Open surgery as first-line treatment in patients with hemorrhagic type III and IV DAVFs: how much anachronism do we need in modern medicine?

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The management of patients with dural arteriovenous fistulas (DAVFs) plays a significant role in the spectrum of various neurovascular diseases managed in many neurovascular centers.

Much has been written about etiology, classification, and therapy of these interesting lesions. Still, even today, DAVFs are not fully understood after being identified and classified more than 44 years ago. Modern treatment options include conservative management, radio-surgical, surgical, and endovascular techniques (EVT). While in the past some DAVFs were considered “difficult to treat lesions”, in particular the evolutions of endovascular capabilities over the last 15 years have triggered a clear paradigm shift.

High-resolution 2-D DSA, in combination with 3D and 4D techniques, has enormously contributed to our current understanding of the detailed and often complex appearing anatomy of these interesting lesions.

Contrast enhanced ultra-high-resolution cone-beam CTs (e.g. “MicroDynaCT”) provides an unprecedented amount of detailed information and allows for more precise localization of the actual AV shunting zone, especially when located inside the adjacent osseous structures (intraosseous fistulas). Some of these lesions have a rather small, localized area of shunting, (shunting pouch, common collector) often obscured by such an extensive feeding network that they create a confusing imaging appearance at first. This can be especially the case in dural cavernous sinus fistulas. Some “difficult to reach” shunts can be approached using precision needle guidance software.

Modern navigation tools such as hydrophilic and highly malleable (recently even steerable) micro-guide wires as

well as low-profile micro-catheters, including detachable tips and novel micro-balloons, have constantly expanded the endovascular armamentarium compared to those of only 10 years ago.

Adapted from ever increasing management of stroke cases, today's routine use of tri-axial (or 4-axial) catheter systems permits more distal and safe delivery of embolic material, coils or liquids.

Finally, the range of embolic material has widened as well with the recent introduction of various improved and novel DMSO based liquids that permit better control and more distal penetrations which result in safer and more efficient injections with higher occlusion rates than were possible in the past.

All of these developments have made both, transarterial and transvenous embolizations significantly more efficient with an increasing number of lesions being cured in a single session.

Does this mean that today all DAVFs can be completely treated by endovascular techniques? Certainly not (or ...not yet), but the shift from open surgery towards EVT is obvious for some time. Very small fistulas or residual AV shunts along the petrous ridge or tent supplied by minute networks in close proximity to, or overlapping with normal territories, including the 7th CN supply may represent such an exception. Some frontal skull base fistulas can be challenging to reach via the ophthalmic arteries while surgery here is relatively straightforward.

The area of the foramen magnum can be another challenging area. Some cases receive their supply from a minute dural network posing a high risk of liquid reflux into dangerous anastomoses. Here too, surgery represents a valuable alternative.

Sonderberg et al.'s study reports and compares the results of 95 patients with DAVFs treated over 10 years. The authors concluded that EVT should be used as first choice modality for type I and II as well as for type III and IV

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non-hemorrhagic cases. They also suggest that type III and IV hemorrhagic cases should undergo surgery a first-choice approach.

While the former is nothing really new and merely a confirmation of current trends, the latter not only seems a bit surprising but also stands in contrast to what is practiced nowadays in most EVT centers. This particular conclusion is drawn from two results: (1) the EVT occlusion rate of (only) 59% for EVT, and (2) the longer time interval of EVT being performed versus surgery.

Completeness of occlusion of a dangerous venous drainage is crucial but occlusion of the entire fistula may not necessarily be the ultimate goal for a first treatment session in an acutely ruptured DAVF. Eliminating the bleeding source and downgrading the fistula can be more important instead.

Of course, the timing of such acute treatment is crucial and should not be delayed. In most centers, DAVFs are managed today similar to ruptured aneurysms. That means treatment should be performed at the earliest possible time. Endovascular services which provide 24/7 ischemic and hemorrhagic stroke treatment can offer acute endovascular treatment of ruptured DAVFs the exact same way.

If a ruptured DAVF case is admitted in the evening, DSA should be done ASAP, at the latest next morning. This diagnostic step is essential for the subsequent management for at least 3 reasons:

First, it usually allows to identify the source of bleeding. *Second*, it helps to characterize the type of AV shunt (AVM, DAVF, tumor?). *Third*, it identifies a potential target for emergency embolization...e.g. arterial or venous aneurysms or pseudoaneurysms. The elimination of the latter to prevent a rebleeding would be the next step and angiography serves here only as preparation for the actual treatment. To bypass DSA and perform surgery without obtaining such relevant information appears not plausible. Even in cases where the AV shunt is completely masked by a compressing hematoma, indirect signs may suggest the underlying cause, and thus provide valuable information for removal of a hematoma. To skip optional EVT when the patient is already on the angiography table does not make much sense either.

Finally, one practical aspect should be considered as well: higher grade lesions are not necessarily technically more difficult to treat by endovascular techniques. In contrast, longer standing lesions, as most type III and IV lesions are, often have more dilated feeders which are easier to catheterize than those in type I and II lesions. In some of these cases, the fistulous communication can be so “wide” that direct positioning of the microcatheter into the “foot of the vein”,

allowing for the most precise and effective endovascular occlusion, becomes possible.

Thus, the suggestion to use surgery as the first line treatment option in all hemorrhagic type III, IV DAVFs is difficult to follow and not justified, neither based on the authors’ results nor on modern practices in most high volume EVT centers. It rather appears an attempt to reverse current trends in an almost anachronistic manner. Would we then also suggest to treat ruptured cerebral aneurysms primarily by surgery if EVT is not timely available?

I must strongly disagree with the authors. In 2021, all centers that treat hemorrhagic DAVFs should offer multidisciplinary therapy; standard of care for most DAVFs is to first undergo EVT while microsurgery must be offered to the few exceptions in cases detailed above.

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