ORIGINAL RESEARCH

Endovascular Treatment of Wide-Necked Intracranial Aneurysms Using the Novel Contour Neurovascular System: Five Year Follow Up

Howra Ktayen, Christopher Y. Akhunbay-Fudge, Atul K. Tyagi, Kenan Deniz, Tufail Patankar

ABSTRACT

BACKGROUND AND PURPOSE: The contour neurovascular embolization device is a novel way to treat wide-necked bifurcation aneurysms (WNBA), which often pose significant treatment challenges. In this study, we aim to evaluate the efficacy and safety profile of this device.

MATERIALS AND METHODS: Prospective clinical and radiological data was collected for all patients treated with the Contour device at our centre, between January 2017 and December 2018. All patients were treated electively, and aneurysms were unruptured.

RESULTS: Fourteen patients were recruited, and the device was successfully deployed in eleven patients. All patients were women with a mean age of 65 years. Four basilar tip, two internal carotid, three middle cerebral, one anterior communicating, and one superior cerebellar artery aneurysms were treated. The mean aneurysmal size was 6mm (width) x 7.6mm (height), with 4.1mm neck. Follow-up imaging included DSA, MRA and CTA. For the 9 patients available at year two follow-up, 5 showed improved occlusion class over time with 8 of 9 having adequate occlusion defined by class 1 and 2 of the Raymond-Roy (R-R) classification system. Eight patients were available for 3-year follow-up: 7 patients had stable occlusion class including 3 patients with stable complete occlusion (R-R class 1). One patient had worsening of R-R occlusion class from 1 to 2 and subsequently presented with acute subarachnoid hemorrhage. Follow up data 5 years following implantation was available for 8 patients (including the ruptured and retreated patient): 7 patients had adequate occlusion (R-R class 1 and 2), however one patient had worsened from R-R class 1 to R-R class 2. Four patients had complete occlusion.

CONCLUSIONS: Results demonstrate progressive occlusion of wide-necked aneurysms over the first 2 years, but we have also demonstrated worsening of Raymond-Roy occlusion class in some aneurysms that were previously completely occluded. Our results suggest that the contour device is a good option in WNBA, however, it appears that patients must be followed up for a minimum of 5 years.

ABBREVIATIONS: WNBA = wide neck bifurcation aneurysms; WEB = Woven EndoBridge; CNS = Contour Neurovascular System; GCS = Glasgow Coma Scale; ACOM = anterior communicating artery; SCA = superior cerebellar artery; R-R = Raymond-Roy.

Received month day, year; accepted after revision month day, year.
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Disclosures: Tufail Patankar has consulting and proctoring agreements with Ceronovus, Stryker, Kaneka, Phenox, Balt, Nvascular tech, Cerus and is an investor in Cerus. The remaining authors declare no conflicts of interest related to the content of this article.

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SUMMARY SECTION

PREVIOUS LITERATURE: Several studies have evaluated the use of the Contour device in wide-necked bifurcation aneurysms. In 2021, the CERUS study reported adequate occlusion rates of 84%11. In 2022, the largest series to date, which included sixty aneurysms treated with the Contour device, demonstrated adequate occlusion rates of 89% at one year12. These results are comparable to those of the WEB device, which has demonstrated adequate occlusion rates between 73% and 89% 4,5, 15-17. Current literature suggests that the Contour device is a good option in treating wide necked aneurysms, however there is limited follow up on these patients.

KEY FINDINGS: We demonstrate an adequate occlusion rate of 87.5% at 5-years. However, our series includes two patients with worsening rates of occlusion, one of whom presented with acute rupture and SAH 3 years after treatment. We have seen a worsening occlusion rate of 18% at five years.

KNOWLEDGE ADVANCEMENT: We have highlighted the importance of following patients up for at least 5 years, regardless of occlusion status. Furthermore, follow up imaging should be sensitive for regrowing aneurysms (catheter and CT angiography), rather than MRI which is susceptible to marker artifact at the neck.

