Internal carotid artery injuries secondary to endonasal surgery

TO THE EDITOR: We read with great interest the article by Sylvester et al.2 (Sylvester PT, Moran CJ, Derdeyn CP, et al: Endovascular management of internal carotid artery injuries secondary to endonasal surgery: case series and review of the literature. J Neurosurg [epub ahead of print January 15, 2016. DOI: 10.3171/2015.6.JNS142483]). They report on their experience in treating 7 internal carotid artery (ICA) injuries after endonasal surgery, and extensively review the literature on management of similar cases.

Iatrogenic ICA injury is an uncommon but potentially lethal complication that all skull base surgeons try to avoid. We share the authors’ opinion that ICA sacrifice, although providing confident hemostasis in acute ICA injury, carries significant risk of cerebral ischemia either immediately or in a delayed manner. This is evident in their literature review of patients who received endovascular ICA sacrifice after ICA injury. While none of the patients experienced a recurrence of bleeding, as many as 21.7% developed permanent neurological complications. With this in mind, vessel preservation should be attempted whenever possible to maintain adequate cerebral perfusion.

Nevertheless, we would like to provide a cautionary note regarding the use of stents in reconstructing the ICA, in particular the flow diverters in the setting of carotid pseudoaneurysms around the skull base. In their paper, Sylvester et al. reported a total of 5 cases in which the ICA pseudoaneurysm was reconstructed with the Pipeline Embolization Device (PED; Covidien Vascular Therapies) and all patients achieved satisfactory outcome without neurological complications. Our experience had been less reassuring in this regard. We recently reported 7 patients who suffered from carotid pseudoaneurysms related to skull base tumor treatment in whom we reconstructed the ICA using the PED. Although all patients attained hemostasis without recurrence of pseudoaneurysm, 1 developed perioperative ischemic stroke, 1 developed delayed infarct at 10 months, and 2 patients developed asymptomatic delayed ICA thrombosis at 5 and 8 months after PED placement, respectively.3 Alarming, 1 of the patients who had delayed ICA thrombosis in the series presented subsequently with PED extrusion and dislodgement from the nasopharynx (Fig. 1). This patient was initially treated with 3 PEDs in telescoping fashion for the pseudoaneurysm at the laceral ICA. The bleeding was controlled without neurological deficit, but the ICA was found to be occluded at 5 months. The PEDs eroded through the occluded ICA and extruded completely 2 years after initial treatment, fortunately without rebleeding. This case highlights the potential risks regarding the use of PEDs and stents in reconstructing ICA pseudoaneurysms where there is a lack of a true vessel wall, especially in cases with a weakened skull base related to surgery or radiation.

Extracranial-intracranial (EC-IC) bypass, on the other hand, provides a healthy alternative conduit to maintain cerebral perfusion while completely excluding the perforated ICA segment from circulation, and had been shown to achieve satisfactory outcome by Rangel-Castilla et al.1 In light of the above experience with PEDs, we have now adopted an approach to manage ICA pseudoaneurysms with endovascular flow diverters or stents only in the acute setting, utilizing the advantage of satisfactory hemostasis and flow preservation. This is followed by early EC-IC bypass together with trapping of the diseased ICA segment once the patient is stable and the primary disease under control.

Anderson Chun-On Tsang, MBBS
The University of Hong Kong, Queen Mary Hospital, Hong Kong

FIG. 1. Left: Plain CT scan of the brain showing PEDs in situ over the left laceral and cavernous ICA (arrow). Right: Plain CT scan of the brain of the same patient 2 years after PED extrusion from the nasopharynx, confirming the absence of flow diverters along the ICA (arrow).

While this is obviously not optimal, it is important to re-occlusions subsequently extruded into the nasopharynx. Delayed ischemic infarct 10 months after PED placement, including 1 with periprocedural ischemic stroke, 1 with aneurysm, necrotic nasopharynx, and recurrent nasopharyngeal carcinoma that had undergone prior treatment with surgery and neck irradiation. The experience of Tsang and colleagues with the use of the PED for pseudoaneurysms is certainly of interest to this topic, but we believe that it is important to remember that Dr. Tsang’s 7 patients with radiation to the skull base were ill with threatened ICA “blowouts,” and that 3 of these patients died of progressive disease. In comparison, our series of patients with iatrogenic injuries did not harbor malignancies, but rather had benign pituitary adenomas, and had not undergone prior radiation.

