

Brain AVMs Endovascular Treatment

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What new to say about embolisation of arteriovenous malformations at the beginning of a century already marked by the incredible difficulty of ethical problems generated by the increasingly fast evolution of technologies? In the field of AVM embolisation, the situation seems rather stagnant, even if new possibilities most probably will develop during the next decades.

Currently, embolisation cannot, in any circumstance, be discussed solely. Once the purely technical problems have been analyzed, and completely mastered, the true difficulty is primarily of a strategic nature. Embolisation is a choice among 5 different strategic possibilities that may be used separately or in association: Surgery - Radiosurgery - Embolisation - Therapeutic Associations - Abstention.

1- The strategic decision is primarily a personal decision thus deeply psychological and consequently truly human.

Of course, the parameters which condition the choice among the "possibilities" should first be known and described, if possible using standardized criteria:

Radio anatomy i.e. the angioarchitecture conditions the use of available technique(s)

- Concerning afferent pedicles, it is obviously not the number which imports but their acces-

sibility and the possibility of carrying out the embolisation within the very center of the nidus.

The nidus is not always easy to identify, especially when the shortcut arteriovenous circuit is extremely rapid. It is defined by its size, its topography, its homogeneity, its character "foreign body or infiltrating" and its shape which is so difficult to apprehend and describe...

The venous drainage is considered differently by the neurosurgical than by the neuroradiologic eye. The neurosurgeon worries when the venous drainage is deep whereas the neuroradiologist when the venous drainage is single.

The presence of aneurysms associated or secondary to high flow, as well as the existence of arteriovenous fistulas must be analyzed and described because they play a significant role in the setting of the indication and the choice of therapeutic strategy. These anomalies are regarded as "weak points" of the arteriovenous malformation, that may increase the theoretical haemorrhagic risk.

General haemodynamic is essential:

Since many years we have personally proposed and used an extremely simple classification scheme that allows us to compare and appreciate the evolution of flow-steal:

- *Grade 0*: No flow-steal - homogeneous and practically simultaneous opacification of the

arteriovenous malformation and the normal vascular structures.

- *Grade 1*: Only one vascular territory depending normally from the injected artery is not opacified (For example internal carotid artery injection without injection of the territory of the homolateral anterior cerebral artery). Only the main territories are taken into account: Anterior cerebral artery, middle and posterior

- *Grade 2*: Only the arteriovenous malformation is opacified and no other normal vascular territory.

This classification can be used only if the various injections are carried out in standard conditions of iodized contrast quantity and flow.

Flow-steal reduction should be progressive because this conditions the way vascular territories feeding the AVM will be taken in charge by normal vascular structures. The extraordinary cerebral "vascular plasticity" illustrates perfectly this evolution when one follows processes of progressive reduction of the angiomatous nidus spread over several years.

Clinical symptomatology with 4 well known main elements (headache - epilepsy - progressive neurological deficit and bleeding), is also significant. In our personal daily practice, this symptomatology is more taken into account for its more or less invalidating character than for its statistical aspects

The statistical data concerning "the natural history of disease", the therapeutic risks and the "chances of success" (care should be taken not to assimilate those of the best teams in the world...) should be used with nuances and precautions. In the population that we have followed for 25 years (721 patients), the annual haemorrhagic risk, before the beginning of any treatment, is 8 % per year, which is definitely higher than 3 % usually quoted in the main publications. This is completely understandable if one takes into account the differences in recruitment methods used for the populations followed by the various teams.

Cure criteria: When the patient receives information on the chances of success concerning the suggested treatment, it is important to specify the adopted "criteria of cure": Is it a complete cure not only radio-anatomical but also clinical? Radio-anatomical cure implies the dis-

appearance of any arteriovenous shunt but can one tolerate the persistence of atypic vascular conditions? Total clinical cure implies the absence of any neurological side-effect including the absence of headaches and epilepsy, the absence of any cognitive side-effect as well as the possibility of carrying out a normal life including professional life, sports activities, and pregnancy.

General parameters and the "personality" of the patient are finally for us the essential elements. Age, possible associated tares, profession, lifestyle and rythm of life are to be taken into account as much as anxiety generated by the decision to treat or not to treat.

