Intracerebral Aneurysms: A Review
With Special Attention to Geriatric Aspects

Thomas Vogel,1,2 René Verreault,2,3 Jean-François Turcotte,4 Michèle Kiesmann,1 and Marc Berthel1

1Centre de Gérontologie, Hôpital de la Robertsau, Strasbourg, France.
2Unité de Recherche en Gériatrie de l’Université Laval, and
3Département des Sciences Neurologiques, Centre Hospitalier Affilié Universitaire de Québec, Canada.
4Département de Médecine Sociale et Préventive, Université Laval, Québec, Canada.

Rupture of an intracranial aneurysm (ICA) remains a devastating complication associated with a high degree of morbidity and mortality. In the past 2 decades, older people were often excluded from active treatment on the unique basis of their chronological age. Recent developments of less-invasive techniques for the diagnosis and treatment of ruptured and unruptured ICAs suggest that this fatalistic attitude toward older patients should be reconsidered. Furthermore, taking into account the heterogeneity of the elderly population, the use of a comprehensive geriatric assessment approach, based on a multidisciplinary evaluation, appears particularly helpful in proposing the optimal treatment strategy for each older patient. This article reviews the geriatric features of epidemiological, physiopathological, as well as clinical and therapeutic aspects of ruptured and unruptured ICAs.

THE rupture of an intracranial aneurysm (ICA) is a devastating event, and is still associated with a relatively poor outcome. Twenty years ago, older people were considered to have such a poor prognosis that they were frequently excluded from active treatment on the unique basis of their advanced age. However, new approaches in the management of ICAs have been developed over the last 2 decades, including early surgery, neurointensive care, interventional neuroradiology, and more aggressive rehabilitation programs. Recent reports suggest that the prognosis of ICA has globally improved in recent years (1), and that carefully selected older patients may benefit from these new treatments for ICA, suggesting that the classical fatalist attitude associated with age and ICA should be reconsidered.

EPIDEMIOLOGY AND PHYSIOPATHOLOGY
The prevalence of ICA varies considerably, ranging between 3.6% and 6% (2,3), and 80% to 85% of ICAs are located in the anterior circulation. The major complication is subarachnoid hemorrhage (SAH) due to rupture. The annual risk of aneurysm rupture has been stable over the last 3 decades, estimated at 1% to 2%, with a range of 0.05% to 4% (3–5). Incidence of SAH due to ICA rupture seems to increase with advancing age (6). Some studies reported a steady increase in incidence rate with age (7–11), while others reported an increase in incidence up to 50–70 years of age, followed by a decline thereafter (12–16). In the Canadian Collaborative Study Group of Stroke Hospitalizations, the incidence of SAH increased with age for both sexes, and reached a plateau of 16.2 per 100,000 between 55 and 59 years for men, and a plateau of 24.4 per 100,000 between ages 69 and 74 years for women (17). Some studies suggested that in patients older than 60 years, SAH occurred predominantly in women, whereas in those younger than 60 years, there was a preponderance of men (8,13,14). Several longitudinal studies reported an increase in incidence of ruptured and unruptured ICAs in recent years among older people (18,19), suggesting a potential change in attitudes as to the diagnosis and treatment of ICA in the elderly population. Mechanisms involved in ICA development remain controversial. Pathogenesis of ICA involves genetic predisposition and environmental factors, probably in interaction (20–23). Potential acquired risk factors include smoking, alcohol, and, to a lesser extent, hypertension (24,25), although specific impact on the risk of formation or rupture has been difficult to individualize (26). Once the ICA is present, factors associated with the risk of rupture include the size of the aneurysm, a location in the posterior circulation, and a previous history of aneurysmal SAH (4,27). The relationship between age and risk of aneurysm rupture remains unclear. The International Study of Unruptured Intracranial Aneurysms (ISUIA) found no association with age (4), while a recent review reported a higher risk of rupture in older age groups (3).

DIAGNOSIS
Unruptured ICA
The gold standard for the diagnosis of unruptured ICAs remains the intraarterial digital subtractions angiography (DSA). It has the highest spatial resolution and allows
visualization of the entire cerebral arterial vasculature (28). DSA, however, carries risk of complication, with an occurrence of permanent neurological injury of approximately 0.07% and a mortality rate of less than 0.1% (29). Higher risk of complications and death after DSA in older patients has been consistently reported. Some studies reported a lower risk of neurological complications when DSA is performed for SAH or ICA, compared with transient ischemic attack or stroke (30–32).

In the last few years, new noninvasive procedures have been developed, including computed tomography helical angiography (CTA), magnetic resonance angiography (MRA), and transcranial Doppler ultrasonography. Compared with DSA, MRA and CTA depicted ICA with a similar accuracy of about 90%, although the sensitivity of detection appears slightly lower for ICAs of small size (33–36).