INTRODUCTION

Endovascular treatment of intracranial aneurysms has become the mainstay of treatment in most neurosurgical centres, particularly in the case of acutely ruptured aneurysms. In terms of treating wide neck bifurcation aneurysms (WNBA), traditional coiling methods are suboptimal, hence the development of intrasaccular devices. In 2019, a multicentre US study looked at wide neck MCA and basilar tip aneurysms treated using endovascular techniques such as simple, balloon or stent assisted coiling. They demonstrated adequate occlusion rates of between 40-63% with retreatment rates of 8.7% 1. Similar findings have repeatedly been published, demonstrating the need for

novel strategies in the treatment of WNBA2,3. New devices have been developed, such as Woven EndoBridge (WEB) and LUNA devices, with better occlusion rates than traditional coiling techniques 4-6.

In 2020, we published the first human series on treating WNBA with the Cerus Endovascular Contour Neurovascular System (CNS; Cerus Endovascular, Fremont, California, USA), and demonstrated a complete occlusion rate of 56% at 1 year 7. Although we demonstrated satisfactory rates of occlusion at one year, it is essential that patients are followed up for longer, to establish the true efficacy, reliability, and safety of this novel device. In this paper, we would like to share our results following five years follow up on 9 of the first eleven patients, who had the CNS device implanted in our centre. To our knowledge, this is the first study to publish up to five years follow-up on patients treated with the Contour device.

MATERIALS AND METHODS

Case Selection

As described in our first in human series with the CNS [7], prior to treatment, all cases were discussed in the neurovascular multidisciplinary team meeting. We identified all patients with aneurysms suitable for endovascular treatment, had a wide neck and were unruptured. We defined wide-necked aneurysms as having a neck diameter of ≥4mm or a dome-to-neck ratio of <2. 2,8 All treatment options were presented to patients, and those consenting were enrolled in the study with the intention to treat with CNS. We collected prospective clinical and radiological data for all patients treated with the CNS between January 2017 and December 2018. Following implantation of the device, they were followed up at 6-months and then annually for 5 years. All cases were treated on an elective basis and informed consent was obtained along with local ethics board approval.

Analysis

Baseline clinical data including patient demographics, baseline Glasgow Coma Scale (GCS), and modified Rankin Scale (mRS) were collected. Follow-up mRS at 6 weeks and any complications were recorded, along with immediate post-treatment, 6-month, 1-year, and 2-year radiological follow-up (in the form of catheter angiography); for detailed information, refer to our prior publication [7]. For the present study, 3-year, 4-year, and 5-year radiological follow-up (in the form of catheter angiography, contrast-enhanced MR angiography or CT angiography performed in the arterial phase) was recorded. Occlusion was quantified using the recognized Raymond–Roy Class classification 9. Class 1 denotes complete occlusion, Class 2 denotes neck remnant, and Class 3 denotes residual aneurysm. We considered Raymond-Roy class 1 and 2 as satisfactory outcomes, given the good clinical outcomes associated with these classes that is described in the literature10. Device migration was reviewed on post procedural imaging and device configuration was reviewed using catheter angiography or CT angiography.

Brief Procedural Technique

All cases were performed by the senior author under general anesthetic via standard common femoral artery puncture and an 8F sheath insertion. Patients did not receive any antiplatelet therapy prior to the procedure, and we did not perform platelet testing. Intraoperatively, 500mg of IV aspirin was given and patients were discharged with 6 weeks of 75mg aspirin once a day. For detailed procedural steps, please refer to our prior publication [7].

