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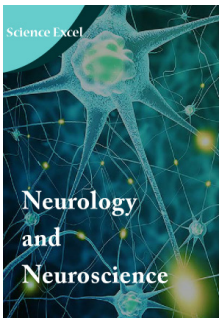
Review Article



Endovascular parent artery coil occlusion for ruptured vertebral artery dissecting aneurysms

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Abstract

Background: The outcome of ruptured vertebral artery dissecting aneurysms (VADA) managed with endovascular coil occlusion technique is reviewed.

Method: This is a retrospective study of prospectively collected data of 25 cases with ruptured VADA managed by a standardized endovascular parent artery occlusion technique. All cases were treated with coil occlusion of the dilated segment with a short proximal segment of the involved non-dominant or co-dominant vertebral artery within 12 hours of admission. All cases were done under general anesthesia with no anticoagulation. Outcome was assessed clinically with modified Rankin score as well as follow up MRI at 6 months.

Results: There were a total of 25 cases, 10 female and 15 males. Age range 18 to 70, mean age 41. Twenty cases (80%) were WFNS grade 1 to 3. Five cases were grade 4 to 5. Treatment complication of cerebellar embolic infarct occurred in one case (4%). There was no hemorrhagic complication post treatment. 16 cases required ventriculoperitoneal shunting. Outcome was good with modified Rankin score of 0 to 2 in 20 cases (80%). There were 5 poor outcomes including one death (4%) due to the primary effect of subarachnoid hemorrhage in a case presenting with WFNS grade 5. All cases with WFNS grade 1 to 3 at presentation obtained good outcome. In all 24 cases who survived, follow up MRI showed that all aneurysms remained occluded at 6 months.

Conclusion: Endovascular parent artery coil occlusion is effective and durable for ruptured VADA.

Introduction

Vertebral artery dissecting aneurysms (VADA) may present with ischemic symptoms or subarachnoid hemorrhage (SAH) [1]. It is an uncommon but increasingly recognized cause for SAH compared to saccular aneurysms [2,3]. Without surgical or endovascular intervention, the risk of rebleeding in the early phase is very high compared to saccular aneurysms. Early intervention is thus recommended to prevent rebleeding [2-6]. Current approaches for these VADA include surgical proximal occlusion or trapping with or without bypass procedures. Endovascular techniques include deconstructive or reconstructive techniques [4,7-10]. Endovascular deconstructive techniques include proximal occlusion or endovascular trapping with balloons and/or coils. Some reports incorporated balloon occlusion test prior to balloon or coil occlusion. Reconstructive techniques include flow diversion or stent placement with or without coiling [7,9-11]. To date, the technique of choice for intervention of ruptured VADA remains controversial although reconstructive techniques are gaining popularity. The techniques for endovascular parent artery occlusion are also diverse with different outcomes and complications. In this study a series of 25 cases of ruptured VADA treated with early endovascular parent artery sacrifice using a standard technique over a period of 17 years is reviewed.

Method

This is a retrospective study of 25 cases of ruptured VADA encountered over a seventeen year period prospectively maintained in a database. The entry criteria include: CT documentation of SAH, angiography showing fusiform/non saccular dilatation of vertebral artery, "pearl and string sign", involvement of non-dominant/co-dominant vertebral artery, MRA/CTA/angiography showing double lumen or intimal flap. Exclusion criteria include: unruptured or incidental dissecting aneurysm, involvement of dominant vertebral artery, involvement of posterior inferior cerebellar artery (PICA) or anterior spinal artery (ASA) in the aneurysmal segment. All cases were treated within 12 hours of admission. General anesthesia was used in all cases with careful attention to maintain normotension. Apart from 1000 units of heparin/L saline of saline in

