Cyanoacrylate encasement of intracranial aneurysms

Technical note

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Some intracranial aneurysms, because of their broad base or incorporation of essential nutritive vessels, must be treated by adhesive reinforcement. The authors report successful results with cyanoacrylate adhesives in five patients. The unique quality of this material permits maximum adhesion in a moist operative field. This adhesive is nonviscous and will coat the entire aneurysm, obviating problems related to incomplete coating. Excellent long-term results are apparently due to the biological effect of this adhesive in which a proliferative fibrous reaction occurs and counteracts recognized erosive properties.

KEY WORDS □9 cyanoacrylate adhesive □9 aneurysm encasement

ACCESSIBLE intracranial aneurysms that have a narrow base are amenable to clipping, and at the present time there seems to be little doubt that this is the surgical therapy of choice. For inaccessible aneurysms other methods, mostly experimental, have been used and reported with enthusiasm. Unfortunately, these techniques necessitate equipment and technical skills not available to most neurological surgeons. In the group of intracranial aneurysms that are accessible but impossible to clip because of a broad base or incorporation of cerebral nutritive vessels, adhesive investment has been used. In such patients, we have used several available adhesives and have found that the cyanoacrylate adhesives are particularly effective. Contrary to a previously published case report, our results have been excellent, and we have found that this substance has unique qualities that make it well-suited for the treatment of otherwise inoperable intracranial aneurysms. This report presents our technique of application and long-term results in five patients.

Technique

Under magnification, the aneurysm is exposed and, if necessary for vascular control, the Ferguson technique of safety ligatures on feeding and outgoing vessels is used. After exposure of the entire aneurysm and a decision that the aneurysmal neck will not be amenable to a clip, the safety ligatures in the immediate area of the aneurysm are removed and a double thickness of Surgicel* is applied both to the bed of the aneurysm and to the neck and fundus, thus forming a

* Surgicel = oxidized regenerated cellulose. Manufactured by Johnson & Johnson, New Brunswick, New Jersey.
matrix for holding the cyanoacrylate. The cyanoacrylate adhesive is dropped onto the Surgicel-covered aneurysm, one drop at a time over a period of 5 to 10 min. To form a visible thin film of the opaque adhesive material, 10 to 20 drops are required.

The cyanoacrylate adhesive will adhere to foreign bodies and any substance within the surgical cavity with which it makes contact. Therefore it is mandatory that cottonoid material and all instruments are removed from the immediate area lest they adhere to the adhesive and the aneurysm, causing irreparable damage upon removal.

Case Reports

Case 1

This 35-year-old man had been hospitalized on several occasions at various psychiatric facilities since the age of 15, with a diagnosis of mild mental deficiency with psychotic reactions. On August 27, 1966, the patient had a grand mal seizure and became unresponsive.

Examination. There was spasticity of both legs, a right hemiparesis, and neck stiffness. Lumbar puncture revealed grossly bloody fluid. Because of the patient's semicomatose state, he was treated conservatively for 4 weeks until he gradually became alert and oriented. Cerebral arteriography then demonstrated a saccular left middle cerebral trifurcation aneurysm (Fig. 1).

Operation. At craniotomy, the aneurysm was exposed and found to incorporate several feeding vessels in its very broad and fibrous base (Fig. 2 left). The aneurysm was treated by investment with Surgicel and Mecrylate* (Fig. 2 right).

Postoperative Course. The patient made an uneventful recovery. Postoperative angiography 3 months later showed no vascular compromise (Fig. 3). He was followed in both the neurosurgery outpatient service and the psychiatric service until April 29, 1968, when he was last reported to be well and working, requiring no further inpatient psychiatric treatment. Throughout the follow-up, the patient exhibited no sequelae as a result of either the intracranial surgery or adhesive encasement of the aneurysm.

Case 2

This 48-year-old man was well until April, 1965, when he had a syncopal episode, and thereafter was confused and disoriented with a marked left hemiparesis.

Examination. Lumbar puncture revealed bloody fluid. A cerebral arteriogram showed a large saccular aneurysm at the trifurcation of the right middle cerebral artery.

Operation. On April 15, 1965, a right temporal craniotomy was performed. For reasons outlined earlier, adhesive investment with Mecrylate was done.

Postoperative Course. The patient was discharged on May 8, with a slight hemiparesis. He did well thereafter, and when last seen in September, 1969, he was normal, working regularly, and without symptoms.

Case 3

This 45-year-old man developed a severe frontal headache, stiff neck, and left hemiparesis 7 days before admission.

Examination. The patient was alert and oriented, and lumbar puncture showed xanthochromic fluid. An arteriogram on March 17, 1965, showed the presence of a middle cerebral trifurcation aneurysm.

Operation. A right temporal craniotomy on March 19, 1965, exposed a saccular middle cerebral trifurcation aneurysm. The aneurysm was coated with Mecrylate.

Postoperative Course. The patient was discharged with a severe hemiparesis, which had not changed from the preoperative state. On January 12, 1966, he was quite well but hemiparetic. There was no evidence of either recurrent subarachnoid hemorrhage or arterial thrombosis. Subsequently, he moved to another state.

