ORIGINAL ARTICLE

Anterior Communicating Artery Aneurysm Surgery through the Orbitopterional Approach: Long-Term Follow-Up in a Series of 75 Consecutive Patients

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ABSTRACT

Objective: In this retrospective review of prospectively collected data, we report outcomes for patients with anterior communicating artery (ACoA) aneurysms treated via the orbitopterional approach and discuss the potential impact in patient outcomes by the reduction of surgery-induced brain damage. Methods: We retrospectively reviewed prospectively collected data from 40 men and 35 women (mean age, 50.8 years) who underwent clipping of ACoA aneurysms through the orbitopterional approach. Results: Overall outcomes at discharge using the modified Rankin Scale were good in 52 (69.4%) patients, fair in 13 (17.3%), and poor in 10 (13.3%). At last follow-up, outcomes were good in 63 (84%) patients, fair in 6 (8%), and poor in 6 (8%). Disability included none in 53.6% patients, mild in 10%, partial in 18.8%, moderate in 8.6%, moderately severe in 1.4%, severe in 2.9%, extremely severe in 2.9%, and vegetative state in 1.4%. Overall, 74% of patients returned to work after 4 months, 83% of previously unemployed patients returned to baseline, and 25% were disabled. Complications were more frequent and severe after subarachnoid hemorrhage. Conclusions: Long-term follow-up data present the orbitopterional approach as an attractive alternative for ACoA aneurysm surgery given the low rates of surgery-related morbidity and good patient outcomes and functionality.

KEYWORDS: Anterior communicating artery, aneurysm, orbitopterional approach

The surgical treatment of anterior communicating artery (ACoA) aneurysms remains a tremendous challenge.[1,2] With refinements in surgical techniques and improvements in overall

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Skull Base 2008;18:265–274.

Received: November 30, 2007. Accepted: January 23, 2008. Published online: February 25, 2008.

DOI 10.1055/s-2008-1058367. ISSN 1531-5010.

care of subarachnoid hemorrhage (SAH), the focus on patient outcome has shifted from goals such as survival and reduction of major disability to more ambitious goals such as return to work and/or previous functionality.[3–5] The introduction of endovascular coiling as an alternative to surgery has sparked increased concern regarding patient outcome.[6,7] Patient functionality after SAH is taking a more predominant role as treatments continue to evolve, particularly after an ACoA aneurysm.

The ACoA is one of the most common locations for intracranial aneurysms as 30 to 37% occur in this location. Aneurysms of the ACoA account for the largest percentage of ruptured aneurysms (39%) and are associated with the worst surgical outcomes among all anterior circulation aneurysms.[8–16] Initial SAH impact, vasospasm, and surgical trauma account for the morbidity and mortality of ACoA aneurysms.[12–14] Therefore, targeted intervention on those variables should result in improved outcomes. Although little can be done to limit initial SAH damage and moderate progress has been made in the treatment of vasospasm, surgery-related morbidity and mortality appear to be areas in which intervention could improve patient outcomes. This problem has also been recognized by others who have explored alternative approaches and techniques.[17–30]

In this retrospective review of prospectively collected data, we evaluate the short- and long-term follow-up of 75 patients with ACoA aneurysms who underwent surgical treatment through the orbitopterional approach. We further discuss the potential improvements afforded by this approach in patient outcomes by the reduction of surgery-induced brain damage.

MATERIAL AND METHODS

From 2000 to 2004, 40 women and 35 men who ranged in age from 18 to 84 years (mean age, 50.8 ± 7.8 yrs) admitted to our service underwent clipping of ACoA aneurysms through an orbitopterional approach. This sample represents a total of 75 consecutive patients with ACoA aneurysms treated through the orbitopterional approach from a total of 926 patients with both ruptured and unruptured cerebral aneurysms admitted to our institution during the aforementioned period. Patients were prospectively followed (mean, 41 mos; range, 15 to 63 mos) after discharge. Of these 75 patients, 63 suffered SAH and 12 had elective surgery. The short-term follow-up findings of 40 of these patients were previously reported.[30]

We recorded patient demographics, postoperative complications, aneurysm size, approach-related complications, and need for gyrus rectus resection and sylvian fissure dissection. For SAH patients, we recorded condition at admission by Hunt-Hess (HH) scores, severity of hemorrhage (Fisher grade on admission computed tomography [CT]), and day of surgery relative to SAH onset. Early surgery (within 72 hours of ictus) was advocated for patients with ruptured ACoA aneurysms. All SAH patients were treated under the same paradigm per the *AHA Guidelines for the Treatment of Subarachnoid Hemorrhage*.[31] Modified-Rankin Scores (mRS) were evaluated and recorded by independent observers at discharge and last follow-up. Work status before admission and at last follow-up was also recorded. All patients were evaluated through the Disability Rating Scale (DRS) at last follow-up.[32] Patient information and data analysis results are summarized in Tables 1 to 6.

