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Original Paper

Intrasaccular Device Occlusion and Location Scale IDOL - a Novel Grading Scale For Cerebral Aneurysms Treated with Intrasaccular Devices

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Key Words
Aneurysm • Flow diverter • Endovascular Procedures • Intrasaccular devices

Abstract
Background: Intrasaccular devices are an emerging treatment for cerebral aneurysms. However, current grading scales for outcome assessment are difficult to apply as device positioning is not taken into account. We present a novel grading scale to assess how likely a complete occlusion is predictale for cerebral aneurysms treated with intrasaccular devices. ***Materials:*** The scale was developed using results from 143 aneurysms treated at our institution with intrasaccular devices from 2019 to 2023. Angiographic images and clinical complications were taken to illustrate key aspects of the scale. ***Results:*** The scale considers device position relative to the parent artery and the aneurysm wall, contrast filling, neck coverage, and contrast inflow/stability. ***Conclusion:*** This scale helps standardize outcome measurements in accordance with the Modified Raymond–Roy Classification and O`Kelly Marotta grading scales, providing a basis for the common reporting of results.

Introduction

Intrasaccular devices are new and promising tools for treating wide-neck and bifurcation intracranial aneurysms.[1-4] Currently, no aneurysm grading scale is compatible with the intrasaccular devices such as the Contour device (Cerus Endovascular, Fremont, California, USA) and the Artisse (Medtronic, Irvine, California, USA). The Raymond–Roy Occlusion Classification and O'Kelly-Marotta grading scales are difficult to apply to aneurysms treated with intrasaccular devices that differ in position and function.[5, 6]

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Only two grading scales exist to score treatment with intrasaccular devices, both used in the context of the Woven EndoBridge device: the Woven EndoBridge Occlusion Scale and the Bicêtre Occlusion Scale Score.[7, 8] Both scales grade occlusion based on contrast filling and stasis inside the aneurysm sac and indicate the device position to the aneurysm wall;[7-9] however, these scales fail to measure key variables that can indicate the likelihood of successful occlusion and/or the need for re-treatment or medication.[7, 8] To successfully grade treatment with intrasaccular devices, a scale should indicate device stability inside the aneurysm, device position at the aneurysm wall and neck, and the presence of device protrusion into the parent artery. Here, we propose a novel grading scale for aneurysms treated with intrasaccular devices applicable to both bifurcation and sidewall aneurysms.

Methods

The scale was developed using results from our animal experience with WEB, Contour and Artisse (n = 50 aneurysms) and consecutive patients (n = 93), treated with these intrasaccular devices for cerebral aneurysms at our institution from June 2019 to June 2023. In some cases, adjunctive treatments such as stent placement or coiling were necessary, based on the experience of thromboembolic complications, parent artery occlusions due to bulging of the device into the parent artery, or recurrences during followup periods. Angiographic images were obtained and evaluated using digital subtraction angiography (DSA). For follow-up imaging coan beam CT and DSA was used. A retrospective analysis of these data including longterm followup was used to devellop the grading scale.

Angiographic images were obtained and evaluated using DSA. Cone beam CT and DSA were used for follow-up imaging.

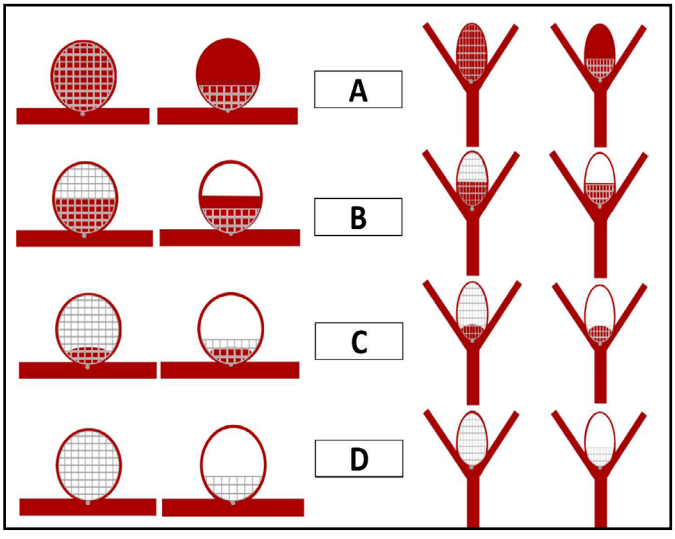
Results

The new grading scale uses one of four letter grades (A-D) to indicate the amount of contrast filling, combined with a number grade (1-4) to indicate device position. Additionally, the score distinguishes between different device positions in relation to the parent artery.

