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The retreatment: Indications, technique and results

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ABSTRACT

Durability of endovascular treatment of intracranial aneurysms has always been an issue and a very strong point of criticism. Although studies on long-term results have made it clear that endovascular treatment safe and effective they, nonetheless showed retreatment after endovascular treatment is nearly 5–10 times more frequent than surgical clipping. Risk factors predisposing high probability of retreatment are aneurysm with dissecting nature, incomplete coiling, sac size larger than 10 mm and localization at the bifurcations such as basilar tip. The indications for retreatment after endovascular treatment are not clear yet, although certain morphologic criteria can be used. Retreatment appears not to negate the initial advantage of endovascular treatment over surgical treatment and can be performed very small morbi-mortality numbers.

1. Introduction

Since aneurysms are due to plastic deformation of vessel wall and its underlying factors are not only operational at the sac but also around the neck region, recurrences following either endovascular or surgical treatment are not unlikely. Retreatment after surgical management is beyond the scope of this chapter and will not be touched upon. Instead we will focus on recurrences and needs of retreatment after endovascular therapy. There have been and still is a longstanding discussion about durability of endovascular treatment. Nonetheless, thanks to the long-term results of ISAT (International Subarachnoid Aneurysm Trial) study it is now unquestionably evident that endovascular treatment by means of platinum coils is safe and durable [1,2]. Meanwhile, same study and others have also shown rather high recurrences and retreatment rates though these numbers are still acceptable, making this subject one of the main topics to discuss on endovascular treatment [3–8].

Before discussing the retreatment issue after endovascular treatment, one needs to define recanalization and regrowth of completely coiled (occluded) aneurysms and obviously incomplete coiling. Although recanalization and regrowth are used interchangeably and rather confusing way, recanalization means opening of the previously embolized aneurysms. It accepts that the fist treatment achieved total occlusion of the aneurysm sac. In recanalized cases, the aneurysm sac has the same size, but the coils have been moved away from the neck very probably due to compaction. That can happen since in some aneurysms there is a preexisting cloth in the sack. Moreover, even in densely packed aneurysms coils can only occupy up to 30% of the sac volume [9]. The rest is filled by cloth then probably due to hemodynamic stresses, coil mass can be pushed toward the dome and the neck will become exposed to the blood flow once again. Regrowth on the other hand signifies that the aneurysm sac has become larger and the coil mass is no longer sufficient to occlude it. Certain types of aneurysms are more prone to recanalization while some others prone to regrowth. But as pointed out by ISAT trial, only 66% of coiled aneurysms have complete occlusion at the end of the treatment and those incompletely embolized aneurysms are the main concern for retreatment [1,2,10]. It then becomes clear that incomplete coiling appears much more important than others and every effort should be exerted in order to reach complete coil packing [11]. When considered as a whole, risk factors leading to retreatment are aneurysm size [3,7,12], aneurysm localization, neck size [5,7,13,14], incomplete occlusion after the first treatment [1,3–5,7,15,16], and initial clinical presentation [3,5,17–19].

It becomes evident that in nearly 30% of endovascularly managed cases, control imaging studies will show some sort of aneurysm filling, though not all of them will need retreatment [3–8,10,12,17,20]. While upto 10% will undergo retreatment either by endovascular or by surgical means, the rest will be observed [3,7,8,10,12,17,20]. This high incidence of aneurysm residuals contrasts with the low reintervention rate given in the literature. When one scrutinizes the literature on how to deal with those cases

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with residual filling, no standardized management protocols are encountered. Moreover, as pointed out by some studies, there exists a substantial inter observer variability whether to retreat or not, meaning that while in certain centers some patients are accepted for retreatment, and in some others observation is taken as a plausible management strategy [21]. Dorfer et al. [22], in their paper, stated that aneurysm residuals more than 20% of the original lesion, unstable neck remnants, aneurysmal regrowth, or new aneurysmal daughter sacs whenever possible should be treated. Their first line treatment choice was endovascular coiling for coil compaction, while aneurysm regrowths were managed by microsurgical clipping. Although not uniformly accepted, retreatment indication as mentioned above are the criteria most widely used.