Neuropsychological examination was performed 12 months after discharge in 16 patients

Table 1 Outcomes at Discharge and at Latest Follow-Up for Ruptured and Unruptured ACoA in 75 Patients

Aneurysm	Outcome	Discharge (%)	Last Follow-Up (%)
Ruptured	Good	40 (63.5%)	51 (81%)
	Fair	13 (20.5%)	6 (9.5%)
	Poor	10 (16%)	6 (9.5%)
Unruptured	Good	12 (100%)	12 (100%)
	Fair	0	0
	Poor	0	0

ACoA, anterior communicating artery; mRS, Modified Rankin Scale (good, 0 to 2; fair, 3; poor, 4 to 6).

Table 2 Summary of Complications in 75 Patients with Aneurysms of the ACoA Who Underwent Surgical Treatment via an Orbitopterional Approach

Complication	Ruptured	Unruptured
Approach-related		
Levator palpebrae paralysis	2	2
Flap infection	1	-
Neurological		
Vasospasm	11	-
Hydrocephalus	4	-
Perforator infarction	2	-
Elevated intracranial pressure	2	-
Vessel occlusion	1	-
Medical		
Pneumonia	6	-
Urinary tract infection	4	1
Sepsis	3	-
Deep venous thrombosis	2	-
Acute respiratory distress	2	-
Endocarditis	1	-
Pulmonary embolism	1	-
Cardiac arrhythmia	1	-

ACoA, anterior communicating artery.

with SAH, and included the Micro Cognitive Test, Computerized Assessment of Cognitive Function (CACF), Wisconsin Card Sort, Trail-making Test, Rey's Complex Figure Test and Recall, and portions of the Wechsler Memory Scale 3.

RESULTS

Size of the ACoA aneurysm ranged from 2 to 27 mm (mean, 6.4 ± 3.2 mm). Overall outcomes at discharge by mRS scores were good (mRS 0 to 2) in 52 patients (69.4%), fair (mRS 3) in 13 (17.3%), and poor (mRS 4 to 6) in 10 (13.3%) (Table 1). Approach-related complications included levator palpebrae paralysis in 4 patients and skin flap infection in 1 patient (Table 2). Two patients underwent proximal sylvian fissure dissection, 4 underwent gyrus rectus dissection, and no retraction injury was noted on postoperative CT scans. Two patients had perforator vessel injuries, 1 had postoperative vessel occlusion, and 1 suffered aneurysmal re-rupture. Vasospasm worsened outcome in 11 patients (Table 2). At latest follow-up, outcomes were good in 63 patients (84%), fair in 6 (8%), and poor in 6 (8%) (Table 1). All levator palpebrae paralyses had resolved within 6 weeks. No long-term cosmetic complications were recorded. Of 69 surviving patients at latest follow-up, 34 (73.9%) were back to work among 46 who had previously worked; 19 of 23 (82.6%) patients who did not work before SAH were at their baseline condition; and 17 of the 69 (24.6%) were disabled. Time to return to work averaged 4 months (range, 1 to 12 months) (Table 4).

Unruptured Aneurysms

All 12 patients with unruptured ACoA presented good outcomes at discharge and long-term follow-up (Tables 1 to 4). Aneurysm size in this subgroup averaged 8 ± 2.2 mm. Reasons for selection of the orbitopterional approach included aneurysm size in 8 patients and high-riding ACoA (> 15 mm above the cranial base) in 4 patients. No patient required sylvian fissure dissection and 2 underwent gyrus

Table 3 Work Status and Patient Self-Perception Relative to Baseline after SAH or Elective Surgery for Aneurysms of the ACoA

Work Status	Unruptured (%)	Ruptured (%)	Total (%)
Returned to work	7/8 (87.5%)	27/38 (71%)	34/46 (74%)
Did not return to work	1/8 (12.5%)	11/38 (29%)	12/46 (26%)
Returned to baseline	12/12 (100%)	43/57 (75.4%)	55/69 (80%)
No return to baseline	0	14/57 (24.6%)	14/69 (20%)

Values in cells are entered as category value/totals in category (percentage within category).
SAH, subarachnoid hemorrhage; ACoA, anterior communicating artery.