Contrast Filling Grade

Contrast filling of the aneurysm sac is graded using a four-letter scale similar to the O'Kelly-Marotta Scale: A indicates complete filling (>95%); B indicates incomplete filling (5-95%); C indicates the presence of a neck remnant (<5%); and D indicates no filling (0%). *Fig. 1* shows a schematic representation of these four grades in the aneurysm and in the aneurysm in relation to the parent artery.

Fig. 1. Contrast Filling. As with the O'Kelly-Marotta scale, the contrast filling of the aneurysm sac is graded: A, complete (>95%); B, incomplete (5-95%); C, neck remnant (<5%); or D, no filling (0%). The left sided drawings show the devices in sidewall aneurysms and the right sided drawings in bifurcation aneurysms.



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Device position

Device position is indicated using a numerical grade of 1-3, similar to Raymond-Roy Occlusion Classification. Grade 1 indicates perfect neck reconstruction with only the proximal marker protruding into the target artery, while Grade 2 indicates a neck remnant - device with proximal marker is inside the sac. Grade 3 indicates inflow into the aneurysm sac, a dog leg, or that the device position is not stable, indicating an unacceptable device position – the selected device was probably too small or too large. Fig. 2 shows a schematic representation of the device position within sidewall aneurysms for each of the three grades. Fig. 3 shows a schematic representation of the device position within bifurcation aneurysms for each of the three grades.

Table 1 provides an interpretation of all scale grades, possible prognosis, and medication strategy sugesstions for each in accordance to our experience. The grade can indicate whether aneurysm occlusion is likely, and whether antiplatelet treatment might become necessary. Illustrative angiographic examples of patients treated with Contour devices are shown in Figures 4 and 5.

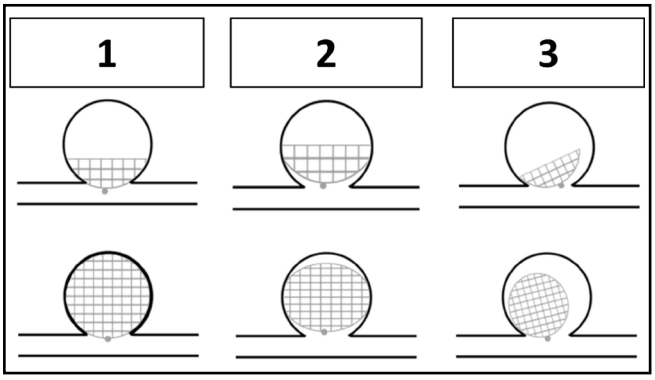

Fig. 2. Device Position in Relation to Parent Artery within Sidewall Aneurysms. Grades (Grade 1-3) indicating neck coverage and device stability in relation to the parent artery. Grade 1, perfect neck reconstruction with only the proximal marker protruding into the target artery – including a slight protrusion of the device into the parent artery; Grade 2, neck remnant; Grade 3, any inflow into the aneurysm sac outside of the device, a dog leg or a protrusion into the parent artery with narrowing of the artery lumen, all indicating that the device position is not stable or can cause thromboembolic complications.

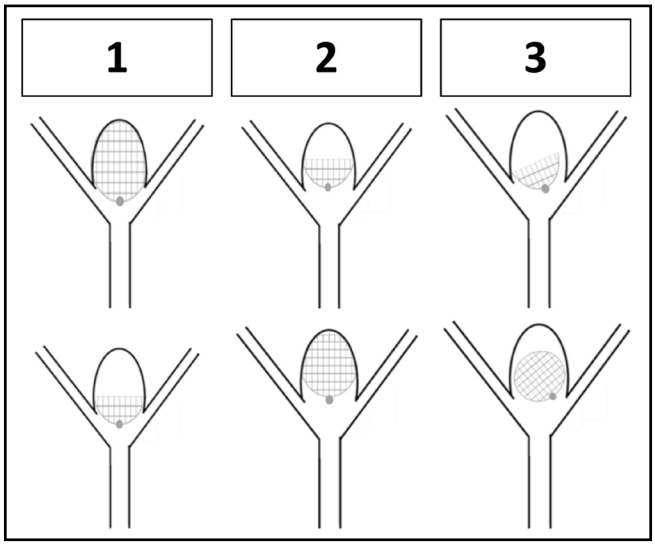

Fig. 3. Device Position in Relation to Parent Artery within Bifurcation Aneurysms. Grades (Grade 1-3) indicating neck coverage and device stability in relation to the parent artery. Grade 1, perfect neck reconstruction with only the proximal marker protruding into the target artery – including a slight protrusion of the device into the parent artery; Grade 2, neck remnant; Grade 3, any inflow into the aneurysm sac outside of the device, a dog leg or a protrusion into the parent artery with narrowing of the artery lumen, all indicating that the device position is not stable or can cause thromboembolic complications.