Case 4

This 37-year-old man was well until 5 weeks before admission when he had a sudden occipital headache and lost consciousness for a short time. He continued to work for the next 3 weeks with a persistent moderate headache. Two weeks before admission he again had a sudden severe headache, and noted a drooping of the right eyelid.

Examination. The patient was alert, and had a stiff neck and a complete right third nerve palsy. Lumbar puncture released xanthochromic spinal fluid containing numerous red blood cells. Angiography revealed an aneurysm of the basilar artery in its midportion.
**Operation.** Through a subtemporal approach on June 27, 1969, the aneurysm was exposed and invested with Bucrylate* adhesive.

**Postoperative Course.** Recovery was uneventful, and the patient was discharged on July 9, 1969, with a complete third nerve palsy. He was readmitted on September 12, 1969, complaining of headache of gradual onset. On examination he had a third nerve palsy and papilledema. A repeat angiogram now showed hydrocephalus. On July 26, 1969, a ventriculojugular shunt was performed. The patient did very well thereafter. By April 1, 1970, he was working without symptoms except for diplopia, and third nerve function was recovering.

**Case 5**

This 57-year-old woman was well until 3 weeks before admission when she experienced the sudden onset of severe left temporal headache which subsided over the following week but was followed by mild confusion and dysphasia.

**Examination.** A lumbar puncture showed xanthochromic fluid. Arteriography revealed a left middle cerebral trifurcation aneurysm.

**Operation.** On July 7, 1969, a left temporal craniotomy was performed and the aneurysm was coated with Bucrylate adhesive.

**Postoperative Course.** The patient made an uneventful recovery. On April 1, 1970, she was normal, without residua.

**Discussion**

We have used several of the available adhesive materials for surgical treatment of intracranial aneurysms but generally prefer the cyanoacrylates. The bed of the aneurysm as well as the aneurysm itself may be moist, and this adhesive will adhere better in a moist field as opposed to a dry field required of other adhesive substances. Cyanoacrylate is markedly nonviscous and will coat the entire aneurysm; if applied to the fundus it will flow evenly around the walls and base, so that there are no problems relating to incomplete coating.

In experimental studies it had been noted that one biological effect of this tissue adhesive is a proliferative fibrous tissue reaction. Erosion of vascular walls has been noted but has not been a problem in our clinical cases. This is probably due to fibrous tissue proliferation which counteracts any erosive effect. The manufacturers consider Bucrylate superior to Mecrylate because it causes less irritation.

Carton, *et al.*, and Messer, *et al.*, reported the use of methyl 2-cyanoacrylate monomer in the management of intracranial aneurysms and leaking cerebral vessels. In their reports, however, the patient either had a clip applied to the aneurysm and the adhesive applied as an adjunct, or some complication of aneurysmal surgery occurred and the material was used to repair a lacerated vessel. In our series no clips were applied nor was there any operative complication necessitating adhesive.

Araki, *et al.*, coated and reinforced intracranial aneurysms with cyanoacrylate adhesive in combination with other components. HANDA, SUGAR, and Tsuchiya, reported the use of EDH adhesive in the coating of aneurysms of the middle cerebral artery and other vessels. This material contains approximately one-third methyl 2-cyanoacrylate. Sachs, *et al.*, reported a fatality from a ruptured intracranial aneurysm after coating with methyl 2-cyanoacrylate adhesive. In their patient, two drops of the adhesive were applied but in our experience this is not adequate. The patient had a stormy course and died on the third postoperative day. Although experimental evidence indicates that the erosive effects of the material should not occur so early, this material was strongly implicated as a causative factor in this fatality.

**Summary**

Five patients have been treated by cyanoacrylate encasement of otherwise inoperable intracranial aneurysms, with excellent results. The technique utilized by the authors is described in detail.

**Addendum**

Since submission of this manuscript for publication, three additional patients with otherwise inoperable middle cerebral aneurysms had the lesion invested with isobutyl-2 cyanoacrylate monomer. Two of the patients are asymptomatic, at 6 and 9 months postoperatively. The

* Bucrylate = isobutyl 2-cyanoacrylate monomer. Manufactured by Ethicon Incorporated, Somerville, New Jersey.
Cyanoacrylate encasement of intracranial aneurysms

third patient, who had a giant left middle cerebral aneurysm that could not be completely coated, had a cerebral hemorrhage on the ninth postoperative day. At postmortem examination there was considerable fresh subarachnoid blood at the base of the brain but no evidence of aneurysmal rupture. She had had four-vessel angiography, and no other aneurysm had been visualized. It is presumed that a small leak occurred in an uncoated portion of that giant aneurysm. Case 5 in the present report was completely well until July 11, 1970 (1 year postoperatively) when she had a massive subarachnoid hemorrhage which resulted in her death. Autopsy revealed that "the aneurysm had been well coated, but the blowout had occurred at the proximal junction of the parent vessel and the aneurysmal base."

References

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Received for publication May 6, 1970.
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