Subarachnoid Hemorrhage

Computed tomography scanning appears as the investigation of choice in patients with suspected SAH. Its sensitivity reaches 90% to 95% if it is performed within 24 hours, and decreases with time, falling to 70% at 3 days, and approaching 0% at 3 weeks (5). Conventional MRI seems to be relatively insensitive in SAH detection, but new MR sequences appear to have potential advantages to CT scanning, especially in the subacute period (37). Lumbar puncture remains the cornerstone investigation if clinical suspicion is strong and if imaging investigations are negative. The lumbar puncture can, however, falsely suggest a diagnosis of SAH in patients with intracerebral hematoma or traumatic tap, and these pathologies are not uncommon in geriatric medicine. Nevertheless, taking into account the frequency of neuroimaging and focal neurological signs in these patients, this remains improbable in modern practice.

CLINICAL PRESENTATION

Unruptured ICAs are usually silent. They occasionally produce classical signs of a mass effect, including headache with neurological manifestations according to ICA location. One of the most frequently described sign is palsy of the third cranial nerve, caused by an ICA located at the junction of the carotid and the posterior communicating arteries or at the upper end of the basilar artery. Other uncommon manifestations of unruptured ICAs include small infarcts or transient ischemia due to distal embolization (38). Specific presentations of unruptured ICAs in older people have not been greatly examined. Classical symptoms and signs may be more difficult to recognize in older patients with concomitant cerebrovascular or neurodegenerative diseases.

Rupture of an ICA usually produces an SAH, but can also cause an intracerebral hemorrhage, an intraventricular hemorrhage, or a subdural hematoma. Signs and symptoms of aneurysmal SAH typically include acute severe headache, signs of meningeal irritation, altered consciousness, various degrees of neurological deficits, and presence of retinal hemorrhages at fundoscopy. Up to 60% of patients with SAH report an episode of sudden severe headache, days to weeks before rupture, often considered as a “warning leak.” Despite this classical clinical presentation, up to 25% of patients with SAH are initially misdiagnosed (39–41).

Management

General Considerations

Treatment strategies differ radically whether the ICA is ruptured or not. In an unruptured ICA, especially if the ICA is asymptomatic, decisions must balance the risk of intervention with the risk of rupture while considering concurrent patient conditions and life expectancy. A comprehensive geriatric assessment remains a crucial preliminary step to better estimate these individual risks. This multidisciplinary geriatric approach includes an evaluation of the medical, functional, as well as neuropsychological and social conditions (42–44). Consideration of chronological age alone appears indisputably insufficient, inducing a potential loss of chance for the older patients. Once rupture has occurred, SAH is a life-threatening disease, and management must first focus on stabilization of the patient as well as prevention and treatment of complications. Secondarily, indication of the specific aneurysmal repair treatment that prevents rebleeding should be discussed. The benefit–risk ratio of this curative option should be weighed against a palliative or a symptomatic approach, taking into account, again, the overall condition of the patient.

For both ruptured and unruptured ICAs, the two procedures currently available for aneurysmal sac repair include surgical clipping and endovascular coiling. Neurosurgical clipping of the neck of the ICA has been the standard approach in ICA treatment for more than 40 years. The risk associated with clipping of an unruptured ICA has been well studied. In a recent meta-analysis, Raaymakers and colleagues reported a mortality of 2.6% and a morbidity of 10.9% (45). The long-term safety of surgical clipping is generally considered as good, with an annual risk of SAH of 1% to 2% (46).

A less-invasive endovascular approach using detachable coils, introduced by Guglielmi in 1991, revolutionized the treatment of ICA (47,48). Several recent clinical studies suggest that coiling carries similar or even lower risk of complications than open surgery, especially for ICAs arising from the posterior circulation (49–56). However, these findings, for the most part, come from small-scale nonrandomized clinical studies with relatively short-term follow-up. No data from large randomized prospective trials comparing the long-term advantages of surgical clipping with endovascular coiling are yet available, so that, although promising, the long-term efficacy of coiling remains unclear. A large prospective multicenter trial (the International Subarachnoid Aneurysm Trial) comparing the cost and outcome between the endovascular and neurosurgical procedures is nevertheless under way.

Currently, the choice of clipping or coiling mainly depends on the characteristics of the ICA, presence of neurological complications, coexisting medical conditions, and experience of the surgical team (57).

Specific Management in the Elderly Population

Unruptured ICA

Management of unruptured ICAs remains controversial in older patients since no large studies have been specifically
conduct in this population. The prognostic impact of age after clipping or coiling remains unclear. In Raaymakers’ meta-analysis, no clear association between age and surgical outcome was found, while in the ISUIA, older age was the only independent predictor of poor outcome after neurosurgery. Similarly, in a series of 172 cases of unruptured ICAs, Khanna and colleagues found an association between increasing age and poor outcome after surgery (58). Conversely, Chung and colleagues reported, in a small study that included 40 patients aged 70 years or older, a good outcome at 6 months among 85% of the patients, and a mortality rate of 2.5% (59).