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Table 1. Grading Scale Interpretation

Aneurysm filling		Device position		Prognosis	Recommended medication after treatment
Grade	Interpretation	Grade	Interpretation		
A	Complete filling	1	Excellent neck coverage	Occlusion highly probable	Depending on neck size, stop antiplatelets after the procedure or single antiplatelet for at least 1one week
B	Incomplete filling				
C	Neck remnant				
D	No filling				
A	Complete filling	2	Neck remnant	Occlusion highly probable; neck remnant may stabilize or progress	Depending on neck size, single antiplatelet for one week
B	Incomplete filling				
C	Neck remnant				
D	No filling				
A	Complete filling	3	Contrast inflow; unacceptable device position or too small, to far in the parent artery; dog leg possible	Highly probable will not occlude or cause thromboembolic complication; aneurysm growing possible; device should be replaced! not very likely possible	Re-treatment is very likely; single antiplatelet until re-treatment
B	Incomplete filling				
C	Neck remnant				
D	No filling				

Fig. 4. 72-year-old male with incidental anterior communicating artery (Acom) aneurysm. A) The untreated Acom aneurysm measuring 5 x 6 mm. B-C) The aneurysm after treatment with Contour 7 mm with significant contrast stasis after detachment. Already, the aneurysm is two thirds smaller, and the image shows correct proximal marker position at the neck. D-E) At 6 months control the aneurysm is completely occluded with unchanged device position. Given the excellent device placement at the neck, occlusion was expected.

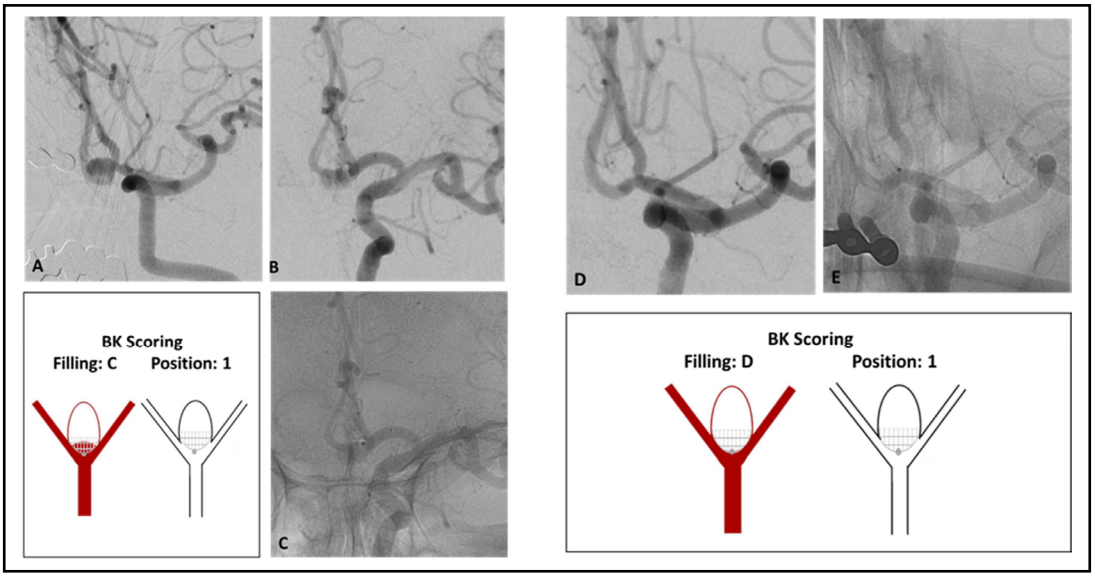

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Table 2. Comparison of Grading Scales for Figure 4

