

# Complications of Sigmoid Sinus Transvenous Occlusion for the Endovascular Treatment of Dural Arteriovenous Shunts with Emphasis on Inner Ear Dysfunction

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OBJECTIVE: Embolization of cranial dural sinus arteriovenous fistulae with transvenous occlusion of the involved sinuses is an established strategy when the collateral brain drainage allows it. We aimed to investigate the frequency and types of complications after endovascular occlusion of the sigmoid sinus.

METHODS: From our database, we detected 52 endovascularly treated consecutive cases of cranial dural arteriovenous shunts involving the sigmoid sinus. The cases treated through the transvenous approach alone or combined with the transarterial one were analyzed retrospectively. Previously reported series and cases were reviewed and critically analyzed.

RESULTS: In 15 cases, a transvenous approach was used and in 4 combined a transvenous approach with a transarterial approach. Two patients (13.3%) both treated with the transvenous approach alone presented postoperatively with vertigo and hearing loss. In the first case, the sinus occlusion involved the whole sigmoid sinus, whereas in the second case the occlusion was restricted to a parallel channel posteriorly to the proximal segment of the sigmoid sinus. Magnetic resonance imaging and ear, nose, and throat investigations failed to elucidate the cause and pathomechanism of these symptoms. No other complications occurred.

CONCLUSIONS: Although the transvenous occlusion of the sigmoid sinus generally is a safe therapeutic option for the treatment of dural arteriovenous fistulae, inner ear dysfunction is still a possible complication. The combined analysis of the reported and our cases did not allow a plausible explanation of this complication and its pathomechanism remains obscure.

#### **INTRODUCTION**

ransvenous embolization of cranial dural arteriovenous fistulae (CDAVF) with occlusion of dural sinuses is an established strategy in cases of extensive involvement of the sinus and when the clinical presentation justifies and collateral brain drainage allows the sacrifice of the involved sinus.<sup>1-4</sup> In particular, the endovascular occlusion of the sigmoid sinus (SS) is considered a relatively safe procedure because of the lack of major draining cerebral veins in that area. Complications after endovascular occlusion of the SS, however, may still occur.<sup>5</sup> Among them, damage or temporary dysfunction of the inner ear has received little attention.<sup>6</sup> We aimed to investigate the frequency, cause, and pathomechanism of complications occurring after endovascular transvenous occlusion of the SS.

#### **MATERIALS AND METHODS**

We retrospectively searched our cases of embolized CDAVFs that involved the SS either exclusively or together with other sinuses and were treated by transvenous alone or together with transarterial approach and endovascular occlusion of the whole or part of the SS. The angiographic, magnetic resonance (MR), and computed tomography (CT) images pre- and postoperatively as well as other relevant examinations were analyzed retrospectively.

#### Key words

- Complication
- Cranial dural arteriovenous
- Fistula
- Shunt
- Sigmoid sinus
- Transvenous embolization

#### Abbreviations and Acronyms

CDAVF: Cranial dural arteriovenous fistulae CT: Computed tomography IPS: Inferior petrosal sinus MR: Magnetic resonance SS: Sigmoid sinus VCA: Vein of the cochlear aqueduct VVA: Vein of the vestibular aqueduct

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The exact site of SS occlusion was recorded as "vertical" or "horizontal" for the proximal segment of the SS that appears almost vertical in the lateral angiographic view and the distal segment of the sinus that appears almost horizontal in the anteroposterior angiographic view, respectively. Cases of coiling at the level of the jugular bulb were recorded accordingly. The coil packing density was described as rather loose or rather dense according to the compactness of the deployed coils. The discovered complications were scrutinized, and their potential pathomechanism is discussed. We also reviewed the literature and checked the validity of the proposed explanations on the basis of our experience.