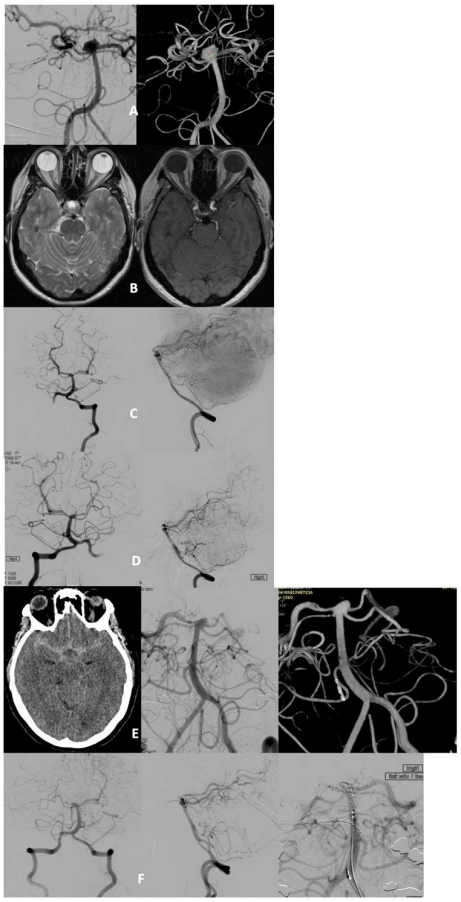

FIG 1. A) Pre-treatment catheter angiography for patient 5, demonstrating large basilar tip aneurysm. B) MRI scan at 6-month follow-up demonstrating complete occlusion. C) Angiography at 1-year follow up demonstrating complete occlusion. D) Angiography at 2-year follow up demonstrating complete occlusion. E) Presentation with SAH at 3-years. F) Stent-assisted coiling treatment for acute SAH.

RESULTS

Cohort summary:

We initially identified fourteen patients suitable for treatment; however, we were only able to place the device in eleven of those. The three failed cases are discussed in more detail in our previous publication [7] and a summary is provided in table 1.

Our series therefore includes eleven patients, treated with the CNS device between February 2017 and February 2018. They were all women with a mean (SD) age of 65.0 (6.4) years. All patients were treated on an elective basis for incidentally found aneurysms with one patient (Patient 1) having previously suffered subarachnoid haemorrhage from a different aneurysm that had been coiled. All patients had a pre-treatment GCS of 15 and an admission mRS of 0. In total, four basilar tip, two internal carotid artery (ICA), three middle cerebral artery (MCA), one anterior communicating artery (ACOM) and one superior cerebellar artery (SCA) aneurysms were treated (Online Supplemental Data). The mean aneurysmal size was 6mm (width) x 7.6mm (height), with 4.1mm neck. In all eleven cases only one CNS device was used, and no adjuvant devices were required at the time of treatment. After six-month, two patients left the study: one patient did not want further follow-up and the other patient developed frontal lobe dementia. After three years, one patient passed away due to medical deterioration unrelated to the aneurysm. Three years following procedure, one patient (patient 5) presented with acute SAH and underwent stent assisted coiling of the previously treated aneurysm. One patient (patient 8) did not have an appropriately sized contour resulting in persistent filling of the aneurysm for five years and has been offered further treatment. All other aneurysms remained stable at four and five-year follow up, with no migration of the device.

	Aneurysm dimensions					
Aneurysm location	Neck (mm)	Width (mm)	Height (mm)	AR	DNR	Procedural difficulties
MCA	3.3	4.6	4.4	1.3	1.4	Unable to catheterize with XT 27 catheter so coils were attempted. Despite eventual catheterization with Echelon 10 microcatheter, balloon inflation and attempts with multiple coils, the procedure was felt to be high risk of stroke and abandoned
Pericallosal	3.7	6.6	5.5	1.5	1.8	Inability to catheterize aneurysm with XT 27 catheter therefore successfully reverted to coiling
MCA	5.1	6.3	7.2	1.4	1.2	An XT 27 was navigated into the aneurysm. There were two failed trials with two 11mm Contour devices. Subsequently a 9×4mm WEB was used but was not suitable and an 8×3mm WEB was used instead with good clinical and radiological outcomes

AR, aspect ratio (height/neck); DNR, dome/neck ratio (width/neck); MCA, middle cerebral artery.

