Aulogous fibrin sealant (Vivostat®) in the neurosurgical practice: Part II: Vertebro-spinal procedures

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Abstract

Background: Epidural hematomas, cerebrospinal fluid fistula, and spinal infections are challenging postoperative complications following vertebro‑spinal procedures. We report our preliminary results using autologous fibrin sealant as both fibrin glue and a hemostatic during these operations.

Methods: Prospectively, between January 2013 and March 2015, 68 patients received an autologous fibrin sealant prepared with the Vivostat® system applied epidurally to provide hemostasis and to seal the dura. The surgical technique, time to bleeding control, and associated complications were recorded.

Results: Spinal procedures were performed in 68 patients utilizing autologous fibrin glue/Vivostat® to provide rapid hemostasis and/or to seal the dura. Only 2 patients developed postoperative dural fistulas while none exhibited hemorrhages, allergic reactions, systemic complications, or infections.

Conclusions: In this preliminary study, the application of autologous fibrin sealant with Vivostat® resulted in rapid hemostasis and/or acted as an effective dural sealant. Although this product appears to be safe and effective, further investigations are warranted.

Key Words: Autologous fibrin glue, cerebrospinal fluid fistula, dural repair, dural sealant, hemorrhage, hemostasis

INTRODUCTION

Cerebrospinal fluid (CSF) fistulas and postoperative hematomas constitute two of the major complications of spinal surgery. Fibrin sealants supplement dural closure and promote hemostasis. This study reports the preliminary results of utilizing a new fibrin sealant Vivostat® (Vivostat A/S, Allerød, Denmark) to achieve both hemostasis and facilitate dural repair in spinal surgery.

MATERIALS AND METHODS

From January 2013 to March 2015, 68 patients undergoing spinal surgery received autologous fibrin sealant prepared with the Vivostat® system and applied epidurally, over the resection bed.

Patients population

Upon approval of the local Institutional Review Board, between January 2013 and March 2015 we performed 68 neurosurgical spinal procedures utilizing autologous...
fibrin sealant/Vivostat® to achieve hemostasis and/or to seal the dura.

In 47% of cases (32 cases), the autologous fibrin glue was used only as an hemostatic agent; in 34% of cases it was used both as an hemostatic and dural sealant agent for strengthening atretic dura (without frank CSF fistula); in 19% of cases the autologous fibrin glue was used to achieve both hemostasis and CSF fistula repair; [Table 1]. In the majority of cases, autologous fibrin glue addressed degenerative disease (43%) or tumor (oncological cases: 32%) [Table 1, Figure 1]. For Vivostat preparation and administration see Graziano et al. and Giugno et al.[6‑8] All patients were monitored postoperatively for an average of 18 months.

**RESULTS**

**Technical and economic considerations**

This system was effective in all three circumstances; as a hemostatic alone, as a hemostatic and to strengthen atretic dura, and for hemostasis and dural repair. The Notably, Vivostat® formed an extremely thin white coat and did not compress the neural structures; additionally, it was physiologically eliminated within 24–36 h [Figure 2]. Only in 2 cases postoperative CSF fistulas were encountered; 1 was successfully treated conservatively while the other required additional dural repair [Table 1]. Notably, no local medullar toxicity, allergic reactions, infection, or systemic complications

