Journal of Clinical Neuroscience xxx (2018) xxx–xxx

Contents lists available at ScienceDirect

Journal of Clinical Neuroscience

journal homepage: www.elsevier.com/locate/jocn

Tools and techniques

Dual lumen balloon catheter – An effective substitute for two single lumen catheters in treatment of vascular targets with challenging anatomy

Ljubisa Borota [a,*], Ehab Mahmoud [a], Christoffer Nyberg [a], Anders Lewén [b], Per Enblad [b], Elisabeth Ronne-Engström [b]

[a] Department of Surgical Sciences, University Hospital, Uppsala, Sweden
[b] Department of Neuroscience, Neurosurgery, University Hospital, Uppsala, Sweden

ARTICLE INFO

Article history:
Received 21 September 2017
Accepted 18 January 2018
Available online xxxx

Keywords:
Neurointervention
Dual lumen
Balloon catheter

ABSTRACT

The aim of this study was to describe our experience in the treatment of various pathological conditions of the cranial and spinal blood vessels and hypervascularized lesions using dual lumen balloon catheters. Twenty-five patients were treated with endovascular techniques: two with vasospasm of cerebral blood vessels caused by subarachnoid hemorrhage, one with a hypervascularized metastasis in the vertebral body, two with spinal dural fistula, four with cerebral dural fistula, three with cerebral arteriovenous malformations, and 13 with aneurysms. The dual lumen balloon catheters were used for remodeling of the coil mesh, injection of various liquid embolic agents, particles and nimodipine, for the prevention of reflux and deployment of coils and stents. The diameter of catheterized blood vessels varied from 0.7 mm to 4 mm. Two complications occurred: perforation of an aneurysm in one case and gluing of the tip of balloon catheter by embolic material in another case. All other interventions were uneventful, and therapeutic goals were achieved in all cases except in the case with gluing of the tip of balloon catheter. The balloons effectively prevented reflux regardless of the type of the embolic material and diameter of blood vessel. The results of our study show that dual lumen balloon catheters allow complex interventions in the narrow cerebral and spinal blood vessels where the safe use of two single lumen catheters is either limited or impossible.

1. Introduction

Various embolic materials are used for occlusion of aneurysms, arteriovenous malformations and fistulas as well as for devascularization of hypervascularized tumors. All these materials are injected through microcatheters placed in the aneurysms or in the arteries feeding the arteriovenous malformations [AVM], arteriovenous fistulas or hypervascularized tumors. There are three goals of endovascular treatment of these structures: to fill them with embolic material, to protect or to restore the flow in the affected blood vessel and to avoid unwanted embolization. The first balloon technique developed to remodel the coil mesh and temporarily protect the flow in parent artery harboring a wide-necked aneurysm was described by Moret et al. in 1997 [1]. The permanent protection of a parent artery harboring a very wide-necked aneurysm was achieved for the first time in early 2000s by a specially designed, self-expandable stent deployed in the artery in front of the aneurysm [2]. A more difficult problem was prevention of the reflux of liquid embolic agents [LEA] along the microcatheter and subsequent unwanted embolization of side-branches when treating an AVM or a fistula. Creation of the plug of an embolic material [Onyx, for example] at the tip of the microcatheter in order to direct the flow of this material toward the AVM or fistula is sometimes a very difficult task with uncertain outcome due to aggressive reflux, prolongation of the intervention with subsequent precipitation of the embolic material and only partial occlusion of the AVM or fistula [3]. Several techniques have been developed to overcome these problems. Two recently described techniques are based on simultaneous utilization of two microcatheters [3,4], while several others are based on the utilization of dual lumen balloon catheters [DLBC] [5–8]. We have recently begun to use a DLBC to facilitate delivery of embolic material and prevent undesired reflux.

The aim of this review was to demonstrate the applicability of dual lumen catheters in treatment of a wide spectrum of patholog-

* Corresponding author.
E-mail address: ljubisa.borota@akademiska.se (L. Borota).

https://doi.org/10.1016/j.jocn.2018.01.070
0967-5868/

ical vascular conditions in the brain and spine and to describe our experience in using these devices.

2. Material and methods

The DLBCs are standard neurointerventional tools, and since 2010 we have used a total of 299 DLBCs in various neurointerventional procedures. In 25 cases treated for various pathological vascular conditions of the brain and spine, the DLBCs were used as dual-purpose devices. Thirteen patients were treated for cerebral aneurysms [seven for ruptured and six for unruptured ones], three for cerebral AVMs, six for fistulas [three for cranial dural fistulas, two for spinal dural fistulas and one for high-flow, posttraumatic, carotico-cavernous fistula], one for vertebral body metastasis and two for spasm of cerebral blood vessels caused by extensive subarachnoid hemorrhage (Table 1). Decision on the use of DLBC in all these cases was taken since the treatment with the two separate devices was considered either impossible, too risky or less feasible.

All interventions were performed under general anesthesia and via the transfemoral approach with full heparinized systemic anticoagulation.

The following dual lumen balloons catheters were used: Ascent^{R}, Scepter^{R} and Eclipse^{R}. (Table 2). The drugs and embolic materials injected through these DLBCs are listed in the Table 3.

Table 1
Technical details of interventions and immediate outcomes.