Table 1: Summary of failed cases with the Contour Neurovascular System as previously published by Akhunbay-Fudge CY, et al. [7]

Clinical outcomes and complications:

As described in our prior publication [7], of the fourteen patients, there were two cases of thromboembolic events (14%), however

there were no cases of postoperative ipsilateral major stroke, aneurysmal rupture, or death due to neurological causes. Patient 5 (basilar tip aneurysm) presented one week after the procedure with transient ischemic attack symptoms and, on MRI, was found to have two small infarcts in the right cerebellar and right occipital lobes. All symptoms completely resolved, the patient had no residual neurologic deficits (NIHSS 0 and mRS 0) and was discharged with 6 weeks aspirin and 3 months clopidogrel. Patient 10 (MCA aneurysm) had two failed attempts at CNS placement before the final 11mm device was suitably sited. Soon after waking, the patient was found to be hemiplegic. Immediate repeat angiography demonstrated an MCA thrombus, which was treated with 15mg IV abciximab. Following this, the patient had no deficits (NIHSS 0 and mRS 0) and was discharged with 2 months of aspirin and clopidogrel. The thrombus was not related to the detachment zone but had formed on the device during the procedure. The operator had failed to recognize the thrombus, and initially thought it was the device itself.

Radiological outcomes

These are demonstrated in Online Supplemental Data. Please note there is a discrepancy in two of the data points compared to our first publication, due to previous error 7.

Immediately post procedure:

Immediate postoperative angiography demonstrated complete occlusion, class 1 as defined by the Raymond-Roy Classification (R-R) was seen in one patient (9%), a small neck remnant (R-R class 2) in two patients (18%) and continued filling of the aneurysm (R-R class 3) in eight patients (73%). The adequate occlusion rate (R-R class 1 and 2) was 27%.

Radiological outcomes at 6-months:

On six-month catheter angiography, complete occlusion was seen in four of the eleven patients (36%), with four (36%) having small residual necks. The remaining three (27%) cases showed persistent filling in the aneurysm at six months. The adequate occlusion rate (R-R class 1 and 2) was 72% (8 of 11 patients).

Radiological outcomes at 1 year:

One-year follow up data was available for nine patients. At one-year, patient 9 improved from persistent filling (R-R class 3) to complete occlusion (R-R class 1). The remaining patients were stable with 8 of 9 patients showing adequate occlusion (R-R class 1 and 2).

Radiological outcomes at 2 years:

Two-year follow up data was available for nine patients. At two-years, patient 2 improved from neck remnant (R-R class 2) to complete occlusion (R-R class 1). The remaining patients were stable with 8 of 9 patients showing adequate occlusion (R-R class 1 and 2).

Radiological outcomes at 3 years:

Three-year follow up data was available for eight patients. At three-year imaging, patient 5 presented with acute SAH and angiography showed worsening of occlusion class from complete occlusion (R-R class 1) to neck filling (R-R class 2). The rupture point was from an area of regrowth along the parent vessel and under the Contour device. This patient was re-treated using stent assisted coiling, representing a retreatment rate of 9% at 3 years (Figure 1). The remaining 7 patients were stable with 6 showing adequate occlusion (R-R class 1 and 2)

Radiological outcomes at 4 years:

Four-year follow up data was available for eight patients. Patient 5 had been retreated and showed complete occlusion. Patient 8 had persistent aneurysmal filling (R-R class 3) but refused further treatment. This represents a re-treatment rate of 18% at four years. The adequate occlusion rate (Raymond-Roy class 1 and 2) was 7 out of 8 patients (87.5%).

Radiological outcomes at 5 years:

Five-year follow up data was available for eight patients. At five-year imaging, four of the remaining eight patients had stable total occlusion of the aneurysm and two had a stable neck remnant. Patient 3 had worsening of occlusion class, from R-R class 1 to class 2, due to growth at the neck of the aneurysm. Patient 8 still demonstrated persistent aneurysmal filling.

A summary of radiological results is provided in tables 2. There was no evidence of device migration or compression over time.