### RESULTS

From 1995 to 2015, 52 patients with CDAVF that involved the SS were treated endovascularly. Fifteen patients were treated by the transvenous approach and coil embolization/occlusion of the whole or part of the SS. Four also were treated through a transarterial route (1 with glue and 3 with particles). None suffered an immediate postoperative neurologic complication. One patient developed a relatively large groin hematoma, which was treated conservatively and had no sequelae. The catheters were infused with NaCl containing 1000 IU heparin/liter, but no systemic anticoagulation was used during the procedure or postoperatively in all patients. Epidemiologic data, clinical presentation,

angioarchitecture, and treatment features of all patients are shown in **Table 1**.

Two female patients (8 and 14) with extensive CDAVF of the distal transverse sinus and SS presented with acute vertigo and reduced hearing ipsilateral to the embolized lesion a few days postoperatively. Both patients had a complete elimination of their CDAVF after embolization and disappearance of their presenting tinnitus. The postoperative MR imaging confirmed the complete occlusion of the lesions and was otherwise normal without signs of arterial or venous ischemia.

#### Case 1

The first patient (patient 8) suffered from an unbearable tinnitus due to an extensive CDAVF of the right distal transverse and SS (Figure 1A–B). After discussion of the alternative treatment options and informed consent, we performed transvenous occlusion of the entire involved segment of the sinuses. The lesion at the end of the procedure was occluded completely, and the tinnitus disappeared (Figure 1C–I). On the third postoperative day, the patient presented with vertigo, a feeling of pressure and "fullness" of the head, and echo in the left ear, which were managed with symptomatic treatment and showed some improvement. One week later, as a result of persisting symptoms she visited another hospital, where she was diagnosed with a left-sided hypacusis that was attributed

Table 1. Patient Demographics, Lesion Locations, Classifications, and Treatment Details									
Pt No.	Sex	Age, years	Presentation*	Location†	Borden	Cognard	DES‡	<b>Occlusion</b> §	Packing
1	М	54	Tinnitus	Tr-S junction	2	ll a+b	DSS, nDnES	V	L
2	F	61	Tinnitus	Tr and S	3	llb	ISS, nDEnS	V	L
3	F	50	Headache, Tinnitus	S	1	lla	DSS no LVR	V, H	L
4	М	79	ICH	Tr-S junction	2	llb	DSS, nDnES	V	L
5	Μ	67	Tinnitus	Tr and S	1	lla	DSS no LVR	V	D
6	М	61	Tinnitus	Tr-S junction	2	ll a+b	DSS, nDnEnS	V	L
7	Μ	33	Tinnitus	Tr and S	2	llb	DSS, nDnEnS	V	L
8	F	59	Tinnitus	Tr and S	2	ll a+b	DSS, nDnEnS	V, H, J	L
9	F	54	Epilepsy	Tr and S	2	ll a+b	DSS, nDnES	V, H	D
10	М	69	Tinnitus	Tr and S, Jug. bulb, Hypoglosal	1	lla	DSS no LVR	V, H	D
11	F	64	Tinnitus	S	1	I	DSS no LVR	V	L
12	М	64	ICH	Tr and S and Jug. bulb	2	ll a+b	DSS, nDnES	V	L
13	F	50	Tinnitus	Tr-S junction	1	I	DSS no LVR	V	L
14	F	65	Tinnitus	Tr and S	1	I	DSS no LVR	V	D
15	F		Tinnitus	Tr and S	1	I	DSS no LVR	V,H	L

\*ICH, Intracerebral hemorrhage.

†Tr, transverse sinus; S, sigmoid sinus; Jug, jugular.

The DES<sup>7</sup> scheme analyzes the CDAVFs according to the level of the lesion (bridging vein, sinus, emissary vein) and the pattern of LVR, leptomeningeal venous reflux; DSS, dural sinus shunts; ISS, isolated sinus shunt; D, direct LVR; E, exclusive LVR; S, cortical venous strain (ectasia and/or congestion) due to LVR, n: no.

§V, vertical segment of sigmoid sinus; H, horizontal segment of sigmoid sinus; J, jugular bulb.

||L, loose coil packing; D, dense coil packing.

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