Table 4 Method of Patient Assessment Using the Disability Rating Scale

Category	Item	Score
Arousability, awareness, and responsivity	Eye opening	0 = spontaneous
		1 = to speech
		2 = to pain
		3 = none
	Communication ability	0 = oriented
		1 = confused
		2 = inappropriate
		3 = incomprehensible
		4 = none
	Motor response	0 = obeying
		1 = localizing
		2 = withdrawing
		3 = flexing
		4 = extending
		5 = none
Cognitive ability for self-care activities	Feeding	0 = complete
		1 = partial
		2 = minimal
		3 = none
	Toileting	0 = complete
		1 = partial
		2 = minimal
		3 = none
	Grooming	0 = complete
		1 = partial
		2 = minimal
		3 = none
Dependence on others	Level of functioning	0 = completely independent
		1 = independent in special environment
		2 = mildly dependent
		3 = moderately dependent
		4 = markedly dependent
		5 = totally dependent
Psychosocial adaptability	Employability	0 = not restricted
		1 = selected jobs
		2 = sheltered workshops (noncompetitive)
		3 = not employable

rectus resection (both patients had high-riding ACoA aneurysms >15 mm above the cranial base). Two patients underwent clipping of multiple anterior circulation aneurysms at the time of ACoA clipping. Approach-related complications recorded were 2 levator palpebrae paralyses, which completely recovered within 6 weeks of surgery. Seven (87.5%) of 8 patients working before surgery returned to work within an average of 2.7 months (range, 1 to 6 months); the remaining patient returned to baseline but elected to retire. One patient who was unable to work (sequel from SAH from a middle cerebral artery aneurysm) returned to his previous condition soon after

Table 5 Hunt-Hess Grades Distribution among 63 Patients with Ruptured ACoA Aneurysms

Hunt-Hess Score	Number of Patients
1	16
2	16
3	19
4	7
5	5

ACoA, anterior communicating artery.

ACoA clipping (mRS 1). Neither patient who underwent gyrus rectus resection presented any deficits at follow-up. No frontobasal hypodensities were noted on postoperative CT scans performed within 48 hours of surgery. No patient underwent postoperative magnetic resonance imaging (MRI) or neuropsychological testing.

Subarachnoid Hemorrhage

Patient HH and Fisher grades are summarized in Tables 5 and 6. After SAH, outcomes at discharge were good in 40 (63.5%) patients, fair in 13 (20.5%), and poor in 10 (16%). At follow-up (mean, 27 months), outcomes were good in 51 patients (81%), fair in 6 (9.5%), and poor in 6 (9.5%). Aneurysm size averaged 6.1 ± 3.4 mm. No patient underwent gyrus rectus resection and 2 had proximal sylvian fissure dissection. Aneurysm clipping was performed at 0 to 14 days after SAH (mean, 1.5 days). All patients admitted within 72 hours of SAH underwent immediate surgery. Two patients referred from outside hospitals presented with vasospasm and had surgery at day 13 and 14, respectively. Three patients presented with intracerebral hemorrhage at the time of bleeding. On follow-up CT scans, 60 patients showed no evidence of frontobasal hypodensities; 2 developed perforator vessel injuries, 1 had postoperative vessel occlusion, and 1 suffered aneurysmal re-rupture. No patient underwent postoperative MRI. Vasospasm worsened outcome in 11 (17.4%) patients with SAH. One patient developed a superficial infection of the skin flap and 4 had transient levator palpebrae paralyses. Medical complications are summarized in Table 2.

Table 6 Fisher Grades Distribution among 63 Patients with Ruptured ACoA Aneurysms

Fisher Grade	Number of Patients
1	4
2	7
3	49
4	3

ACoA, anterior communicating artery.

At last follow-up among 57 SAH survivors, 27 (71%) of 38 patients previously employed returned to work (3 part-time) within an average of 4.2 months, 16 (84.2%) of 19 unemployed returned to their baseline condition, and 11 (19.3%) were disabled (Tables 3 and 4). All patients were offered a neuropsychological evaluation at 12 months after surgery. Nine of the 16 patients who agreed to neuropsychological testing demonstrated mild short-term memory problems; all 16 of these patients were back to work at their previous occupations.