Immediately Post-Treatment		
RROC	II	Neck remnant
MRRC	II	Neck remnant
OKM	C3	Neck remnant
WOS	C	contrast opacification of the neck extending beyond the expected bounds of the marker recess
WOS simplified	1	Neck remnant
BOSS	2	Neck remnant
IDOL	1C	Neck remnant inside the device with excellent device position at aneurysm wall and neck/parent artery area
6-Months Post-Treatment		
RROC	I	Complete obliteration
MRRC	I	Complete obliteration
OKM	D1	Complete obliteration
WOS	A	Complete occlusion
WOS simplified	0	No residual flow inside the aneurysm
BOSS	0	No residual flow inside the aneurysm
IDOL	1D	Complete occlusion with excellent device position at aneurysm wall and neck/parent artery area

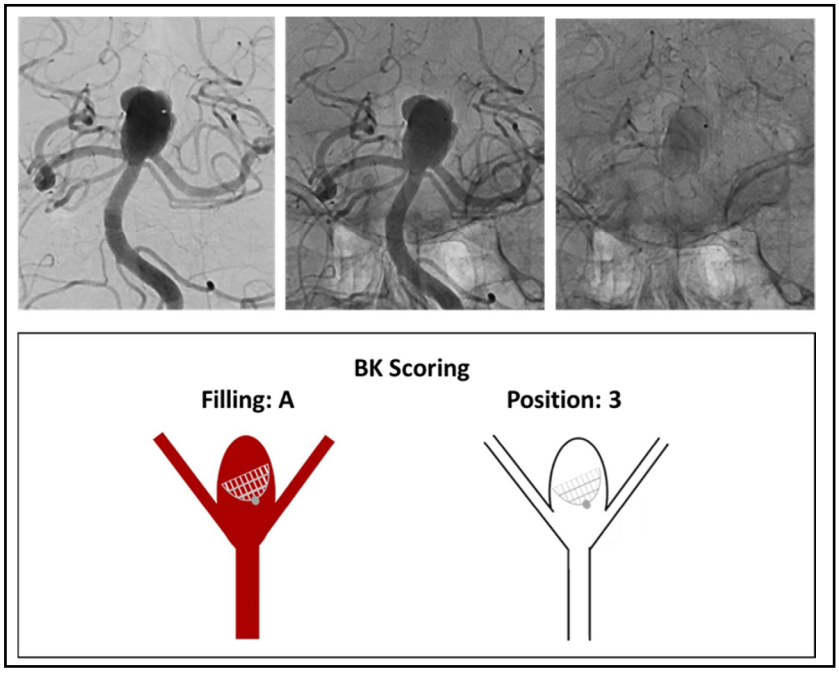

Fig. 5. 67-year-old patient, incidental finding of a basilar tip aneurysm. A) Basilar tip aneurysm measuring 9.0 x 10.0 mm treated with Contour 14. B) At one month control, device turned over resulting in an improper position during contrast filling inside the aneurysm sac. Due to the incorrect device position, the treatment is likely insufficient and may need to be repeated. IDOL Intrasaccular Device Occlusion and Location Scale; BOSS, Bicêtre Occlusion Scale Score; MRRC, modified Raymond–Roy Classification; RROC, Raymond–Roy Occlusion Classification; WOS, WEB Occlusion Scale

Table 3. Comparison of Grading Scales for Figure 5

RROC	III	Residual aneurysm
MRRC	IIIa or IIIb	Residual aneurysm with contrast within coil interstices, or Residual aneurysm with contrast along the aneurysm wall
OKM	A2	Residual aneurysm filling, with not significant contrast stasis
WOS	D	Residual aneurysm filling indicated by contrast opacification extending beyond the aneurysm neck and into the fundus,
WOS simplified	2	Aneurysm remnant
BOSS	1+3 or 3	Contrast agent media depicted inside and around the device, Or Aneurysm remnant
IDOL	3A	Aneurysm filling with incorrect device position, not sufficient covering the neck and dog leg