2. Anatomical and clinical considerations

2.1. Aneurysm location

After years of experience, it has become evident that certain aneurysm localizations appear clearly related to recurrences and retreatment. Those aneurysms at the bifurcations such as internal carotid artery (ICA) and middle cerebral artery (MCA) bifurcations show high percentage of regrowth (Fig. 1). Basilar artery tip is also another localization for recurrence (Fig. 2). Not only basilar bifurcation aneurysm but also those located between PCA–SCA junctions are found to be more prone to retreatment due to aneurysm regrowth. That is also author's personal experience especially during pre stent era. Aneurysms on the curved vessel such as parophthalmic ICA when treated by simple coiling without balloon remodeling or stent are also emerged as another group of aneurysm likely to recur. Those reopenings can be explained by the fact that in above mentioned localizations, hemodynamic stresses are much more operational at the vicinity of the aneurysms which in turn result in continuous plastic deformation of either sac or neck region.

2.2. Aneurysm and neck size

Many studies confirmed that aneurysm size larger than 10 mm is an independent risk factor for aneurysm reopening [11,16]. Some studies also state that neck size more than 4 mm is another variable related to retreatment [11,18]. That is understandable too, since larger the aneurysm larger the circumference of artery involved and obviously more difficult to reconstruct the parent vessel. That insufficient vessel reconstruction then leads to reopening.

2.3. Aneurysm type

Among the intracranial aneurysms, dissecting ones are the most likely to recur probably related to the nature of artery wall destruction [23]. Especially when located on the anterior surface of supracavernous segment of ICA (Fig. 3) and on the basilar trunk they will practically always reopen after coiling due to regrowth unless special measures are taken such as parent vessel geometry correction or modifying the biomechanical properties of dissected segment by endoluminal permanent devices such as stents or flow diverters. If the recurrences cannot be prevented, in most instances parent artery occlusion appears the only plausible option provided that it is possible.

2.4. Patient initial presentation

Several studies have concluded that patients presenting with subarachnoid hemorrhage (SAH) are more likely to undergo further treatment for their aneurysms [3,4,17,18]. ISAT trial which is the largest study on patients with ruptured intracranial aneurysms has shown that after first endovascular coiling, 17% of patients had further treatment while other although smaller studies on unruptured patients stated nearly 10% of retreatment rates nearly half of those with SAH [3]. Those numbers may reflect higher percentage of incomplete coiling in the setting of SAH very probably due to.

3. Retreatment strategies

3.1. Patient selection

As pointed out by CARAT (Cerebral Aneurysm Rerupture After Treatment) study, the retreatment of endovascular cases (13.3%, 4.5% and 1.1% during first, second, and later years, respectively) are most frequent during the first year after initial treatment and all patients with completely occluded aneurysms should therefore have a year control angiography by noninvasive (MRA) or invasive means (DSA) [4,20]. Those patients with incomplete treatment have to be scheduled for control imaging earlier for example at 3–6 month [24]. Should there be recanalization revealed by control imaging, depending upon morphologic appearance of reopening and patient history, the case needs to be managed by retreatment or scheduled for further control imaging at 6 moths to 1 year intervals. If control imaging proves that the recanalization is not stable and enlarges, retreatment has to be reconsidered. Regrowths on the other hand are best managed by retreatment provided that it is technically feasible since they herald an ongoing continuous deformation of the vessel wall. Handling of incompletely coiled cases is rather more complex. Here we better talk on incomplete coiling and staged coiling. The first highlights that it is impossible to achieve total occlusion, although aimed due to some technical and/or anatomical constraints or a complication, staged treatment on the other hand means that especially during first phase complete occlusion is impossible related to anatomical aspects of target aneurysm generally due to a necessity of adjunctive device such as stents. Some preexisting condition like hydrocephalus or SAH with high Fisher grade may preclude from using them. Therefore, a second session is needed to complete the treatment once the acute phase is faded. This should not be regarded as retreatment.

Considering incompletely coiled cases, very few of them will turn out to be completely occluded during control imaging. In general control imaging shows either stable residual filling or enlargement of aneurysmal remnant. Depending upon the size of residual filling, one may choose to follow the patient provided that morphology of residua does not show any feature such as baby sac or wall irregularities that are accepted as risk factors for rupture. Nonetheless, any filling although stable, larger that one fifth of the original sac, those with above mentioned features or filling at the vicinity of dome where the sac is most likely to rupture should be strongly advised to have a second treatment.