In the series from Dr. Tsang and colleagues the patients received antiplatelet medications immediately prior to the procedure followed by a shortened course of dual antiplatelet medications (clopidogrel 1–4 weeks and aspirin 6 months) due to perceived risk of bleeding from pseudoaneurysm, necrotic nasopharynx, and recurrent nasopharyngeal carcinoma. Four cases had unintended outcomes, including 1 with peri-procedural ischemic stroke, 1 with delayed ischemic infarct 10 months after PED placement, and 2 with asymptomatic PED occlusions. One of the PED occlusions subsequently extruded into the nasopharynx. While this is obviously not optimal, it is important to remember that this patient did not suffer a hemorrhage.

One of the patients in the series of Dr. Tsang and colleagues was treated successfully despite what is, in general, considered to be a contraindication to treatment with the PED, i.e., a previously placed covered stent. In the 3 patients who developed occlusions, these occurred at 5, 7, and 10 months after treatment with the PED. This latter patient experienced a lacunar infarct near the time of the discovered occlusion. One other patient had multiple bilateral, not unilateral, strokes and had the opposite ICA previously occluded. This patient underwent angioplasty and stenting of a more proximal lesion prior to placement of the PED. While the 3 occlusions are bothersome, as are the 2 infarctions (only 1 of which had an occlusion), there are several problems with their technique to consider.

Given the outcomes in their series of 7 patients, Tsang and colleagues recommend initial endoluminal vessel repair followed by EC-IC bypass and vessel trapping for sacrifice when there is iatrogenic injury to the ICA during surgery. This bypass strategy is similar to the methodology described by Rangel-Castilla et al. One wonders about the technical ease and safety of bypass in the type of patients in the series of Tsang et al., 3 of whom died from tumor progression. The quality of the recipient and donor vessels certainly could be unfavorable in patients with malignancy who had undergone prior surgery and radiation treatment of the head and neck.

In the Tsang et al. article, the authors hypothesize that the high rate of ischemic complications was potentially due to 1) delayed repair of the endothelium secondary to radiotherapy, 2) inadequate platelet regimen, and 3) use of multiple PEDs. It is our opinion that the high rate of PED failure in Tsang and colleagues’ cases was likely related to the prior radiotherapy effect, and possibly due to inadequate antiplatelet therapy. The patients received a clopidogrel loading dose, and received 75 mg of clopidogrel for at least 1 week afterward. In the cardiology literature it is well known that at least 30% of Asians are resistant to clopidogrel. It is also known that neointimal hyperplasia can be related to platelet deposition. All of our patients treated with the PED are maintained on aspirin and clopidogrel for a minimum of 6 months and if there is any observed narrowing (all angiographically confirmed), the aspirin and clopidogrel are continued. It is understandable that Dr. Tsang and his colleagues were worried about hemorrhage in their group of patients who were ill and had threatened carotid blowouts. However, none of their patients suffered bleeding from the pseudoaneurysm and all had the aneurysm obliterated as demonstrated on the available follow-up evaluations.

In our study and review, we reported on 5 cases of iatrogenic ICA pseudoaneurysms sustained during surgery (4 cases after transsphenoidal surgery, 1 case after endoscopic sinus surgery). None of these patients received radiotherapy or had ICA infections, both of which can cause disintegration of the vessel wall that is fundamentally different than the puncture or tear caused during surgery. Furthermore, typically our patients were generally in good health, with benign tumors (pituitary adenomas) rather than the more malignant tumors described in the report of Tsang and colleagues. Similar to the study of Tsang et al., a case was previously reported from our institution in which the PED was used in the setting of an ICA with poor vessel integrity, and a different etiology (osteomyelitis of the skull base) rather than malignancy. This did not provide a durable solution, and 12 days later after another hemorrhage, sacrifice of the ICA was performed.