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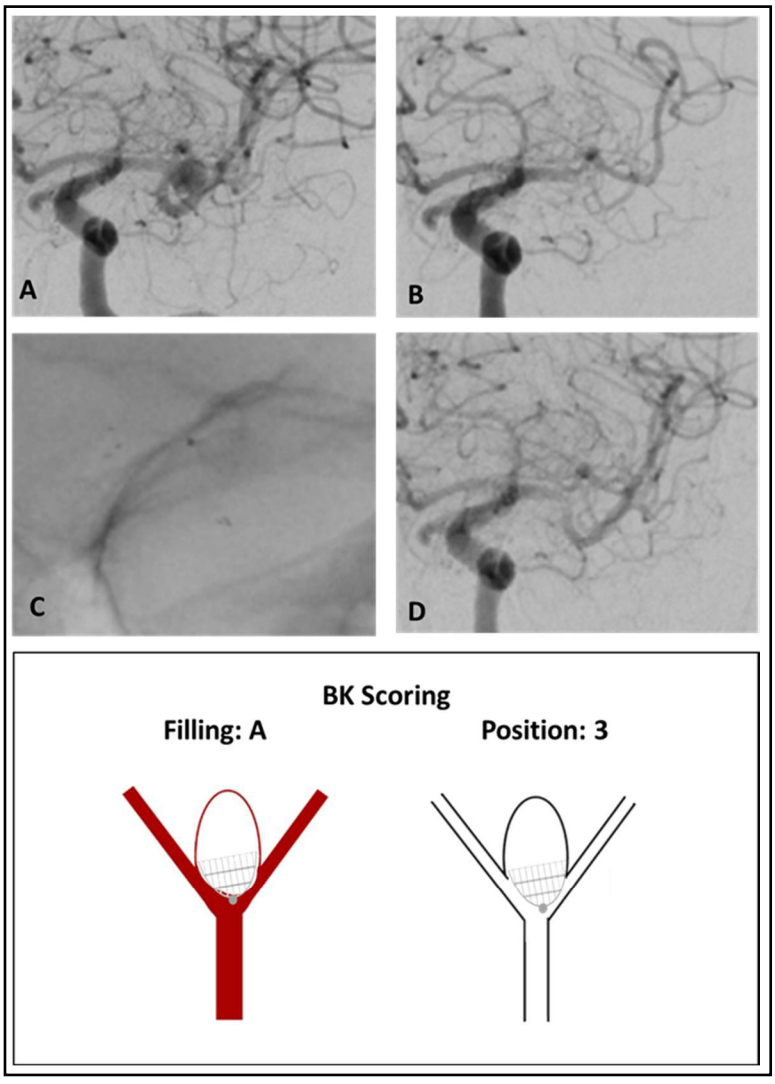

Fig. 6. 68-year-old female with incidental finding of an a middle cerebral arterial (MCA) aneurysm, measuring 6.5 x 6.0 mm (A), treated with Contour 9 mm. After Contour deployment the inferior branch showed, beside immediate aneurysm occlusion, a significant reduced flow (B), because of Contour system comprising the inferior branch, so that additionally a Neuroform Stent (3.5x15) was implanted to keep the branch open (C). After stent implantation the branch was open and the aneurysm remained occluded (D).

Discussion

We present a novel grading scale for sidewall and bifurcation aneurysms treated with intrasaccular devices. The scale is designed to standardize aneurysm occlusion grading and intrasaccular device position in relation to the parent artery, which is critical in determining the need for re-treatment or changes in medication.

Current grading scales for intrasaccular devices do not adequately consider device position.[7-9] If an aneurysm continues to show complete filling of the aneurysm sac after treatment with an intrasaccular device, but otherwise shows excellent device position at the neck, it would receive a score of "1 A" with our scale, indicating that the aneurysm is well-treated with occlusion predicted over the follow-up periods. This same aneurysm would receive a score of III using the Raymond-Roy Occlusion Classification, and either IIIa or IIIb using the modified Raymond–Roy classification;[6, 10] both indicating insufficient embolization. The only Woven EndoBridge Occlusion Scale grade that would be appropriate is D, indicating contrast opacification extending beyond the aneurysm neck.[7] The Bicêtre Occlusion Scale Score (3 or 3+1) would also indicate poor results.[8] Therefore, all current grading scales would suggest disappointing results, while the aneurysm is likely well-treated and will presumably occlude over time.

Treatment using intrasaccular devices is likely to increase, underscoring the need for an appropriate and consistent grading system.

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Conclusion

We present a novel scale that characterizes results after aneurysm treatment that incorporates the position of the device in an attempt to help standardize outcome measurements in accordance with the currently used grading scales.

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Author contributions
MKO: Conception of the work
EMTB: Data collection and drafting of the article
AG: Critical revision of the article
JF: Critical revision of the article
All authors: validated the results independently and approved the final version of the manuscript.

Ethics approval for the animal studies and patient consent for each treatment are available. No ethical approval as a retrospective data analysis.

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Disclosure Statement

No competing interests related to the methods or materials used in this study.

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