3.2. Treatment modality selection

Once the patient is decided to undergo a retreatment session, depending on patient's and aneurysm's characteristics, either further endovascular treatment or microsurgical clipping can be proposed. Definitive decision should be made not only on the basis of medical facts, patient's preferences should also be taken into consideration. Decision-making appears to be different among institutions. Some publications accept microsurgical clipping as a viable option especially for regrowth [22,25]. Surgery may also be used for combined treatments such as parent vessel occlusion coupled with microsurgical extracranial–intracranial by-pass [25]. Nonetheless, it is the author's personal experience that unless there exists a treatment failure during first coiling attempt or a combined treatment plan, no patient has had retreatment by microsurgical intervention.

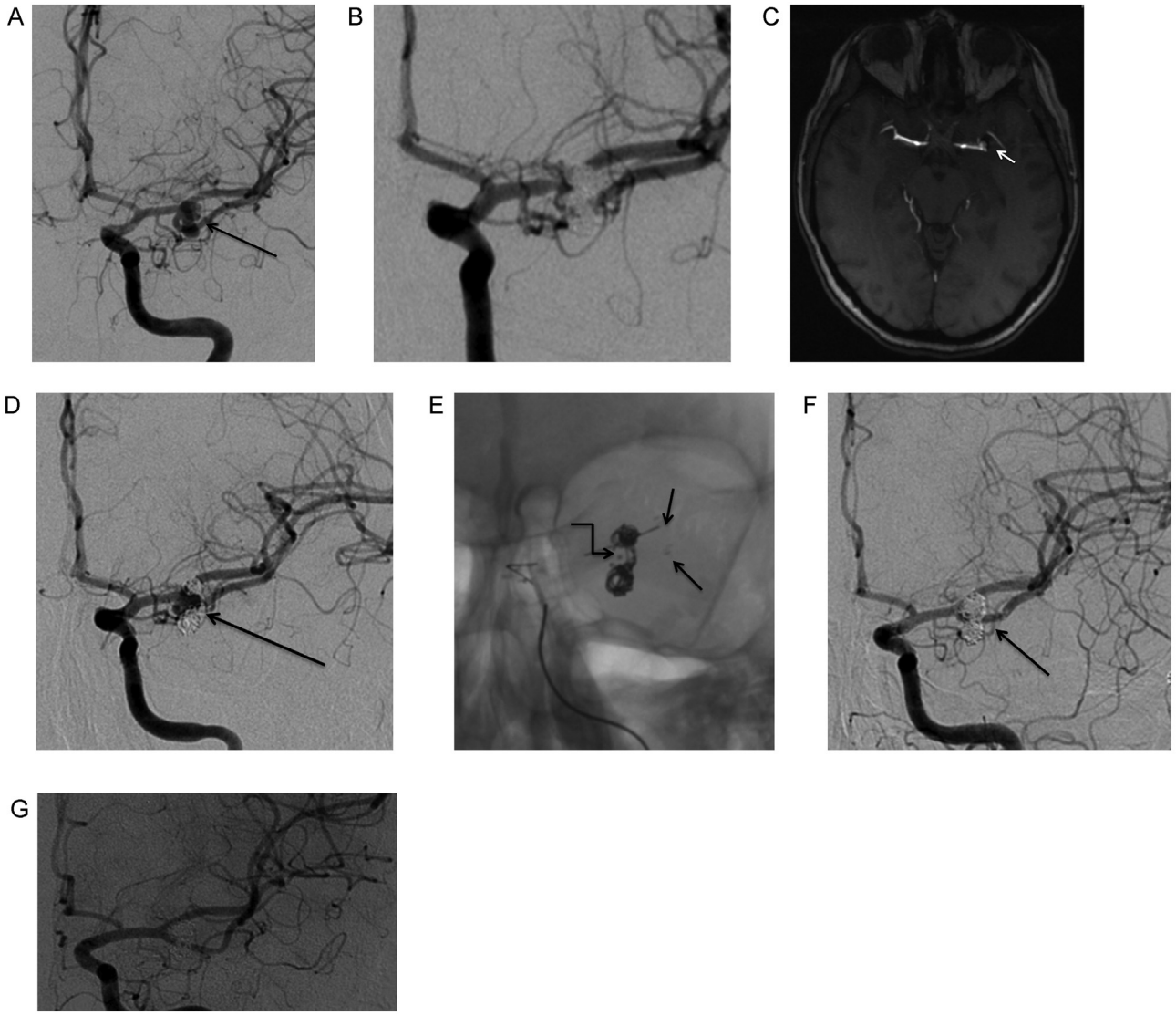

Fig. 1. 38-Year-old female with ruptured bilobed left MCA bifurcation aneurysm. Pretreatment DSA PA (posterior–anterior) projection (a) shows left ICA aneurysm located on M1–M2 bifurcation. MCA bifurcation angle is nearly 180° (arrow). Post embolization left ICA DSA (b) confirms total occlusion. 6-Month control MRA thick MIP image (c) shows a small filling (arrow). Control DSA (d) reveals a regrowth with displacement of previous coil masses (long arrow). Y stenting (short arrows) with microcatheter in the sac (elbow arrow) (e). Total occlusion of regrown sac (f). Please note that MCA bifurcation has now acute angle (arrow). Control DSA (g) 1 year later shows persistent sac occlusion and acute angled MCA bifurcation.

3.3. Endovascular approaches in retreatment procedures

Unless there happens to be a rerupture, all retreatment procedures are performed under elective conditions. It gives the opportunity that whatever pretreatment preparations are needed can be done. In most of the cases, filling part of the previously treated sac has unfavorable dome to neck ratio or parent