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the routine flush for catheters, no systemic anticoagulation was employed. Antiplatelet medications were also not administered. Standard transfemoral approach was used. A 5F or 6F Envoy guide catheter (Codman, USA) is placed in the cervical vertebral artery. SL 10 microcatheter (Stryker, USA) was maneuvered into the disease segment carefully with Synchro 14 microguide wire (Stryker, USA) and coil packing was performed carefully with bare Hypersoft (Microvention, Terumo, Japan) or Target (Stryker, USA) coils until occlusion of the diseased segment, plus a short 2 to 3mm segment proximally to ensure coverage of the origin of dissection, taking care not to occlude the origin of PICA or anterior spinal artery if present proximal to the aneurysm. In this series on angiography, there is a focus of stenosis proximal to the fusiform dilatation in all cases. This focus of stenosis is presumed to be the starting point of dissection and it must be occluded to avoid recurrence. The segment of occlusion is kept as short as possible to minimize the risk of embolic complication [12-14]. The procedure was concluded when antegrade flow into the diseased segment is no longer visualized on contrast injection. Balloon occlusion test was not used in this series because of the adequate collateral from contralateral vertebral artery, inherent risk of balloon occlusion, and that its use will require anticoagulation. This treatment technique is considered as parent artery occlusion, as opposed to trapping, because there is no deliberate occlusion of the parent artery distal to the aneurysm, as traditionally defined in neurosurgical terminology (in classic neurosurgical literature, trapping refers to application of aneurysm clips proximal and distal to artery segment containing an aneurysm). The occlusion of parent artery distally prior to proximal occlusion and obliteration of the aneurysmal dilatation may precipitate catastrophic intraprocedural rupture. For these reasons occlusion of the distal segment beyond aneurysmal dilatation was avoided. A total of 25 cases met the above listed inclusion criteria without any exclusion criteria. During this period, 12 cases of ruptured VADA were excluded (2 cases treated with flow diverter assisted coiling due to small contralateral vertebral artery, 9 cases treated with proximal clip occlusion, and one requiring occipital artery-PICA bypass combined with surgical proximal occlusion due to origin of PICA arising from dissected segment.) MRI was performed the next day to document occlusion of the diseased segment, as well as to assess for hydrocephalus, rebleeding, status of aneurysm/vertebral artery/PICA or infarcts if present. Outcome was assessed with MRI and Modified Rankin Scale (mRs) at 6 months.

Table 1. *Clinical presentation, WFNS grade and outcome of the 25 cases with ruptured VADA as assessed using modified Rankin score (mRs).*

Age	Gender	Side	WFNS	VP shunt	mRs	Complication
70	Male	Right	2	No	0	Nil
55	Female	Left	3	Yes	0	Nil
30	Male	Left	3	No	0	Nil
18	Male	Left	5	Yes	1	Nil
29	Male	Left	1	Yes	1	Nil
27	Female	Left	2	No	0	Nil
35	Male	Left	2	Yes	0	Nil
40	Male	Right	5	Yes	Death	Death from primary impact of SAH
28	Male	Left	5	Yes	3	Nil
41	Female	Left	3	Yes	2	Nil
35	Male	Left	2	No	0	Nil
37	Male	Right	5	Yes	4	Nil
52	Male	Right	3	Yes	1	Nil
25	Male	Right	1	No	0	Nil
48	Male	Right	1	No	1	Cerebellar infarct
52	Female	Right	4	Yes	3	Nil
60	Male	Right	3	Yes	3	Nil
49	Female	Right	3	Yes	1	Nil
42	Male	Right	2	Yes	0	Nil
56	Female	Left	1	No	0	Nil
43	Male	Left	2	Yes	0	Nil
41	Female	Left	1	No	0	Nil
38	Female	Left	2	Yes	0	Nil
45	Female	Left	1	Yes	0	Nil
31	Female	Left	2	No	1	Nil

WFNS: World Federation of Neurosurgical Societies; VP shunt: ventriculoperitoneal shunt; mRs: Modified Rankin Scale