No	Intervention	DLBC	Use of DLBC	Blood vessel and diameter	Complication	Immediate outcome
1	Coiling of a ruptured a.comm. ant. Aneurysm	Scepter 4 × 10	Coiling through balloon and remodeling	A1, 1.5 mm	None	Partially occluded aneurysm, RR III
2	Coiling of an a.comm. ant. ruptured aneurysm	Ascend 4 × 10	Coiling through balloon and remodeling	A, 1. 2 mm	Rupture of aneurysm	Occluded aneurysm, RR I
3	Coiling of an unruptured a.comm. ant. Aneurysm	Scepter 4 × 11	Remodeling and stenting	A2, 1.6 mm	None	Occluded aneurysm, RR I
4	Coiling of a ruptured basilar tip aneurysm	Scepter 4 × 11	Remodeling and stenting	P1, 1.3 mm	None	Occluded aneurysm, RR I
5	Coiling of an unruptured a.comm. ant. Aneurysm	Ascend 4 × 10	Coiling through balloon and remodeling	A1, 1.12 mm	None	Partially occluded aneurysm, RR III
6	Coiling of a ruptured a.comm. ant. Aneurysm	Ascend 4 × 10	Coiling through balloon and remodeling	A1, 2 mm	None	Occluded aneurysm, RR I
7	Coiling of an unruptured MCA aneurysm	Scepter 4 × 11	Remodeling and stenting	M2, 1.5 mm	None	Occluded aneurysm, RR I
8	Coiling of an unruptured a.comm. ant. Aneurysm	Scepter 4 × 11	Remodeling and stenting	A1/2, 1.7 mm	None	Occluded aneurysm, RR I
9	Coiling of an unruptured basilar tip aneurysm	Scepter 4 × 11	Remodeling and stenting	P1, 1.7 mm	None	Occluded aneurysm, RR I
10	Occlusion of dissected right VA	Eclipse 6x7	Coiling through balloon and remodeling	V4, 1.8 mm	None	Occluded VA and normal flow from left VA to right PICA
11	Coiling of a ruptured a.comm. post. Aneurysm	Eclipse 6 × 7	Coiling through balloon and remodeling	ICA/neck of the aneurysm. 4.6 mm	None	Occluded aneurysm, RR II
12	Occlusion of dissected right VA	Eclipse 6 × 7	Coiling through balloon and remodeling	V4, 2.6 mm	None	Occluded VA and normal flow from left VA to right PICA
13	Coiling of an unruptured MCA aneurysm	Eclipse 6 × 7	Coiling through balloon and remodeling	M2/neck of the aneurysm, 2.1 mm	None	Occluded aneurysm, RR I
14	Embolization of a ruptured AVM	Scepter 4 × 11	Injection of Onyx and prevention of reflux	M3, 1.6 mm	None	Occlusion of the nidus.
15	Embolization of an unruptured AVM	Scepter 4 × 11	Injection of Onyx and prevention of reflux	M3, 1.8 mm	None	Occlusion of the nidus.
16	Embolization of an unruptured AVM	Scepter 4 × 11	Injection of Phil and prevention of reflux	Frontopolar artery, 1.5 mm	Gluing of the tip of micro-catheter	Occlusion of intranidal aneurysm, partial occlusion of the nidus.
17	Embolization of an unruptured dural fistula	Scepter 4x10	Injection of glue and prevention of reflux	MMA, 1.7 mm	None	Occluded fistula.
18	Embolization of a ruptured dural fistula	Scepter 4 × 11	Injection of glue and prevention of reflux	Occipital artery, 2.5 mm	None	Occluded fistula.
19	Embolization of a spinal fistula	Eclipse 6 × 7	Injection of glue and prevention of reflux	Muscular branch of Th6 intercostal artery, 1.6 mm	None	Occluded fistula.
20	Embolization of a spinal fistula	Eclipse 6 × 7	Remodeling, coiling and prevention of reflux	V3/V4, 3.9 mm	None	Occluded fistula.
21	Embolization of a dural fistula	Eclipse 6 × 7	Injection of Squid and Onyx and prevention of reflux	MMA/OccA, 1.7 mm/1.8 mm	None	Occluded fistula.
22	Embolization of a high-flow posttraumatic CC fistula	Eclipse 6 × 7	Injection of Onyx and control of flow in fistula	Dilated inferior petrosal sinus, 6.4 mm	None	Occluded fistula.
23	Treatment of spasm caused by SAH	Scepter 4 × 10	"Massage" and injection of nimodipin	Basilar artery, 1 mm	None	Radiologic relief of spasm.
24	Treatment of spasm caused by SAH	Eclipse 6x7	"Massage" and injection of nimodipin	M1, 0.9 mm	None	Radiologic relief of spasm.
25	Embolization of C7 vert. body metastasis	Scepter 4 × 10	Injection of 400mcr Embozene microspheres and prevention of reflux	Muscular branch of VA, 2.4 mm	None	Devascularized tumor.

Abbreviations in the Table 1: DLBC – dual lumen balloon catheter; ICA – internal carotid artery; MMA – middle meningeal artery; OccA – occipital artery; VA – vertebral artery; MCA – middle cerebral artery; AVM – arterio venous malformation; CC – carotico cavernous; SAH – subarachnoid hemorrhage, RR – Raymond-Roy classification of intracranial aneurysms treated with coil embolization.

Please cite this article in press as: Borota L et al. Dual lumen balloon catheter – An effective substitute for two single lumen catheters in treatment of vascular targets with challenging anatomy. J Clin Neurosci (2018), https://doi.org/10.1016/j.jocn.2018.01.070