Once the *decision* is taken, it is essential to propose to the patient a "referring physician", able to follow him until the cure of its arteriovenous malformation is completed. Of course, this referring physician will differ according to the choosen therapeutic strategy and the respective training of the various intervening physicians. When embolisation is selected as the first option, it is desirable that the neuroradiologist who will carry out the embolisations will also be the referring physician since he is the one that will follow the patient for many years.

2 Technical questions concerning embolisation: What does *endovascular treatment* exactly means?

The evolution of embolisation materials during the last three decades, shows that the brain has been regarded as a "dustbin" where all the materials available were successively injected beads of steel, glass, polystyrene, particles of all kinds, silk wire, microcoils, polymerizing and precipitating substances... In fact, the difference between all these materials concerns the level one wishes to reach the target. To be effective, the embolisation must be intra-nidal, fact that clearly separates biological adhesives (histoacryl - glubran - onyx...) from all the other materials which generally block afferent pedicles without reaching the nidus; the nidus then is of course taken in charge secondarily by collateral circulation.

Analysis of the angioarchitecture by selective angiography makes it possible to predict the embolisation result?

To this question, experience shows without doubt that the answer is negative. Of course, when the catheter is "driven" in the heart of the nidus, in a situation of blocked catheterization, and the concentrations of the polymerizing mixture are well selected, the chances to carry out an effective embolisation are very important. However, everyone knows that in some cases, even when all the favorable conditions appear to concur, the embolisation may be immediately followed by a backward flow which will make it very quickly ineffective. Among the completely unknown parameters that we currently do not control, there is the intranidal pressure, probably mainly related to the level of the blood pressure. Experience shows, indeed, that an embolisation carried out under the cover of a pharmacodynamic arterial hypotension is, very often, of better quality than when the pressure level remains generally high.

Why is it preferable to *embolise by successive stages*, rather than in "only one session"?

This question may generate a lot of controversies. One should recall that the "Break-through Phenomena" observed by many neurosurgical surgeons at the end of arteriovenous malformations resections, was an indisputable reality. The gained experience, unfortunately impossible to randomize, shows that the haemorrhagic complications are much more frequent when the embolisation is "too significant" compared to the volume of the initial nidus. The same happens when very brutal haemodynamic modifications are created by embolisation of one or more arteriovenous shunts with a very high flow. Let us not forget that the only goal of the first cerebral AVM embolisations that were carried out, was precisely the progressive reduction of the volume of malformation and the flow-steal, a new possibility compared to the "brutality" of neurosurgical resection in one time.

When is it necessary to stop during a session of embolisation and on which criteria?

There again, nothing is "black or white", nor quantifiable. Some rules can be enacted: it is preferable to stop when one is unable to find a

situation favorable to do an embolisation of good quality. One should know that he should stop when the haemodynamic modifications pulled by the embolisation are very significant. One should know that he should stop when he observes venous stagnation prolonged on venous phase during post-embolisation control angiography.

When the embolisation has reached its *technical or functional limits*, which technique to use to supplement the eradication?

The answer to this question depends on the topographic situation of the angiomatous remnant, on the functional risks of the therapeutic procedure considered but also, on the choice of the patient. Currently, many patients fear instinctively "craniotomy" and prefer immediately radiosurgery.

Is abstention reasonable?

In our personal statistics, over the last 25 years, abstention was decided in 40 cases out of 721 patients, which represents 5.54 % of the cases. It is interesting to consider this decision because over the years, most of the patients remained alive and very few worsened.

General Conclusions

After twenty five years of efforts, groupings and research, it appears that the embolisation now has become a major therapeutic option for arteriovenous malformations. Technical progress made enables to cure, solely by embolisation, between 33 and 40 % of patients, according to the experience of different therapeutic teams and by taking into account that a significant percentage of "partially embolised" patients will be able to see their radio-anatomical cure supplemented by the radiosurgery or by the surgery. However, let us keep in mind that the essence is not the lesion itself but the life quality that the suggested therapeutic strategy should allow these patients to obtain. Thanks to that, patients harboring an intracerebral arteriovenous malformation will not be regarded as handicapped people any more but as human beings, able to carry out a normal life, or at least a life as normal as possible.