Vertebral artery aneurysm rupture and hemothorax in a patient with neurofibromatosis Type-1: A case report and review of the literature

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1. Introduction

Neurofibromatosis type-1 (NF-1) is an autosomal dominant genetic condition caused by mutation in the neurofibromin gene. Classic symptoms include neurofibromas, hyperpigmented cutaneous spots (café-au-lait macules), axillary and/or inguinal freckling, iris hamartomas (Lisch nodules), and bone lesions [1]. Rarely, patients with NF-1 can have vascular abnormalities such as aneurysms, stenoses, and arteriovenous malformations. The exact pathogenesis of these abnormalities is unknown, but is thought to be due to alteration of neurofibromin expression in endothelial and smooth muscle cells of blood vessels [2]. Most patients remain asymptomatic. The most common site of involvement was reported to be the renal artery, which leads to renal artery hypertension [2].

We report a case of a 30-year-old female with NF-1 who presented with a spontaneous rupture of a vertebral artery (VA) aneurysm. A review of the literature by Oderich et al. found 46 reports of carotid, vertebral, and cerebral aneurysms, and noted that they occur most commonly in the third decade of life and are more frequent in women [3]. However, extracranial vertebral artery aneurysm in neurofibromatosis type 1 is very rare. Our review of the literature reveals 24 cases of extradural vertebral artery aneurysms in patients with NF-1, 12 of which ruptured and caused hemorrhage [4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24] (Table 1).
The patient had a computerized tomography (CT) study which revealed a right vertebral artery (VA) aneurysm and right hemothorax (Fig. 1). A chest tube was placed. CT soft tissue of the neck with contrast showed soft tissue prominence in the right supraclavicular region with a blush of contrast posteriorly suggestive of evolving hematoma with arterial extravasation (Fig. 2). There were some delays in the proper assessment of the patient’s status and severity of their condition, possibly due to lack of effective communication. Patient was eventually taken for a cerebral angiogram on hospital day two. Coil embolization was performed of the right VA/V1 segment pseudoaneurysm with therapeutic right VA sacrifice (Fig. 3). Patient received 2 units of packed red blood

