Embolization of Cerebral AVMs with Polylene Threads: Technical Procedure, Results and Complications

A. Benati, S. Perini, A. Pasqualin 1, M.G. Pecoraro, A. Maschio, L. Rosta, E. Piovan, and P. Zampieri

Department of Neuroradiology and 1Neurosurgery, City Hospital, Verona

Summary

In order to determine possible risk factors and to assess the value of polylene threads as particulate embolic agents for the treatment of brain AVMs, we reviewed our experience with this procedure. At present we utilize 1.5–2 mm long micro-emboli to occlude AVM nidus; they are inserted into a 22 gauge catheter needle (5 fragments for each needle) and then injected into the feeding vessel through a coaxial micro-catheter system. When AVM flow-rate is reduced, 2–3 cm long threads are injected through the same micro-catheter to complete the closure of the feeder. This double embolization, both of the nidus and of the afferent vessel is important in order to avoid bleeding inside the AVM, as a consequence of the stump pressure effect on the thin walled venules of the remaining portion of the nidus after embolization.

Embolization was performed in 108 patients: 71 of them (65%) underwent surgery; 14 (13%) radiosurgery; no other therapy was performed in 23 cases (21%). In all cases occlusion of the malformation and hemodynamic changes were carefully evaluated. A complete closure of the AVM was obtained in 3 cases only (2.5%); in the remaining 105 patients (97.5%), only an incomplete occlusion was observed, ranging from 5% to 70%, with average reduction of 37%.

Complications: hemorrhage was observed in 5 cases; it was less frequent (4.5%) but more severe than ischemia. It caused a transient neurological deficit in 2 cases, a permanent disability in 1 case and death in 2 patients. Ischemia was observed in 16 cases (15%) and caused a transient neurological deficit in 9 patients and permanent disability in 7 cases. A transient neurological deficit occurred in 11 patients. A permanent neurological deficit was observed in 8 patients (7.5%).

The overall complication rate was 19.5% (21/108); “stroke” rate (permanent deficit + death) 9% (10/108).

Clinical and angiographic results were evaluated in a follow-up period ranging from 1 to 4 years in 13 patients who didn’t undergo surgical or radiosurgical therapy. Permanent occlusion of A-V malformation was never observed. In 6/13 cases a persistent reduction of AVM nidus was observed; in 11/13 cases occlusion of the feeders was stable. Re-bleeding occurred in a patient who had bled before embolization and in a patient who had never bled. No death occurred in this group of patients. No significant evaluation could be made on clinical follow-up, but severe headache markedly improved in 4/6 cases. Decrease in frequency of epileptic seizures was observed in 2/13 cases.

Keywords: Arteriovenous malformation; embolization; endovascular therapy, hemorrhage.

Introduction

Endovascular treatment of cerebral AVMs has been performed in our Department since 1983, using different procedures of embolization. Our previous experience with balloon catheter systems and glue injection was not satisfactory, because of the risk of arterial rupture due to balloon inflation and difficult assessment of the proper polymerization time of cyanoacrylates (with consequent possible occlusion of the feeding arteries or drainage veins). Moreover occurrence of vasospasm due to catheter withdrawal was frequent. Pathologic findings in resected specimens often showed signs of angionecrosis related to the well-known hysto-toxicity of cyano-acrylates.

More satisfactory results were obtained using a particulate embolization technique based on selective injection of suture threads (polylene 3–0) into the feeders of the AVM. This technique was frequently modified and refined during the last years according to the evaluation of angiographic, clinical and surgical results of the embolization and the incidence of complications.

In the first stage of our experience 2–3 cm long fragments of suture thread were injected directly into the feeding vessels of the malformation; afterwards, to avoid re-habitation of the A-V shunt by the neighbouring vessels, 2 mm long micro-emboli were injected more distally to occlude AVM nidus. At present, we occlude both the nidus and the afferent arteries (double embolization), possibly in each compartment of the malformation, in order to avoid any possible hemorrhagic complication during the treatment, and make recurrences less frequent.

The results of the embolization as pre-operative procedure in the surgically removable AVMs and its value as the sole therapeutic treatment of inaccessible...
AVMs were previously reported\textsuperscript{3,11}. Our recent experience of combined treatment of 75 AVMs is discussed elsewhere in this book.

The aim of the present report is to describe the technical procedure performed nowadays, to establish the value of this embolic agent, to assess the angiographic and clinical results and to determine any possible risk factors and the incidence of complications.

### Technical Procedure

Our technique consists of a super-selective catheterization of the AVM feeders by means of a coaxial micro-catheter system. At present flow independent micro-catheters are preferred (Target therapeutics Tracker 18 Balt S Mag 3F/2F), but also flow directed micro-catheter (Ingenor Siltane 1.8F with enlarged tip) are successfully employed mainly for the catheterization of middle and posterior cerebral arteries that allow a good intravascular navigation.

Polyfilament polyethylene 3–0 (0.2 mm in diameter) is a suture thread commonly utilized in surgical rooms (Hammer-Ethicon). It can be cut in fragments of various length (from 1.5 mm to 2–3 cm or longer) according to the type of AVM and to the different stages of the embolization procedure (Fig. 1).

At present the procedure is performed as follows:

\begin{enumerate}
\item \textit{AVM Nidus Occlusion}

We utilize 1.5–2 mm long micro-emboli that are inserted into a 22 gauge catheter-needle (Fig. 1. b, c). Five fragments are loaded inside each needle and then injected into the feeding vessel, through the coaxial micro-catheter system. Emboli are then discharged into the artery by 1.5–2 ml of saline. The polyethylene fragments break out into smaller micro-fibrils (Fig. 1a) which reach the nidus of the AVMs (Fig. 2b). A progressive embolization is achieved under continuous angiographic control and neurologic observation in the alert patient. Nidus occlusion is well demonstrated by angiography and MRI (Fig. 2a. Fig. 3).

The higher flow shunts are first occluded, followed by the slower-flow ones. When shunt flow is markedly reduced few threads deposit on the walls of the arterial pedicles, close to AVM nidus.

\item \textit{Feeder Occlusion}

When AVM nidus is occluded, 2–3 cm long threads are injected through the same micro-catheter to complete-

\end{enumerate}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{fig1.png}
\caption{(a) Polyethylene 3–0 suture threads are cut at various lengths as embolic agents. The fragments are 1.5 mm to 2–5 cm long. (b) Micro-emboli are inserted into a 22 G catheter-needle. (c) Every catheter needle is loaded with 5 micro-emboli. After injection the small polyethylene fragments break out into smaller micro-fibrils which can reach the AVM nidus (arrow)}
\end{figure}