vessel around the neck is now incorporated with the aneurysms. For those reason, during most of the endovascular interventions, adjunctive devices either remodeling balloons or stents become necessary. Although not a generally accepted rule, aneurysm reopenings due to coil compaction are best managed by balloon assisted coiling, whereas regrowths need stent assisted approaches (Figs. 3 and 4). That is in general due to the need of parent vessel or bifurcation reconstruction in cases with regrowth, while in recanalization parent vessel is stable and the aim is to occlude the remaining filling that can be easily achieved by balloon assisted coiling.

Once the retreatment approach has been decided, the patient should be prepared accordingly. For simple balloon assisted coiling there is no need for loading with anti aggregant drugs such as acetylsalicylic acid and clopidogrel, ticlopidin, or prasugrel. On the other hand, in cases with planned stent assisted coiling or flow treatment such as flow diverters, patients are not only pretreated with above mentioned drugs but also drugs activity should be checked with different aggregometric methods against drug resistance. That will make the planned procedure as safe as possible since most of the complications of stent assisted procedures are related to ischemic events. Preloading with drugs may also be logical for cases with planned balloon assisted coiling in whom there exists an uncertainty about stent usage. The drugs should be discontinued if no stent is applied. Balloon assisted coiling for retreatment has nothing different than primary treatment. Concerning coil selection, residual filling should be taken as a separate aneurysm and coils will be sized accordingly. Complex shaped 3D coils are more suitable than their two-dimensional counterparts and slight oversizing works much better with the help of balloons. In general, under the balloon assistance, total occlusion with dense packing without neck remnant is highly probable and this will result in