Follow up	No. of Patients	Complete occlusion Raymond-Roy class 1 (number of patients)	Small neck remnant Raymond-Roy class 2 (number of patients)	Adequate occlusion Raymond-Roy class 1 & 2 (number of patients)	Residual aneurysm Raymond-Roy class 3 (number of patients)
6 months	11	36% (4)	36% (4)	73% (8)	27% (3)
Year 1	9	56% (5)	33% (3)	89% (8)	11% (1)
Year 2	9	67% (6)	22% (2)	89% (8)	11% (1)
Year 3	8	50% (4)	37.5% (3)	87.5% (7)	12.5% (1)
Year 4	8	62.5% (5)	25% (2)	87.5% (7)	12.5% (1)
Year 5	8	50% (4)	37.5% (3)	87.5% (7)	12.5% (1)

Table 2: Summary of radiological results of Contour Neurovascular System series

DISCUSSION

Two years ago, we published data on the first eleven patients treated with the Contour device in our centre [7]. We continued to observe these patients to evaluate the longer-term efficacy of the device. By four years, we had lost three patients to follow up, leaving us with eight patients. We have five years follow up on all remaining patients in the study (Online Supplemental Data and 3), demonstrating an adequate occlusion rate of 86%.

In 2021, a multi-centre prospective study (CERUS study) evaluated the use of the Contour device for bifurcation aneurysms, and their results are very similar to ours. They demonstrated a progressive occlusion rate from 44% at 6 months to 69% at 12 months, with 84% adequate occlusion rate (R-R 1 and R-R 2)11. They also demonstrated a thromboembolic rate of 11%, which is comparable to our thromboembolic rate of 14%. The following year, the largest series to date was published, which included sixty aneurysms treated with the Contour device 12. They successfully implanted the device in 54/60 (90%) aneurysms and report adequate occlusion rates of 89% at one year 12 compared to our implantation success of 78% and one year adequate occlusion rate of 89% . For a relatively new device, it is reassuring that several studies have reported similar occlusion rates and a similar safety profile. Our series, although small, has the longest follow up on these patients, with some interesting findings.

Although we have demonstrated satisfactory rates of occlusion, our series also includes one patient whose R-R class 3 filling at 6 months did not improve over 5 years, and two patients with worsening rates of occlusion, one of whom presented with acute SAH (patient 5). We had treated this patient with the Contour device for a large basilar tip aneurysm (Figure 1). The initial result was very good, with total occlusion demonstrated on MRI and catheter angiography for two years post procedure. However, three years following treatment, the patient presented with a WFNS grade 1 SAH. Angiography demonstrated the rupture point to be from a progressive regrowth along the vessel, and under the Contour device. On re-review of angiography at 1- and 2-year follow up, we can appreciate the dysplastic appearances of the parent vessel – something we had not appreciated at the time and a reminder of the disease process in these patients, who often fail to manage risk factors such as smoking. This a well-recognized phenomenon in aneurysmal treatment and a similar regrowth was seen in patient 3, at five years (Figure 2). These two cases highlight to us the requirement to follow patients up, regardless of occlusion status, as regrowth at the base of the aneurysm is possible and may not be detectable for years after treatment. Furthermore, follow up imaging should be sensitive for these regrowing aneurysms (catheter and CT angiography), rather than MRI which is susceptible to marker artifact at the neck.

