Pitfalls and Complications Management in the Endovascular Treatment of Aneurysms

Samer G. Zammar, MD, Youssef J. Hamade, MD, Tarek Y. El Ahmadieh, MD, Najib E. El Tecle, MD, Bernard R. Bendok, MD, MS*

KEYWORDS

• Intracranial aneurysms • Endovascular • Complications • Outcomes assessment

KEY POINTS

- It is crucial to recognize and understand the potential complications associated with endovascular treatment of intracranial aneurysms.
- Understanding the complications associated with endovascular treatment of intracranial aneurysms allows the health care provider to account for several measurements that could potentially avoid the complications and provide more efficiency in their treatment.
- Improved patient selection for endovascular treatment, meticulous planning and preparation of the procedure, anticipating potential complications and preparing for management, building databases that include patients' outcomes assessment, and allowing peer rating and feedback on operative skill can all help to avoid complications.
- The importance of the operator's expertise cannot be overemphasized in the prevention and successful management of these complications.
- Current advancements in simulation, 3-dimensional printing, and holography can potentially play a crucial role in training the novices in endovascular management of intracranial aneurysms and increasing the level of proficiency of the graduating physicians, thus decreasing the incidence of complications.

INTRODUCTION

Complications associated with the endovascular management of intracranial aneurysms can be devastating.[1–4] Successful patient management requires vigilant avoidance, recognition, and management of complications. Both neurologic and nonneurologic complications can occur. Several patient-related and procedure-related parameters can increase the incidence of complications. Reduction of complication rates can be achieved by careful patient selection, meticulous planning and preparation for the procedure, anticipating potential complications, and preparing for their management. Tracking outcomes and a robust case conference for discussion of cases and

Disclosures: None.
Department of Neurological Surgery, Northwestern Memorial Hospital, 676 North St. Clair, Suite 2210, Chicago, IL 60611, USA
* Corresponding author.
E-mail address: bbendok@nmff.org

Neurosurg Clin N Am 25 (2014) 405–413
http://dx.doi.org/10.1016/j.nec.2014.04.002
1042-3680/14/$ – see front matter

complications can further enhance outcomes. Education of the care team and a collaborative environment can foster greater focus on complication avoidance. This article reviews complications associated with the endovascular management of intracranial aneurysms, focusing on risk factors, avoidance, recognition, and management.

RISK FACTORS

Patient-Related Risk Factors

Age

Using the National Inpatient Sample (NIS) database, Lawson and colleagues[5] retrieved data on 14,050 patient admissions and concluded that endovascular procedures may confer greater risks than aneurysmal rupture in patients older than 80 years. On the other hand, patients younger than 70 years may have greater benefits from endovascular coiling. Similarly, Brinjikji and colleagues[6] collected data from the NIS on patients undergoing clipping or coiling of unruptured intracranial aneurysms in the United States between 2001 and 2008 to assess the effect of age on clinical outcome. Their analysis showed that for both treatment groups, morbidity and mortality rates increased with age yet were more pronounced in the surgical group. Furthermore, the biggest difference in outcome was seen in the age group of 80 years and older, whereby morbidity reached 33.5% for clipping versus 9.8% for coiling ($P<.0001$) and mortality reached 21.4% for clipping versus 2.4% for coiling ($P<.0001$).[6] On a more specific level, rising trends of morbidity and mortality with age were also seen in patients undergoing endovascular coiling, starting respectively from 3.5% and 0.6% in the age group younger than 50 years, to 0.5% and 4.0% in patients aged 50 to 64 years, to 0.8% and 6.9% in patients aged 65 to 79 years, and reaching 2.4% and 9.8% in those older than 80 years.[6] Fifi and colleagues[7] conducted a retrospective study to assess clinical predictors of complications in 3636 diagnostic catheter cerebral angiograms at a single center. Among predictors including patient age, sex, inpatient versus outpatient status, and indications for angiography, only age older than 65 years was significantly associated with development of complications. Patients in this age group were 4 times more likely (95% confidence interval 1.268–13.859) than younger patients to develop procedural complications.[7] Similar findings were reported by Willinsky and colleagues,[8] who evaluated prospectively a total of 2899 cerebral digital subtraction angiograms to determine risk factors for neurologic complications related to cerebral angiography. Patients aged 55 years and older were found to be significantly more prone than their younger counterparts to develop neurologic complications (1.8% vs 0.9%, respectively; $P<.035$). Although age seems an important risk factor to take into consideration, it may be difficult to determine a specific cutoff beyond which risks of endovascular procedures would significantly increase, as cutoff ages have been shown to vary among studies.

Cerebrovascular risk factors

Cerebrovascular risk factors have been implicated in increasing the risk of neurologic complications following cerebral angiography.[2,8–16] Of these, stroke and transient ischemic attacks (TIAs) have been shown to increase the rate of complications the most.[13] Cloft and colleagues[17] conducted a meta-analysis to assess patients who presented with subarachnoid hemorrhage, cerebral arteriovenous malformation, and aneurysms. The risk of transient and permanent neurologic complications was found to be greater in the presence of TIAs and strokes (3.7%) than in patients with subarachnoid hemorrhage (1.8%) or aneurysms/arteriovenous malformations (0.3%).

Cardiovascular risk factors

The presence of cardiovascular risk factors such as elevated blood pressure, diabetes, and heart failure also has an impact on the risk of procedural complications. A systolic blood pressure of more than 160 mm Hg appears to be significantly associated with the risk of complications.[8,11] In their prospective study, Earnest and colleagues[11] found an increased risk of local (small hematomas) and neurologic complications with the presence of systolic blood pressure greater than 160 mm Hg. Similar findings were also reported by Willinsky and colleagues,[8] who noted a 2.3% risk of complications in patients with a history of cardiovascular disease. Diabetes was found to increase the risk of neurologic complications between 24 and 72 hours following cerebral angiography procedures.[2]

Renal and hydration status

Although contrast-induced nephropathy (CIN) is a well-known complication of angiography with severe consequences, its incidence has decreased remarkably since the advent of nonionic contrast media. In the absence of other causes of renal damage, CIN can be defined as a decline in renal function with more than 25% increase in serum creatinine levels within 24 hours following exposure to contrast agents.[18–21] The risk of CIN tends to increase with the presence of comorbidities such as diabetes and heart failure, in addition to a state of hydration before endovascular procedures.[5,19] Earnest and colleagues[11] found that