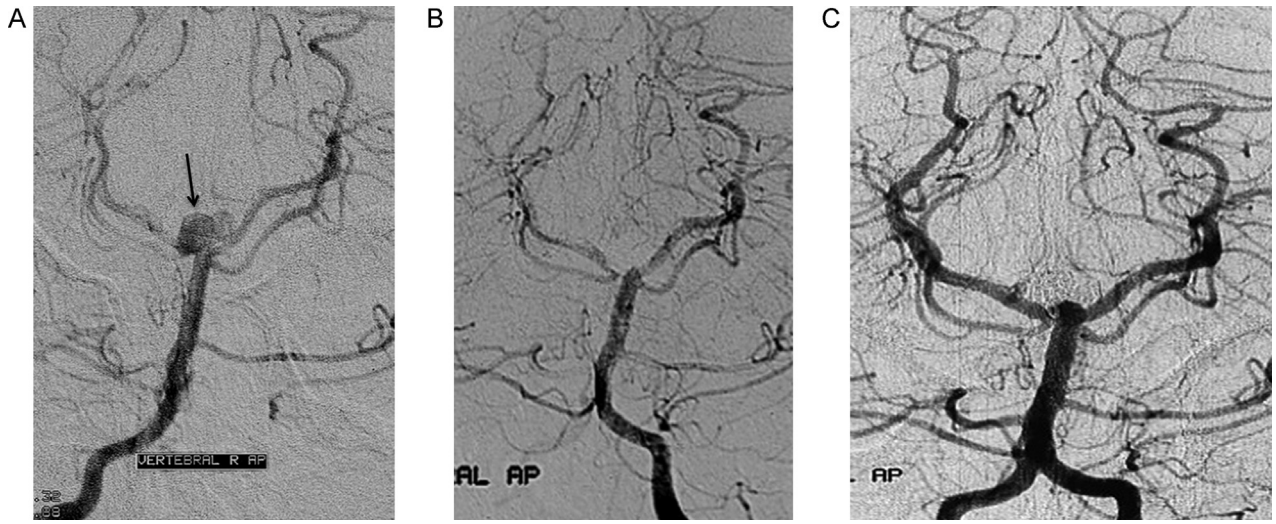

Fig. 2. 35-Year-old female with ruptured basilar tip aneurysm. Large neck aneurysm on basilar artery bifurcation (arrow) shown on right vertebral artery injection with PA projection (a). Post treatment PA projection (b) reveals total occlusion. 5-Year control DSA (c) shows slight opening of the aneurysm neck.

better stability of the occlusion of the aneurysm sac. Those aneurysmal regrowths appear to be better managed with stenting. Sometimes, single stents turn out to be sufficient for side wall aneurysms [26], but generally dual stents work better for the aneurysms located at the bifurcations since they not only preserve daughter branches but also, as pointed out by Cekirge et al. [27], act as a flow diverter and help to have more stable total occlusion. While performing dual "Y" stenting, more angled therefore more difficult branch should be catheterized and stented first then the other one be attempted. It must be remembered that some anatomical