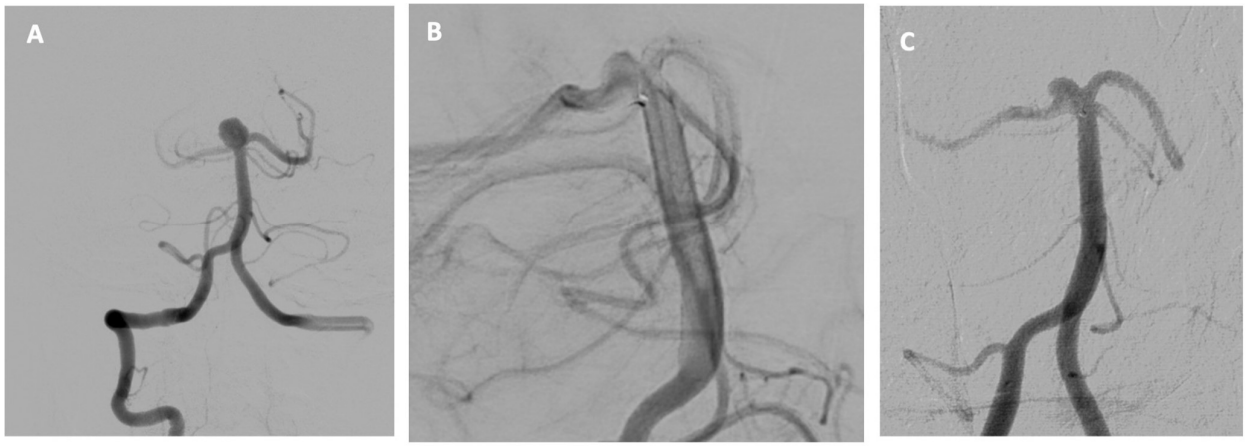

Figure 2: A) Pre-treatment catheter angiography for patient 3, demonstrating basilar tip aneurysm. B) Catheter angiography at 1-year follow up, demonstrating complete occlusion of the aneurysm. C) Catheter angiography at 5-year follow up, demonstrating recurrence at the base of the aneurysm.

There are several other devices currently on the market, for example the LUNA and Artisse, but probably the most widely used and researched is the WEB device. The WEB device is an intrasaccular embolization device that has been increasingly used in treating wide necked aneurysms 4. Several studies have demonstrated an adequate occlusion rate between 73% and 89% 4,5 with need for adjuvant device in 8% of cases and a thromboembolic rate of 14% 13-15. This has been replicated in numerous studies4,15-17. More recently, a prospective study comparing the WEB to the Contour device demonstrated adequate occlusion rates to be similar between the two devices, but the rate of complete occlusion was significantly higher for the Contour, with the WEB showing a significantly higher retreatment rate18. The results that have been published for the Contour device, by us and other groups 11,12,18 demonstrate that it is a good option to consider when deciding on an intrasaccular device.

The CERUS Contour study reported a need for re-treatment in 9% of patient at one year 11, whilst the largest published Contour study reported a 0% re-treatment rate at one year 12. We have demonstrated a worsening occlusion rate of 18% at five years and an 18% retreatment rate at five years, further emphasizing the need to follow patients for a minimum of five years. Similarly, the WEB device has been associated with a retreatment rate of 16.7%, however these studies have also included ruptured aneurysms, making direct a comparison impossible 5,19,20. Furthermore, surgical clipping continues to remain a good option, with lower rebleed and retreatment rates than published endovascular methods 21,22.

One advantage of the Contour device over the available devices is that it is comparatively easy to size. With the CNS device, only the

widest diameter of the aneurysm and neck width are needed for sizing (Figure 3). Evidence in other endovascular devices, such as the WEB device, has demonstrated better occlusion outcomes and reduced rates of compaction when oversizing the device. For that reason, we choose to oversize the Contour device when an aneurysm is suitable for two different sizes. In the case of patient 8, we placed a size 11 Contour device, when a size 14 would have been more appropriate (they were not available at the time). This has resulted in persistent flow and filling of the aneurysm, even five years down the line.

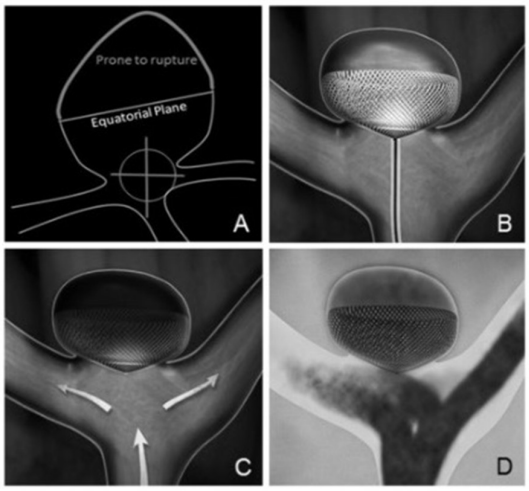

Figure 3: (A) Target zone of Contour Neurovascular System (CNS) device deployment at the intracranial aneurysm neck and within the equatorial plane. (B) Schematic representation of the CNS device with catheter attached. (C) Schematic representation of the CNS device deployed in the aneurysm showing expected flow diversion. (D) Schematic representation of angiographic view of the CNS device. Akhunbay-Fudge CY, et al [1]