Postoperative Functional Outcome Evaluation

In our 69 surviving patients, levels of disability measured by DRS were none in 53.6% patients, mild in 10%, partial in 18.8%, moderate in 8.6%, moderately severe in 1.4%, severe in 2.9%, extremely severe in 2.9%, and vegetative state in 1.4% (Table 4). In our series, 100% of patients who underwent unruptured ACoA aneurysm surgery and 75% of 57 SAH survivors returned to their previous preoperative status. Overall, 74% of patients returned to work, 83% of previously unemployed patients returned to baseline, and 25% were disabled (Table 3). Time to return to previous activities averaged 4 months. Approach-related, neurological, and medical complications were more frequent and more severe in SAH patients (Table 2).

DISCUSSION

In our previous study that correlated laboratory data with a clinical series of 40 patients, we identified the benefits of the orbitopterional approach in ACoA aneurysm surgery that included increased exposure and visualization of the ACoA complex and thus decreased risk of intraoperative brain damage.[30] Benefits of the orbitopterional approach versus the pterional approach in terms of exposure of the ACoA complex were recently corroborated by Figueiredo et al.[21] In this article, we discuss the potential impact of this approach on patient outcomes on the basis of a potential decrease in surgery-related morbidity. We also provide long-term follow-up data on our first 75 consecutive patients with ACoA aneurysms operated on through the orbitopterional approach. Furthermore, we acknowledge that these data are not derived from a randomized clinical trial, and we included no control cases treated through the "gold standard" (i.e., the pterional approach). However, we firmly believe that this report could eventually serve as background data for further clinical studies comparing different surgical approaches.

Outcome Assessment

Objective assessment of the outcomes after aneurysm surgery is extremely complicated; many factors that affect this equation are unique to the condition of a specific patient. Effect of SAH, surgery, and other comorbidities make any universal grading system too imprecise and unreflective of both patient outcomes and the condition relative to the premorbid states. Aside from cognitive testing, some efforts have been made recently that incorporate other aspects of patient outcome in terms of economic, social, and employment spheres. However, these tools have not yet gained widespread use because of their inherent complexity and licensing restrictions.

In our series, the DRS was used as a tool that incorporates some of those aspects overlooked by more commonly used scales (e.g., Glasgow Outcome Scale and mRS). As no cognitive assessments were made before SAH or elective clipping, the impact of intervention could be extrapolated but not objectively established. Another major issue with neither consensus nor guideline is the right timing to perform cognitive assessment of patients. Consequently, we decided to use the DRS, work status, and patients' perception of their condition relative to baseline as outcome measures.

Surgery-Related Morbidity and Functional Outcomes: The "ACoA Syndrome"

Incidences of neuropsychological disturbances after ACoA aneurysm surgery of higher than 80% have been reported in recent studies.[5] Long-lasting cognitive deficits after SAH and ACoA repair have been reported in 30 to 55% of patients as "severe" or "marked" in one or more cognitive domains up to 1 to 7 years after surgery.[33] In fact, patients with SAH from ruptured ACoA have historically been observed to suffer from poor neuropsychological and functional outcome. A triad of symptoms (i.e., memory loss, confabulation, altered personality) has earned the name "ACoA syndrome."[4,34,35] However, thanks to technical refinements of surgery and better perioperative care of these patients, full-blown ACoA syndrome is now rarely seen. Nevertheless, a similar set of symptoms, often of lesser severity, is often observed. The pathophysiological mechanism seems to be related to basal forebrain injury, possibly surgical trauma, especially among patients with SAH.[4,33,35–37]

The neuropsychological analysis of cognitive dysfunction after ACoA aneurysm surgery is a complicated one.[36] Furthermore, some clinicians even challenge the concept of an ACoA syndrome.[4,34,35] A paucity of significant findings in neuropsychological tests classically sensitive to frontal lobe dysfunction suggests that frontal lobe pathology does not contribute significantly to the symptoms described above.[5] In fact, many have pointed out that the traditional areas implicated in amnesia (i.e., mesial temporal lobe, diencephalic structures) appear unaffected, yet amnesia can still manifest.[5,36] This manifestation could suggest involvement of other brain structures (e.g., temporal lobe) that are sometimes subject to dissection and retraction when dissecting the proximal sylvian fissure for exposure of ACoA aneurysms.[4,34,35]