| Case number | Sex | Age | Pathology                          | Treatment                                | Dural opening | Vivostat® indication | Postoperative complications |
|-------------|-----|-----|------------------------------------|------------------------------------------|---------------|---------------------|----------------------------|
| 1           | Male | 50  | Cervical disc herniation           | Microdiscectomy, arthroplasty            | No            | Hemostasis          | None                       |
| 2           | Male | 67  | Dorsal spondylodiscitis           | Decompression, arthrodesis               | No            | Hemostasis, dural    | None                       |
| 3           | Female | 66  | Dorsal meningioma                  | Lamincotomy and microsurgical asportation | Yes (intentional) | Dural sealing       | None                       |
| 4           | Male | 75  | Dorsal pathologic fracture         | Arthrodasis                               | No            | Hemostasis, dural    | None                       |
| 5           | Female | 80  | Lumbar canal stenosis             | Decompression, arthrodesis               | Yes (accidental) | CSF fistula repair | None                       |
| 6           | Female | 60  | Cervical myelopathy                | Decompression, arthrodesis               | Yes (accidental) | CSF fistula repair | None                       |
| 7           | Female | 79  | Cauda equina neurinoma             | Decompression, microsurgical asportation | Yes (intentional-duroplasty) | Dural sealing | None                       |
| 8           | Female | 76  | Cervical myelopathy                | Decompression, arthrodesis               | No            | Hemostasis          | None                       |
| 9           | Female | 69  | Postoperative CSF fistula (lumbar canal stenosis) | CSF repair, duroplasty                   | Yes (intentional) | CSF fistula repair | None                       |
| 10          | Female | 77  | Lumbar pathological fracture       | Decompression, arthrodesis               | No            | Hemostasis          | None                       |
| 11          | Male | 57  | Dorsal vertebral metastasis        | Decompression, microsurgical asportation | No            | Hemostasis          | None                       |
| 12          | Female | 53  | Cervical extra-assial neoplasm      | Decompression, microsurgical asportation | No            | Hemostasis          | None                       |
| 13          | Male | 54  | Lumbar spondylolithesis            | Decompression, arthrodesis               | Yes (accidental) | CSF fistula repair | Postoperative CSF fistula; conservative treatment |
| 14          | Male | 51  | Lumbar canal stenosis             | Arthrodasis system revision              | Yes (accidental) | CSF fistula repair | None                       |
| 15          | Male | 52  | Dorsal neoplasm                    | Decompression, microsurgical asportation, arthrodesis | No            | Hemostasis          | None                       |
| 16          | Male | 55  | Dorsal extra-assial neoplasm       | Decompression, microsurgical asportation, arthrodesis | Yes (intentional-duroplasty) | Dural sealing | None                       |
| 17          | Male | 43  | Lumbar CSF fistula                 | CSF fistula repair                       | Yes (intentional-duroplasty) | CSF fistula repair | Postoperative CSF fistula; reintervention with other sealants |
| 18          | Female | 72  | Dorsal extra-assial neoplasm       | Decompression, microsurgical asportation | No            | Hemostasis          | None                       |
| 19          | Female | 76  | Dorsal epidural haematoma          | Decompression, evacuation                | Yes (accidental) | Hemostasis CSF fistula repair | None                       |
| 20          | Female | 53  | Dorsal vertebral metastasis        | Decompression, arthrodesis               | No            | Hemostasis, dural    | None                       |
| 21          | Male | 74  | Lumbar canal stenosis             | Decompression, microdiscectomy, arthrodesis | Yes (accidental) | Hemostasis CSF fistula repair | None                       |