Additionally, the Contour device allows the treatment of wide necked aneurysms without the need for adjuvant devices due to its ability to disrupt flow in the aneurysm as well as divert flow at the neck of the aneurysm, resulting in reduced operative time. As it has no major parent vessel component, this removes the need for lifelong antiplatelet therapy, which is a distinct advantage over devices such as the PulseRider and pCONus and, indeed, any stent-assisted coiling technology.

One of the characteristics of the Contour device, is that it has been shown to show progressive occlusion11. We have also seen this in our cohort of patients, with aneurysms demonstrating progressive occlusion over the years. For example, in patient 9 there was continued filling of the aneurysm at six months. On retrospective review, we should have used a 14mm Contour device, rather than the 11mm device that was placed. At one-year angiography, it was seen that the aneurysm had occluded without further treatment and the aneurysm has remained totally occluded at five-year follow up (Figure 4). The Contour device's progressive occlusion results from its' flow diverting properties that are like that of flow diverters23. The advantage that the Contour device has over a flow diverter, is that the Contour device only needs antiplatelet treatment in the periprocedural period and up to 6-8 weeks afterwards, unlike flow diverters which are often accompanied by antiplatelet therapy for years. Additionally, although flow diverters have provided an excellent option for the treatment of unruptured side wall aneurysms, they can be ineffective for a significant percentage of aneurysms (35–50%) which arise from bifurcations 24 with risk of branch occlusion, failure of aneurysm occlusion and a situation that makes further treatment difficult.

Our initial protocol was to put all patients on a 6-week course of aspirin postoperatively. We are also considering if routine premedication with antiplatelet agents may be helpful in the run-up to the procedure and, with the failed cases, in retrospect this may have been helpful as it could have allowed the utilization of other devices in the case of failure of Contour deployment.

In our series we also found no evidence of device compression over time, which can occur with other devices 25. As far as could be determined by intermodality comparison, the device position and shape appear unchanged in all cases. We believe that oversizing the device to the aneurysm is crucial to this as it subsequently prevents displacement and migration of the device into the aneurysm following deployment. In our limited experience we believe the device should not be manipulated once deployed in the aneurysm to adjust position, and if the placement appears suboptimal (for example, that the detachment marker is not in the parent vessel), then it should be resheathed and redeployed in a more satisfactory position.

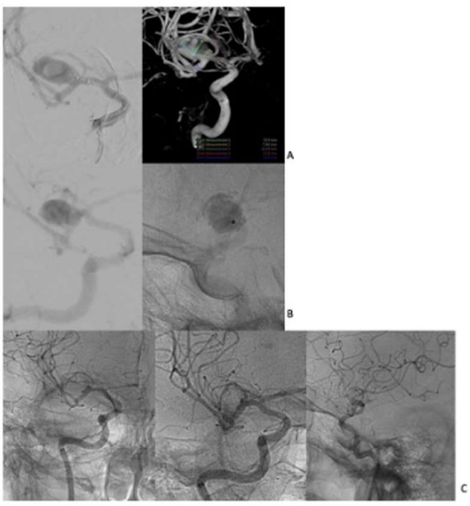

Figure 4: [Patient 9] (A) Endovascular treatment of MCA aneurysm using an 11mm contour device. There is complete filling of the aneurysm at the end of the procedure. (B) 6-month follow up angiography demonstrates continued filling of the aneurysm. (C) 1-year angiography demonstrates complete occlusion of the aneurysm, without further treatment.