Balancing life expectancy with risk of rupture appears crucial in determining potential benefits of treatment of unruptured ICAs in older patients. In order to estimate the number of life-years saved by surgical treatment, recent studies have reported results of actuarial risk analysis. Although the results remain controversial, they suggest that, assuming that the risk of rupture is constant over time, benefits of treatment in terms of life expectancy is expected to decrease with increasing age at diagnosis and to be lowest for patients in the oldest age groups (60,61). It has been suggested, however, that the risk of rupture could change over time, and that estimation of that risk could be much more complex, especially for older patients. Consequently, the choice of optimal treatment strategy remains particularly difficult in elderly patients, as individual life expectancy, risk of surgery, and risk of ICA rupture are extremely difficult to predict. These risk–benefit analyses are made even more complex by multiple comorbidities frequently observed in these populations. In addition, decisions need to be weighed against the wishes of patients and their quality of life.

Ruptured ICA

Prognosis of aneurysmal SAH remains poor with a mortality rate of 25–50%, while 10–20% of patients will remain severely disabled (82). In the study by Chung and colleagues, 45% of the 89 older patients with a ruptured ICA died after 6 months (59). Prognostic factors include location of the ICA, clinical grade at admission, age, coexisting illnesses, systemic and neurological complications, timing of surgery, and experience of the surgical team (63,64). A poorer prognosis with increasing age has been largely documented (65–76). Advanced age has been associated with a high rate of mortality, morbidity, and cognitive impairment (77). Whether this worsening in prognosis could be explained by age itself or by concomitant prognostic factors associated with age remains unclear. Potential age-associated factors include less-aggressive management (78), poorer clinical grade, more frequent comorbidities (79), and higher rates of neurological (71,80) and other complications (66,80,81). Some studies found an association between older age and poor outcome after SAH, independent of other prognostic factors (18,68), while others failed to observe any association between age and mortality (13), or sequelae after SAH (82). Finally, occurrence of cerebral vasospasm, one of the most severe neurological complications after SAH, appeared to be less frequent in older age groups in several studies (81–83), but these findings remain question-able. Recent studies suggested that some elderly patients might have a particularly favorable outcome after an aneurysmal SAH, especially those with good clinical condition prior to rupture (84). Johansson and colleagues studied 281 older subjects, and 85% of those with good neurological conditions at admission (Hunt and Hess I and II) had a favorable outcome (19). In a study by Fridriksson and colleagues, 25 of 76 patients aged 70 to 74 years who were treated with surgery returned to independent living with good cognition (85). In addition, Stachniak and colleagues reported using a small sample of older subjects (n = 47); despite a high mortality rate, elderly patients who survived had a good quality of life (64).

Potential benefits of the newer endovascular procedures in older patients have not been specifically studied. Endovascular coiling is a far less invasive approach than craniotomy with open surgery. It could offer definite advantages for older patients, in particular, by reducing the risk of complications such as pneumonia and anemia (54,86,87). Moreover, the theoretical advantage of the cisternal washing during open surgery to prevent vasospasm is reduced since incidence of vasospasm appears lower in older patients. In addition, the controversial problem of long-term consequences of occasional incomplete aneurysm occlusion after coiling appears less crucial in older people with shorter life expectancy. Finally, it has been suggested that endovascular coiling, by minimizing structural brain damage, may result in less-frequent cognitive impairment than surgery (88).

Conclusion

The number of older people presenting with an ICA will undoubtedly increase over the next decades in developed countries due to the rapid aging process. Prognosis after aneurysmal SAH seems to have improved over the last 20 years, especially for older patients (89). New approaches in treatment and better neurointensive care units have certainly contributed to this improvement. Although the sole consideration of chronological age for choosing between a conservative or a more aggressive treatment now appears no longer justified, optimal management of ruptured as well as unruptured ICAs among older patients remains a matter of debate. The use of a comprehensive geriatric assessment approach, based on multidisciplinary evaluation, should prove particularly helpful in screening potential suitable candidates for invasive procedures after thorough evaluation of medical, functional, psychological, and social conditions. Nevertheless, large-scale clinical studies are clearly needed to better understand the patterns of prognosis after an ICA in the elderly population and to determine the best management strategies, which could reduce mortality, morbidity, and disability while maximizing quality of life.

Acknowledgments

Dr. Thomas Vogel was responsible for the initial literature review and analysis, the initial text draft, and subsequent revisions to the text. Dr. René Verreault contributed substantially to the conception, design, and revisions to the text. Dr. Jean-François Turcotte revised the manuscript critically for important intellectual content. Dr. Michèle Kiesmann and Dr. Marc Berthel contributed to the revising of the article. All authors take full responsibility for the manuscript and its conclusions.
REFERENCES