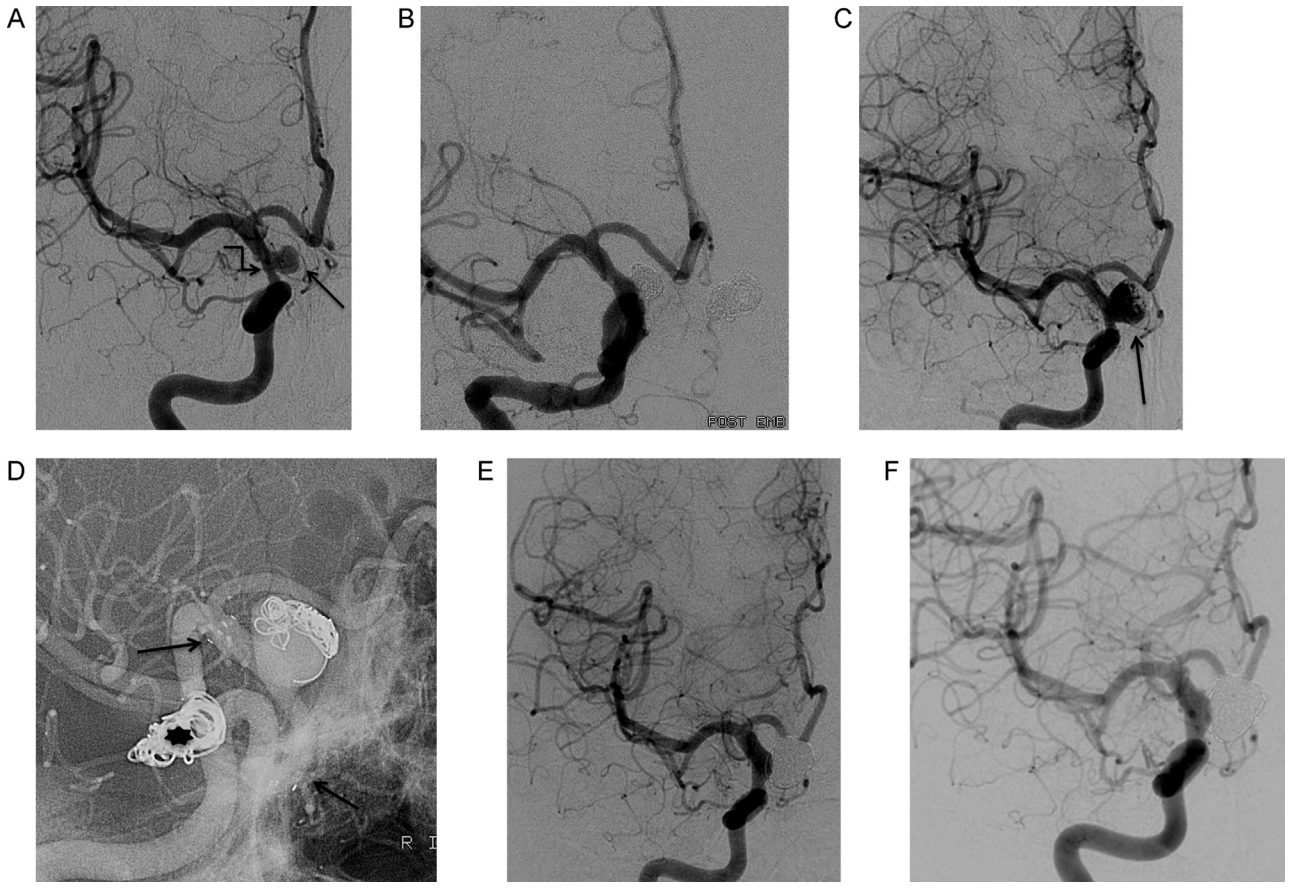

Fig. 3. 32-Year-old female with ruptured right supra cavernous ICA medial face aneurysm probable dissecting in nature. Right ICA PA projection (a) shows the medially oriented aneurysm sac (arrow) with asymmetrically irregular parent vessel (elbow arrow). Total occlusion achieved with balloon remodeling (b). 3-Month control DSA (c) confirms regrowth of the aneurysm (arrow). Right ICA right-anterior-oblique projection (d) shows stent placement (arrows). Please note that the patient has another previously coiled left vertebral artery dissecting aneurysm (star). Post treatment right ICA DSA (e) reveals total occlusion and slight dilatation of parent vessel. Control DSA (f) 2 years later confirms persistent and stable occlusion.