LIMITATIONS

There are several limitations to this study. Important to highlight is that these were the first eleven patients we ever treated with the Contour device. A combination of familiarity and new sizing options will inevitably allow more patients to be treated with better outcomes, as seen with prior devices like the WEB. 17. Although we have up to five years follow up, our sample size is small and suffers from loss of patient to follow up. It is reassuring that we demonstrate similar results to larger, multi-centre studies, however we cannot draw conclusions from such a small sample size. Secondly, after two years, most patients were followed up with MRA, as per the standard practice in our centre. We appreciate that the Contour device produces pronounced susceptibility artifacts that not only obscure the aneurysm, but also the parent vessel. This means that a remnant or recurrence may be undetectable and for that reason, most patients at five years follow up had either catheter angiography or a CT angiogram.

Of note, the efficacy of the Contour device in this study was evaluated using the Raymond-Roy classification, as the most widely used and validated scoring system. This allows comparability amongst endovascular techniques; however, the Raymond-Roy scale was initially introduced to assess coiling outcomes. More recently the Bicêtre occlusion scale has been proposed, which provides a more comprehensive assessment of occlusion following intrasaccular device implantation and its use should be encouraged for future studies.

Finally, we have only used the Contour device in unruptured aneurysms and further studies will be essential in establishing the efficacy and safety of using the Contour device in the acute setting.

CONCLUSIONS

In this study, we have demonstrated an adequate occlusion rate of 87.5% at five years. We have demonstrated a retreatment rate of 18% with the Contour device and a 14% thromboembolic rate, which is comparable to other endovascular devices. We have also seen a worsening occlusion rate of 18% following three or more years of complete occlusion, emphasising the importance of long term radiological follow up in patients treated with Contour. Importantly, follow up imaging needs to be sensitive for these re-growing aneurysms and MRI may be suboptimal due to artifact. Since this cohort of patients, we have continued to use the Contour device and hope to publish further data on a larger population both in our centre, and in collaboration with other centres.

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SUPPLEMENTARY FILES:

	Aneurysm dimensions								Raymond-Roy class					
ID	Lesion location	Neck (mm)	Width (mm)	Height (mm)	AR	DNR	Device size	Procedure	Month 6	Year 1	Year 2	Year 3	Year 4	Year 5
1	ICA	2.4	3.5	4.3	1.8	1.5	7	Class 1	Class 1	Class 1	Class 1*	Mortality (medical cause)	n/a	n/a
2	ICA	3.9	8.7	9.1	2.3	2.2	9	Class 3	Class 2	Class 2	Class 1	Class 1*	Class 1*	Class 1*
3	Basilar	3.2	6.7	7.8	2.4	2.1	11	Class 3	Class 1	Class 1	Class 1	Class 1*	Class 1*	Class 2
4	SCA	3.6	5.1	6.7	1.9	1.4	9	Class 3	Class 2	Class 2	Class 2	Class 2*	Class 2*	Class 2*
5	Basilar	2.7	4.2	5.5	2.0	1.6	9	Class 3	Class 1	Class 1*	Class 1	Class 2- RUPTURE	Class 1*	Class 1
6	Basilar	3.5	5.9	6.5	1.9	1.7	11	Class 3	Class 3	n/a	n/a	n/a	n/a	n/a
7	ACOM	3.2	4.3	5.8	1.8	1.3	7	Class 3	Class 1	Class 1	Class 1	Class 1	Class 1*	Class 1
8	MCA	5.4	10.2	12.0	2.2	1.9	11	Class 3	Class 3	Class 3	Class 3	Class 3*	Class 3*	Class 3*
9	MCA	4.4	7.5	13.0	3.0	1.7	11	Class 3	Class 3	Class 1	Class 1†	Class 1	Class 1†	Class 1†
10	MCA	4.8	6.5	7.1	1.5	1.4	11	Class 2	Class 2	n/a	n/a	n/a	n/a	n/a
11	Basilar	4.0	3.8	6.1	1.5	1.0	7	Class 2	Class 2	Class 2	Class 2	Class 2*	Class 2*	Class 2†

* MR angiography.

† CT angiography

ACOM, anterior communicating artery; AR, aspect ratio (height/neck); DNR, dome/neck ratio (width/neck)); ICA, internal carotid artery; MCA, middle cerebral artery; SCA, superior cerebellar artery.

Online Supplementary Data: Radiological results of Contour Neurovascular System series