### Table 1
Cases of Vertebral Artery Aneurysm in association with NF-1.

| Case Number | Author/Year | Age (years)/Gender | Ruptured or Unruptured | Side/Level/AVF | Treatment | Symptoms | Outcome |
|-------------|-------------|--------------------|------------------------|----------------|-----------|----------|---------|
| 1           | Uneda et al. [4]/2016 | 35/F | Ruptured | R/C3-C4/AVF | Endovascular (coil) | Neck and shoulder pain | Recovery |
| 2           | Pentecost et al. [34]/1981 | 1/F | Unruptured | L/Th1/No | Observation | Limited range of motion, weakness | Disabled |
| 3           | Schuhüger and Yasargil [24]/1978 | 50/M | Unruptured | L/C2-C6/No | Surgery | Radiculopathy | Recovery |
| 4           | Detwiler et al. [23]/1987 | 52/F | Unruptured | L/C2/No | Endovascular (balloon) | Neck mass, pain, bruising | Recovery |
| 5           | Negoro et al. [7]/1990 | 47/F | Ruptured | L/C1/No | Endovascular (balloon) | Neck pain, cervical hematoma | Recovery |
| 6           | Muhonen et al. [22]/1991 | 52/F | Unruptured | L/C2/No | Endovascular (balloon) | Neck mass and pain, arm weakness | Recovery |
| 7           | Schievink and Piepgras [21]/1991 | 43/F | Unruptured | L/C7/No | Observation | None | Recovery |
| 8           | Ohkata et al. [20]/1994 | 48/F | Unruptured | L/C4-C7/No | Surgery | Radiculopathy | Recovery |
| 9           | Horsley et al. [11]/1997 | 56/F | Ruptured | L/C5-C7/No | Endovascular (coil) | Neck pain and mass, arm parasthesias | Recovery |
| 10          | Hoffmann et al. [12]/1998 | 59/M | Unruptured | R/C6/No | Observation | None | Recovery |
| 11          | Ushikoshi et al. [19]/1999 | 40/F | Ruptured | L/C1/AVF (secondary) | Endovascular (balloon) | Occipitalgia, cervical hematoma | Recovery |
| 12          | Miyazaki et al. [5]/2004 | 52/F | Ruptured | L/C5-C7/No | Endovascular (balloon), surgery | Hemorrhage, radiculopathy, hypotension, altered mental status | Death |
| 13          | Arai et al. [17]/2007 | 38/M | Ruptured | L/-/No | Endovascular (coil, n-buty1 cyanocrylate) | Neck pain, angina, dyspnea, hypotension, hematoma, coma | Recovery |
| 14          | Hieda et al. [26]/2007 | 36/F | Ruptured | L/-/No | Endovascular (coil) | Neck pain and mass, arm parasthesias | Recovery |
| 15          | Hiramatsu et al. [14]/2007 | 67/M | Unruptured | L/proximal vertebral artery/No | Endovascular (coil) | Neck pain and mass, arm parasthesias | Recovery |
| 16          | Pereira et al. [18]/2007 | 14/F | Unruptured | R/C5-C6/No | Endovascular (balloon) | Head and neck pain, vomiting, subarachnoid hemorrhage | – |
| 17          | Peyre et al. [6]/2007 | 18/F | Unruptured | R/C5-C6/No | Endovascular (coil) | Head and neck pain, vomiting, subarachnoid hemorrhage | – |
| 18          | Hori et al. [12]/2008 | 30/F | Unruptured | R/C5-C6/No | Endovascular (coil) | Head and neck pain, vomiting, subarachnoid hemorrhage | – |
| 19          | Higa et al. [27]/2010 | 60/F | Ruptured | L/-/No | Endovascular (coil) | Cervical hematoma, stridor, respiratory failure | Disabled |
| 20          | Morvan et al. [9]/2011 | 36/F | Ruptured | L/C3-C4/No | Endovascular (coil, stent) | Head and neck pain, vomiting, subarachnoid hemorrhage | – |
| 21          | Hiramatsu et al. [15]/2012 | 31/M | Ruptured | R/C6/No | Endovascular (coil) | Head and neck pain, vomiting, subarachnoid hemorrhage | – |
| 22          | Gouallier-Vulcain F et al. [16]/2014 | 32/M | Unruptured | L/C8/No | Surgery, endovascular (stent) | Radiculopathy | Recovery |
| 23          | CY Lin et al. [10]/2017 | 18/F | Ruptured | L/proximal/No | Endovascular (coil, stent) | Seizures, neck swelling | Recovery |
Vertebral artery aneurysm rupture can be a fatal condition if not recognized promptly and managed aggressively, especially when the patient presents in hemorrhagic shock. Management options include surgical or endovascular treatment, or observation. Surgical treatment carries a higher risk of exsanguination, and observation in many cases results in death [17, 27]. Operative treatment with endovascular coiling is necessary for prevention of further complication and potentially fatal hemorrhage, as this method of treatment in minimally invasive and shorter in duration. Very rarely, the aneurysm can hemorrhage into the thoracic cavity, leading to hemothorax [28]. Hemorrhagic shock due to hemothorax in NF-1 patients can alternatively be caused by hemorrhagic mediastinal tumors or erosion of thoracic vessels by a tumor [29, 30, 31], but when an aneurysm is identified in patients with hemothorax, intervention becomes necessary after hemodynamic stabilization [29]. It is important to note that a variety of aneurysms have been reported with different arterial origins causing intrathoracic hemorrhage, and various arteries have been identified as sources of bleeding, such as intercostal and subclavian arteries, often secondary to enlarging tumors [29, 32].

In patients with airway compromise, early evacuation of resultant hemothorax in NF-1 patients can alternatively be caused by hemorrhagic shock [3, 34]. In the cases of patients who are diagnosed with an aneurysm that has not ruptured yet, it critical to serially monitor these vessels and assess for progression and intervene as needed [35].

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