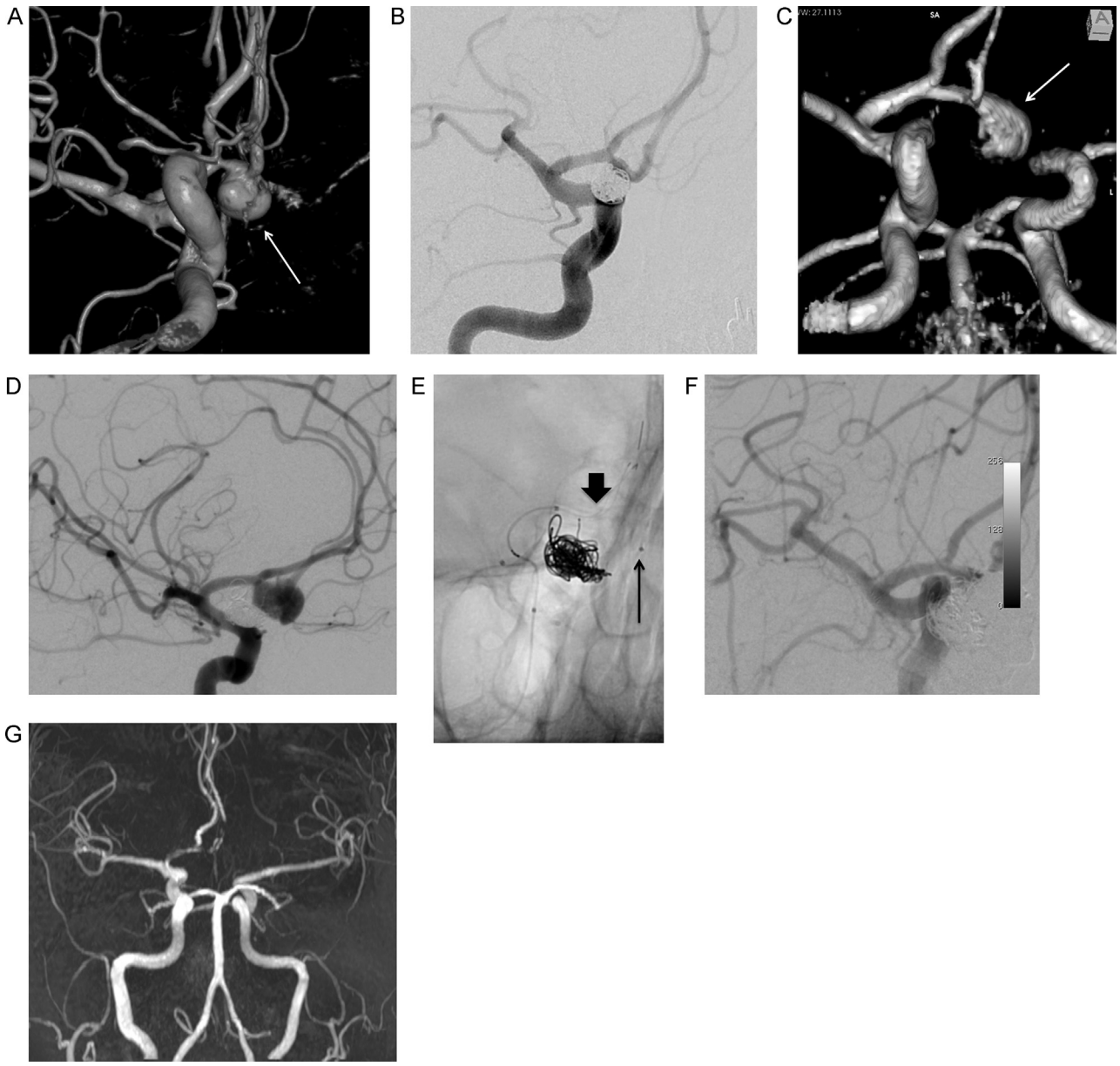

Fig. 4. 72-Year-old female with unruptured ACoA aneurysm presenting with headaches. 3D angiography (a) shows rather large and irregular aneurysm on ACoA (arrow). Right ICA DSA (b) confirms total occlusion of the sac coiled with balloon remodeling. 1-Year control MRA (c) highlights striking regrowth (arrow). Pretreatment DSA (d) during second endovascular treatment. Nonsubstracted image (e) shows totally deployed LVIS Junior stent (thick arrow) and microcatheter (thin arrow) in the sac. Near total occlusion after stent assisted coil embolization (f). 3-Month control MRA (g) after second coiling now shows stable occlusion.

configuration changes can happen and may hamper the access to the second branch. The very same anatomy change will be very helpful by lowering the hemodynamic stresses at the bifurcation level due to smaller bifurcation angles created by stenting (Fig. 1).

When stents are used as sole device for retreatment, either flow diverters or covered stents should be chosen. Since covered stents are more rigid and carry the risk of side branch occlusion especially perforators, their usage is very limited. Flow diverters on the other hand now emerge as a logical solution for reopening of side wall aneurysm such as those located on the supra cavernous segment of ICA [28,29]. It is obvious that in patients presenting with rerupture, flow diverters cannot be applied, unless they are coupled with endosaccular coiling. Liquid embolic agents such as high density polyvinyl alcohol copolymers have been used for retreatment purposes, but they are now totally abandoned due to difficulty of application.

3.4. Safety of retreatment procedures

Several papers in the literature have stated that retreatment of previously either coiled or clipped aneurysms is as safe as first intervention [16,22]. Unless presented with rehemorrage the mortality and morbidity rates are less than 1% and 2%, respectively [30]. Therefore, while deciding whether to retreat or not, those morbimortality numbers should be weighed against the risk of natural history.

4. Conclusion

Although nearly 10 times more frequent than surgical clipping, retreatment after endovascular treatment appears not to offset the advantages gained during first treatment. Several factors can be blamed on the retreatment issue, nonetheless, incomplete coiling

during first treatment appears much more important than the others therefore complete occlusion should be aimed whenever possible. Regrowths on the other hand are in general related to the ongoing plastic deformation and should be managed by acting not only on the sac but on the parent vessel wall as well.

Conflict of interest statement

None.

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