is available for review by the Editor.

**Data Availability.** Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

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