Contd...
| Case number | Sex   | Age | Pathology                                      | Treatment                                         | Dural opening | Vivostat® indication | Postoperative complications |
|------------|-------|-----|-----------------------------------------------|--------------------------------------------------|---------------|----------------------|-----------------------------|
| 22         | Male  | 68  | Dorsal vertebral metastasis                   | Decompression, arthrodesis                       | No            | Hemostasis           | None                        |
| 23         | Male  | 74  | Lumbar pathologic fracture                    | Decompression, arthrodesis                       | No            | Hemostasis           | None                        |
| 24         | Male  | 65  | Cervical canal stenosis                       | Vertebral corpectomy                             | Yes (accidental) | Hemostasis, dural sealing | None                        |
| 25         | Male  | 55  | Recidivant lumbar disc herniation             | Decompression, microdiscectomy, arthrodesis      | No            | Hemostasis           | None                        |
| 26         | Female| 66  | Lumbar spondylolisthesis                      | Decompression, arthrodesis                       | No            | Hemostasis           | None                        |
| 27         | Male  | 40  | Dorsal vertebral metastasis                   | Decompression, corpectomy                        | No            | Hemostasis           | None                        |
| 28         | Male  | 39  | Posttraumatic lumbar fracture                 | Decompression, arthrodesis                       | No            | Hemostasis           | None                        |
| 29         | Male  | 50  | Recidivant lumbar disc herniation             | Microsurgical discectomy, arthrodesis            | No            | Hemostasis           | None                        |
| 30         | Male  | 50  | Lumbar disc herniation                        | Microsurgical discectomy, decompression, arthrodesis | No            | Hemostasis           | None                        |
| 31         | Male  | 77  | Lumbar canal stenosis and spondylolisthesis   | Decompression, arthrodesis                       | No            | Hemostasis, dural strengthening | None                        |
| 32         | Male  | 55  | Dorsal vertebral metastasis                   | Decompression, arthrodesis                       | No            | Hemostasis           | None                        |
| 33         | Male  | 61  | Posttraumatic lumbar vertebral fracture       | Decompression, arthrodesis                       | Yes (accidental) | CSF fistula repair | None                        |
| 34         | Male  | 61  | Posttraumatic lumbar vertebral fracture       | Decompression, arthrodesis                       | Yes (accidental) | CSF fistula repair | None                        |
| 35         | Male  | 66  | Lumbar canal stenosis, recidivant lumbar disc herniation | Microdiscectomy, decompression, arthrodesis | Yes (accidental) | Hemostasis CSF fistula repair | None                        |
| 36         | Male  | 67  | Recidivant lumbar disc herniation             | Microdiscectomy, decompression, arthrodesis      | No            | Hemostasis           | None                        |
| 37         | Male  | 79  | Cicatrizial adhesions in previous lumbar stenosis | Surgical decompression and adhesions resolution | No            | Hemostasis           | None                        |
| 38         | Female| 57  | Dorsal neurinoma                              | Decompression, microsurgical asportation, arthrodesis | Yes (intentional) | Hemostasis, dural sealing | None                        |
| 39         | Male  | 56  | Lumbar canal stenosis                         | Decompression, arthrodesis                       | Yes (accidental) | Hemostasis, dural sealing | None                        |
| 40         | Female| 59  | Dorsal vertebral burst fracture               | Laminectomy and arthrodesis                      | No            | Hemostasis           | None                        |
| 41         | Female| 68  | Lumbar canal stenosis                         | Decompression, arthrodesis                       | Yes (accidental) | Hemostasis, dural sealing, CSF fistula repair | None                        |
| 42         | Male  | 75  | Epidural dorsal abscess                       | Laminectomy, abscess drainage                   | No            | Hemostasis           | None                        |
| 43         | Male  | 77  | Cervical canal stenosis                       | Decompression, arthrodesis                       | No            | Hemostasis           | None                        |
| 44         | Male  | 55  | Lumbar canal stenosis                         | Decompression, arthrodesis                       | No            | Hemostasis           | None                        |
| 45         | Female| 57  | Lumbar extra-axial neoplasm                   | Decompression, microsurgical asportation         | Yes (intentional - duroplasty) | Hemostasis, dural sealing | None                        |
| 46         | Male  | 51  | Cauda equina lipoma                           | Decompression, microsurgical asportation         | Yes (intentional - duroplasty) | Hemostasis, dural sealing | None                        |
| 47         | Male  | 66  | Lumbar canal stenosis                         | Decompression, arthrodesis                       | No            | Hemostasis           | None                        |
| 48         | Female| 56  | Intramedullar dorsal metastasis               | Decompression, microsurgical asportation         | Yes (intentional - duroplasty) | Hemostasis, dural sealing | None                        |
| 49         | Female| 87  | Cervical tarumatic vertebral fracture         | Arthrodesis                                      | No            | Hemostasis           | None                        |
| 50         | Female| 84  | Mielopathy (cervical trauma)                  | Discectomy, corpectomy, arthrodesis              | Yes (accidental) | Hemostasis CSF fistula repair | None                        |
| 51         | Male  | 67  | Dorsal traumatic vertebral fracture           | Decompression, arthrodesis                       | No            | Hemostasis, dural strengthening | None                        |
| Case number | Sex | Age | Pathology                                         | Treatment                      | Dural opening | Vivostat® indication | Postoperative complications |
|-------------|-----|-----|--------------------------------------------------|--------------------------------|---------------|----------------------|----------------------------|
| 52          | Female | 65  | Lumbar traumatic vertebral fracture             | Arthrodesis                    | No            | Hemostasis           | None                       |
| 53          | Male   | 60  | Lumbar pathological fracture                    | Decompression, thermo-ablation, arthrodesis decompression, arthrodesis       | No            | Hemostasis           | None                       |
| 54          | Male   | 71  | Lumbar vertebral micro-instability              |                                | No            | Hemostasis           | None                       |
| 55          | Female | 61  | Lumbar canal stenosis, lumbar disc herniation   | Decompression, microdiscectomy, arthrodesis                                | No            | Hemostasis, dural strengthening | None                       |
| 56          | Female | 61  | Lumbar canal stenosis, lumbar disc herniation   | Decompression, microdiscectomy, arthrodesis                                | No            | Hemostasis, dural strengthening | None                       |
| 57          | Male   | 41  | Cicatrizal adhesions and recidivant lumbar disc herniation | Decompression, adhesions resolution, microdiscectomy, arthrodesis | No            | Hemostasis           | None                       |
| 58          | Male   | 53  | Intra-extradural lumbar vertebral metastasis    | Decompression, microsurgical asportation, thermo-ablation, arthrodesis       | Yes (intentional) | Hemostasis, dural sealing | None                       |
| 59          | Female | 54  | Lumbar disc herniation, lumbar canal stenosis   | Discectomy, arthrodesis        | No            | Hemostasis           | None                       |
| 60          | Female | 60  | Cervical burst fracture                          | Corpectomy, arthrodesis        | Yes (accidental) | Hemostasis, dural sealing | None                       |
| 61          | Male   | 54  | Dorsal meningioma                               | Decompression, microsurgical asportation Yes (intentional - dural patch)  | No            | Hemostasis, dural sealing | None                       |
| 62          | Male   | 67  | Lumbar canal stenosis                           | Decompression, arthrodesis     | No            | Hemostasis, dural strengthening | None                       |
| 63          | Female | 48  | Lumbar spondylolisthesis                        | Arthrodesis                    | No            | Hemostasis           | None                       |
| 64          | Male   | 72  | Lumbar canal stenosis and spondylolisthesis     | Decompression and arthrodesis  | No            | Hemostasis, dural strengthening | None                       |
| 65          | Male   | 84  | Cervical myelopathy and vertebral listhesis     | Listhesis reduction and cervical arthrodesis                              | No            | Hemostasis           | None                       |
| 66          | Male   | 57  | Dorsal vertebral metastasis                     | Decompression, arthrodesis     | Yes (intentional) | Hemostasis, dural sealing | None                       |
| 67          | Female | 54  | Dorsal vertebral abscess                        | Decompression, biopsy          | No            | Hemostasis           | None                       |
| 68          | Male   | 52  | Lumbar spondylodiscitis                         | Decompression, microdiscectomy, arthrodesis                                | No            | Hemostasis           | None                       |