Results

There were a total of 25 cases, 10 female and 15 males. Age range 18 to 70, mean age 41. Twenty cases were World Federation of Neurosurgical Societies (WFNS) grade 1 to 3. Five cases were grade 4 to 5. Good outcome with mRS score 0 to 2 was achieved in 20 cases (80%). There were three mRs 3 (12%) and one mRs 4 (4%). There was 1 death (4%) due to primary effect of subarachnoid hemorrhage in a case presenting with WFNS grade 5. All cases with WFNS grade 1 to 3 at presentation obtained good outcome. The clinical features and outcome are tabulated in Table 1. PICA was proximal to the diseased segment in 10, not visualized in 3 in ipsilateral vertebral artery, and distal to it in 12 cases. Among the cases with PICA proximal to the diseased segment the PICA origin was more than 3mm proximal to it. In one case the PICA was extracranial in origin. Despite actively searched for, the anterior spinal artery was not visualized in the ipsilateral vertebral artery in the entire series. None of the cases rebled before the treatment procedure was carried out. Complete angiographic occlusion occurred in all cases. There was no hemorrhagic complication post treatment. Treatment complication of cerebellar embolic infarct occurred in one case (4%). This patient was noted to have ataxia one day post parent artery occlusion. The MRI showed several small embolic infarcts in the ipsilateral cerebellum, likely due to embolism during embolization. There was no hydrocephalus. He was given aspirin 300mg daily. The ataxia resolved completely at 6 months follow up and he made a good recovery. Sixteen (64%) cases required ventriculoperitoneal shunting. There was no recurrence in all 24 cases with MRA follow up at 6 months.

Discussion

VADA is an uncommon cause of SAH that is increasingly being recognized [1-3,15]. Over the years surgical or endovascular techniques evolved to include deconstructive or reconstructive techniques [4,7-10]. Since the publication of ISAT study, endovascular approach became the preferred treatment modality [5]. It is important to note, however, that the key issues in the treatment of VADA depends on the dominance of the involved vertebral artery, the origin of PICA as well as the ASA. If the involved vertebral artery is dominant, and the contralateral vertebral artery is small, preservation of the parent artery with endovascular reconstructive techniques or surgical bypass procedures needs to be considered. If the dissected segment involves the origin of PICA or ASA, techniques to preserve their flow becomes paramount. For PICA origin involvement, surgical PICA-PICA or occipital artery-PICA bypass, followed by endovascular or surgical parent artery sacrifice, may be required. There were also techniques reported for deploying a stent from the vertebral artery into the PICA to preserve flow and coil occlude the dissecting aneurysm [16]. For ASA origin involvement, flow diversion may need to be performed to prevent cervical spinal cord infarction. The addition of surgical revascularization increases the complexity and risk of treatment, especially in the acute post hemorrhagic setting. Flow diversion or stent assisted coiling techniques to preserve the parent artery are increasingly being used. However, antiplatelet medications and anticoagulation are required when flow diverters or stents are deployed to prevent thromboembolic complications. These could increase the risk of bleeding, adversely affecting patient outcome, when cerebrospinal fluid diversion procedures are required [9,10]. Moreover, in the setting of ruptured VADA, early recurrence with fatal rebleeding have been reported with these stent or flow diverter assisted endovascular reconstructive techniques [11,17]. Endovascular parent artery occlusion also has been reported to have a higher immediate postoperative occlusion rate, compared to stent assisted or flow diverter assisted techniques [5,10]. Therefore, when the anatomy is favorable (namely co-dominant or dominant contralateral vertebral artery and no involvement of PICA in the aneurysmal segment), endovascular parent artery occlusion has been the author's preferred option.

All the cases were treated under general anesthesia to eliminate movements and allow more precise coil embolization of the diseased segment. For cases with high grade SAH airway control was an important added advantage. Because of the risk of rebleeding, the increased risk of bleeding if cerebrospinal fluid diversion procedures when needed, anticoagulation and antiplatelet medications were omitted for these ruptured dissecting aneurysms [9,10]. With omission of anticoagulation there is potential for increase in the risk of thromboembolism. In this series there is one case of embolic infarct in the cerebellum. When a segment of vertebral artery is occluded, there is a risk of thrombus extension either proximally or distally to occlude the PICA origin when present. In this situation aspirin or other antiplatelet agents may be instituted when embolic infarcts are noted on MRI post procedure in the absence of hydrocephalus. In the presence of hydrocephalus ventricular drain may be inserted prior to antiplatelet administration to minimize the risk of bleeding.