Diamond and associates reported that only ACoA amnesiac patients had involvement of areas beyond the frontal lobes in CT scans.[36] Therefore, avoidance of dissection, retraction, or manipulation of other areas beyond the frontal lobe (i.e., temporal lobe, sylvian fissure) could represent a target to decrease surgery-induced cerebral damage. Even careful dissection of the arachnoidal planes of the sylvian fissure can affect cerebral microvasculature. Schaller et al reported that a noteworthy proportion of patients who underwent microneurosurgical dissection of the sylvian fissure exhibited statistically significant findings compatible with impaired cerebrovascular reactivity on postoperative Doppler ultrasounds and hexamethylpropylene amine oxime-single-photon emission computed tomography scans. These results led the authors to conclude that the trans-sylvian approach is "minimally invasive" but not "atraumatic."[38]

Brain retraction injury in aneurysm surgery has been approximated as 5% when using CT scan as a parameter.[39–42] Yundt et al documented an uncoupling of flow and metabolism in a focal area where retractor blades had been placed in patients who suffered from brain retraction injuries.[43] In a high-field MRI study, Kivisaari and colleagues documented a 35% incidence of lesions in the basal frontotemporal region on the side of the pterional approach in 101 patients with aneurysmal SAH treated surgically. These lesions were more frequently located at the temporal apex, and persisted in follow-up scans performed 2 to 6 years after surgery.[44]

It becomes evident that even minimal manipulation of brain tissue during aneurysm surgery may cause damage. Areas unrelated or nearby to the aneurysm itself may suffer anatomical or functional damage. In support of this statement, the work of Böttger et al identified seven specific patterns of cognitive and psychopathological dysfunction in ACoA patients on a neuroanatomical basis.[34]

Orbitopterional Approach

Use of the orbitopterional approach offers some attractive features. First, no dissection of the sylvian fissure is entertained, therefore decreasing the risk of temporal lobe dysfunction and/or injury. Patients in our series neither exhibited injury of the temporal lobe nor evidence of temporal lobe dysfunction clinically or on neuropsychological testing (16 SAH patients only). Second, the need for retraction on the basal frontal lobe is decreased at the expense of a significant space gained from removal of the sphenoid ridge and superior and lateral orbital rim. A very low incidence of frontobasal hypodensities on postoperative scans and the lack of clinical evidence of frontal lobe dysfunction may be the result of improved exposure and decreased use of brain retraction. Third, improved exposure allows for a better cisternal toilette, which, complemented by fenestration of the lamina terminalis during ruptured ACoA aneurysm surgery, can decrease the incidence of cerebral vasospasm and post-SAH hydrocephalus, in addition to providing improved relaxation of the brain during surgery.[45–49] Despite lack of evidence of brain damage on postoperative CT scans, some of the subset of the patients in this series who agreed to neuropsychological evaluation exhibited minor short-term memory problems. Whether this is a direct effect of surgery, focal vasospasm of the subcallosal branches of the ACoA, or the impact of SAH remains undetermined. Further efforts must be directed to minimize the cognitive and socioeconomic sequelae in patients with ACoA aneurysms.

Appropriate surgical technique and avoidance of surgical trauma as a result of good surgical exposure could be associated with a decrease in the burden of disability in ACoA aneurysm surgery. Whether the use of this approach or the several others[17–29] that share the same precepts of minimal brain retraction, maximal exposure, and improved visualization represent a step in that direction should be tested in a randomized trial. Furthermore, while at most the data from this study may be rated as "informed opinion" or the result of other factors (i.e., good surgical technique, good neurocritical care), they may add to the burden of clinical background necessary for the design of such clinical trials. The goal of no disability as an outcome must be pursued in modern neurovascular surgery.

CONCLUSIONS

Long-term follow-up data in 75 consecutive ACoA aneurysm patients operated on through the orbitopterional approach present low surgery-related morbidity rates and good patient outcomes and functionality. Further randomized clinical studies and better outcome measuring tools are greatly needed to assess the impact of SAH and surgical technique on patient outcome.

ACKNOWLEDGMENTS

The authors would like to acknowledge and thank Ms. Mary Kemper for her valuable editorial assistance in the completion of this manuscript.

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Commentary

The authors report their series of 75 patients who underwent an orbitopterional approach for clipping of anterior communicating artery aneurysms. They demonstrate excellent results with good follow-up, making evident their significant surgical expertise. At the Barrow Neurological Institute, we also approach all ACoA aneurysms via a modified orbitozygomatic approach. In fact, we use this approach as the workhorse for exposing all circle of Willis aneurysms. We agree with the authors that the additional removal of bone in this skull base approach avoids significant brain retraction during surgery and hence improves overall outcome.

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Published online: February 25, 2008.
DOI 10.1055/s-2008-1058368. ISSN 1531-5010.