Safety and Efficacy of Intra-Operative Angiography in Craniotomies for Cerebral Aneurysms and Arteriovenous Malformations: A Review of 1089 Cases

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Introduction

In an era of indocyanine angiography (ICG), the routine use of intra-operative angiography (IOA) in the surgical treatment of intracranial aneurysms and arteriovenous malformation (AVM) is controversial. As complex and surgically challenging lesions (which typically require IOA assistance) are increasingly and consistently being managed with endovascular therapy, the usefulness of IOA could be called into question.

We assess the safety and efficacy of IOA and determine predictors of clip readjustment in a consecutive series of patients treated at our institution.

Methods

Between 2003 and 2011, IOA was performed during surgical treatment of 976 aneurysms, 97 AVM, and 16 arteriovenous fistulas (AVF) in our institution. A 5-French sheath and Berenstein catheter were used under a portable single-plane fluoroscopy unit. In each case, IOA was performed by the operating neurosurgeon.

The mean duration of a single-vessel IOA was 16.7 minutes with a range of 15 to 19 minutes.

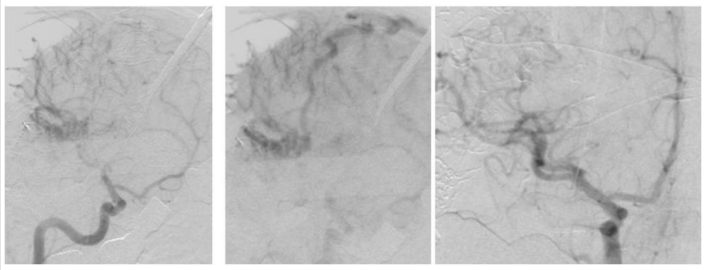
A multivariate analysis was carried out to determine predictors of unexpected findings and surgical revision.

Results

Complications

IOA-related complications were all minor and occurred in 0.9% (n=10) of patients (5 retroperitoneal hematomas, 3 groin hematomas, 1 transient limb ischemia, and 1 visual transient ischemic attack); none resulted in permanent morbidity.

AVM resection



Residual AVM nidus (left) with persistent early venous drainage (center) after initial resection. Second intra-operative angiogram after additional resection showing complete disappearance of the AVM (right).

Aneurysms

In 80 of 976 cases (8.2%) IOA prompted clip repositioning. The reason for the readjustment was a residual aneurysm in 53.8% (43/80), parent or branch vessel occlusion in 42.5% (34/80), and both findings in 3.7% (3/80) of cases. Ten aneurysms (12.5%) required multiple clip readjustments. A single-vessel was catheterized in 800 (90.3%) patients, 2 vessels in 82 (9.3%) patients, 3 vessels in 3 (0.3%) patients, and 4 vessels in 1 (0.1%) patient.

In multivariate logistic regression analysis, increasing aneurysm size ($p<0.0001$), ruptured aneurysm ($p=0.001$) and increasing number of vessels injected ($p=0.001$) were strong predictors of clip readjustment. There was a strong trend for posterior circulation aneurysm location to predict clip repositioning ($p=0.06$).

AVM and AVF

IOA revealed residual nidus/fistula in 8 (8.2%) of 97 AVM and 3 (18.8%) of 16 AVF. In 21.8% of AVM and 56.3% of AVF, more than 1 vessel was injected during IOA.

Mean Spetzler-Martin Grade was 3.0 in AVM requiring surgical revision versus 2.3 in those not requiring a revision ($p=.05$).

Conclusions

IOA remains a valuable tool in the surgical treatment of brain vascular abnormalities, guiding surgical re-exploration in over 8% cases with a very low complication rate.

Patients with large and ruptured aneurysms, high-grade AVM, and AVF benefit the most from IOA. Easy access to angiographer and routine use of IOA are important factors contributing to procedural safety and efficacy.

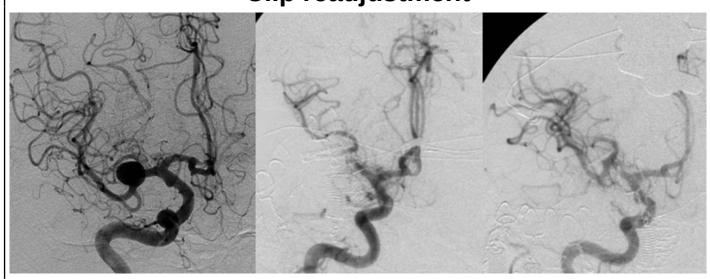
Learning Objectives

By the conclusion of this session, participants should be able to:

1) Discuss the safety and efficacy of IOA during surgical treatment of intracranial aneurysms, AVM, and AVF.

2) Discuss predictors of clip revision for aneurysms and further nidus/fistula resection for AVM and AVF

Clip readjustment



Preoperative angiogram (left) demonstrating a 10 mm aneurysm of the right middle cerebral artery. Significant occlusion of the anterior temporal branch of the middle cerebral artery was noted on IOA (center), with restoration of flow after clip readjustment (right).