The outcome of this study is consistent with published series of ruptured VADA treated by endovascular parent artery sacrifice [6-8,10,18]. Good outcome occurred in 80%. There was one complication (4%) of thromboembolic cerebellar infarct. All the cases presenting with good grade SAH achieved good independent outcome in this series. In the study reported by Raper et al where 44 out of 45 cases were treated by endovascular parent artery occlusion and heparin was administered during embolization, complications occurred in 13% (including 4.4% thromboembolic complication) and good outcome occurred in 77.8% [8]. Similar to this study, all the aneurysm remained occluded at follow up. In the study reported by Peluso et al where 13 out of 14 cases (93%) presented with SAH and 13 cases were treated with parent artery occlusion, good independent outcome was achieved in all cases and there was no postoperative thromboembolic infarction or rebleeding [18]. Interestingly in their series two cases with PICA origin involved in the diseased segment were occluded with no evidence of lateral medullary infarcts in postoperative imaging. All the aneurysm remained occluded at follow up. They concluded that endovascular trapping of the dissected segment should be performed for most cases and that more sophisticated techniques aimed at parent artery preservation are only required in exceptional cases. In the study reported by Nakamura et al, good outcome was achieved in 59.1% with a complication rate of 20.2%, inclusive of 12.8% ischemic complications. Anticoagulation or antiplatelet agent was used in 54% of cases [6]. It is important to note that their study included higher percentage of poor grade SAH cases and significant number had some delay in treatment. In the study by Ikeda et al, good outcome was achieved in 58%. Ten of 26 cases (38%) developed lateral medullary infarcts despite full anticoagulation for endovascular trapping [13]. Their study found that the length of proximal segment occlusion correlated with the risk of post-intervention lateral medullary infarction. Among the cases there were significant number of pre-treatment rebleeding and poor grade SAH, likely accounting for the poorer outcome and higher risk of infarction post-intervention. It is important

to note that for ruptured VADA aneurysms, thromboembolic complication is not always related to intervention alone. Vasospasm and delayed ischemic neurological deficit, which occurs in a significant percentage of patients after SAH, may be the underlying cause for some of the infarcts. For this reason, cerebrospinal fluid drainage and hypertensive hypervolemic therapy, which improves cerebral perfusion, plays a crucial role in reducing delayed ischemic neurological deficits. Interestingly, in a study by Endo et al, which included balloon occlusion test and a mixture of balloon and coil parent artery occlusion for ruptured VADA, revascularization bypass procedure prior to endovascular trapping did not prevent lateral medullary infarction in 3 out of five (60%) cases [12]. Our study, with 80% of cases presenting with good WFNS grade and no rebleeding prior to treatment, coupled with the favorable anatomy (namely co-dominant or dominant contralateral vertebral artery and no involvement of PICA in the aneurysmal segment), likely accounted for the good outcome.

Our study, similar to Raper et al and Peluso et al, showed no recurrence at follow up, demonstrating durable effect of the treatment strategy. Although delayed recanalization of vertebral artery or aneurysm has been the subjects of some case reports in the literature post embolization, the majority of these cases involved aneurysmal dilatation at a close distance distal to the PICA origin. It is postulated that inclusion of a short segment of vertebral artery proximal to the aneurysmal dilatation to cover the origin of the intimal dissection when feasible helps to minimize this potential delayed complication [14,19-21]. When the distance between the PICA origin and the dissecting segment is short, in a situation when PICA is proximal to the aneurysmal dilatation, the technique reported by Chung et al can be considered in order to minimize the possibility of delayed recurrence [16]. They described a technique of deploying a stent from the vertebral artery into the PICA to preserve antegrade flow and coil occlude the dissecting aneurysm distally. It is also possible to stage the procedure, by coil occluding the aneurysmal dilated segment first, followed by stent or flow diverter assisted coiling of the proximal segment, at a stage when antiplatelet agents can be safely administered.

Conclusion

While the use of flow diverter or stent assisted coiling has been gaining popularity of late, it is important to remember that endovascular parent artery coil occlusion for ruptured VADA is simple, effective and durable. It is straight forward technically and should be considered with priority for the treatment of ruptured VADA aneurysms.

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