CSF: Cerebrospinal fluid fistula

![Pathology](assets/pathology.png)

Figure 1: Graph showing the percentage of the pathologies included in the study

occurred. The cost per kit needed (e.g., automated preparation of 6.5 ml of fibrin glue) is around 700 USD. Each procedure typically requires only kit; only 5–10% of cases may require two kits.

**DISCUSSION**

**Application for durotomies and hemostasis**

In spinal surgery, the major intraoperative complications are typically due to accidental durotomies or postoperative hematomas. Cammisa *et al.* found 66 (3.1%) durotomies occurring during 2144 spinal operations; they were immediately treated with dural suturing and fibrin glue.[4] During minimally invasive spine surgery, the durotomy incidence has been estimated to be 9%, 4% among 565 patients in the case series of Ruban and O’Toole.[17]
Do dural sealants inhibit fusion
Some are concerned whether these sealants on the vertebral fusion rate.\textsuperscript{[5]} Turgut et al. assessed the impact of Tissel on anterior cervical interbody allograft fusion at the C5–C6 level in cats (12 received Tissel, 12 did not); it was not suitable for “fixation of bone fragments” for anterior cervical discectomy and fusion in this cat model.\textsuperscript{[22]} Landi et al. determined the efficacy of utilizing a topical platelet gel to supplement posterolateral fusions rates in 14 instrumented fusions; fusion rates were comparable for both groups at 6 postoperative months.\textsuperscript{[12]}

Arguments favoring utilization of Vivostat system
The Vivostat® system is successfully used in several specialties.\textsuperscript{[1,3,10,11,14,15,19,20]} The autologous nature of Vivostat® eliminates the risks of bovine or human-borne contaminants, protecting the patient against viral diseases. It provides rapid polymerization, set rapidly, and provides instant tissue-fibrin adhesion, enabling the surgeon to manipulate the treated area early.\textsuperscript{[9,25]} In our clinical series, the Vivostat® provided immediate hemostasis without compression of neural tissues. Furthermore, there were 2 cases complicated by postoperative CSF fistula out of 68 patients treated, but only one required repeated surgical intervention.

CONCLUSION
Vivostat® system appears to be a safe/effective fully autologous hemostatic and dural sealant agent. Its composition and mechanism of action makes it able to adhere immediately to tissues and its rapid degradation time avoids any potential long-term mass effect.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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