Cases reported in our review also had a more aggressive antiplatelet medication regimen, likely with a lower risk of bleeding than cases reported by Tsang et al. Cases from our study and from Amenta et al. received preprocedural dual antiplatelet medication confirmed by Verify in the laboratory.
Now testing and continued for 2 months and 6 months, respectively. One of the cases in our series (Case 5) underwent delayed treatment of the pseudoaneurysm to achieve a suitable antiplatelet effect prior to treatment. Nerva et al. also used a similar preprocedural dual antiplatelet regimen, but postprocedural medication was not discussed.3

In summary, we believe there are potentially fundamental differences between the cases reported in our study (iatrogenic ICA injury during surgery for pituitary adenomas) compared to those reported by Tsang et al. (ICA pseudoaneurysms in patients with head and neck malignancy previously treated using surgery and radiation). These differences between the patients reported likely contributed to the higher rate of postoperative complications in the series by Tsang and colleagues. We do, however, admit that we cannot make strong statements regarding safety and efficacy of PEDs for intracranial pseudoaneurysms and iatrogenic ICA injury based on a 5-patient case series, and we appreciate Dr. Tsang’s insight into these challenging clinical scenarios.

Peter T. Sylvester, MD
Christopher J. Moran, MD
Colin P. Derdeyn, MD
DeWitte T. Cross, MD
Ralph G. Dacey, MD
Gregory J. Zipfel, MD
Albert H. Kim, MD, PhD
Keith M. Rich, MD
Michael R. Chicoine, MD
Washington University School of Medicine, St. Louis, MO

Training and career aspects of female neurosurgical residents in Europe

TO THE EDITOR: We read with great interest the article by Renfrow et al. (Renfrow JJ, Rodriguez A, Liu A, et al: Positive trends in neurosurgery enrollment and attrition: analysis of the 2000–2009 female neurosurgery resident cohort. J Neurosurg 124:834–839, March 2016), which impressively described recent trends for enrollment and retention of females in neurosurgery in the US. Even though the goals outlined by the American Association of Neurological Surgeons (AANS) and Women in Neurosurgery (WINS) in 2008 have not been reached,3 the proportion of females in neurosurgery has increased from 10.7% of each class in the 1990s to 12% in the 2000s and up to 15.5% in 2013.8 At the same time, attrition rates for female neurosurgeons decreased during the last decade. They were reported to be as high as 37% in females (vs 19% in males) for board certification and 24% in females (vs 12.8%) for completing residency from 1990 to 1999.6 A decade later (2000–2009) attrition rates for females have decreased to 17% (vs 5.3% in males).8 The authors conclude that while positive trends are visible, gender disparity exists in retention of neurosurgical residents, and the number of females entering neurosurgical residency remains disproportionate to the number of those eligible. The authors are to be commended for their scientific contribution, highlighting data to help understand the extent of disparity between males and females in US neurosurgery programs—indeed an important subject. In Europe, neurosurgery residents strive to participate in the training courses organized by the European Association of Neurosurgical Societies (EANS) that take place over a 4-year period for each participant. While this is not mandatory, the courses are usually followed by participation in the European Board Examination of Neurological Surgery (EBE-NS) Part I (written) and Part II (oral) in order to be appointed a Fellow of the European Board of Neurological Surgery. Figure 1 illustrates official data kindly provided by the EANS; participation of females at the training courses steadily increased from 19.2% in 2009 up to 26.4% in 2015. At the same time, a trend for increasing participation of females at the EBE-NS Part I is visible, but less so for Part II. While the numbers have to be interpreted cautiously, as selection of trainees to participate at the EANS training courses is not standardized, they do shed some light on the recent positive development of gender disparity at the EANS trainee level.

In Europe, also with support of the EANS, an international survey recently addressed various aspects of neurosurgical training, working time, and future career aspects.1,12 Of a total of 532 responders, 126 were female (23.7%; Table 1). Analyzing these data demonstrates that, at present, while training conditions are largely comparable for males and females, profound gender differences exist pertaining to career planning and anxiety. Logistic regression analysis showed no difference between how female and male trainees rated their satisfaction with hands-on surgery (OR 1.16, 95% CI 0.72–1.89; p = 0.530).

References
or microsurgical training (OR 0.82, 95% CI 0.54–1.24; p = 0.345). Working time per week was similar for trainees of both genders (Pearson χ² 4.76, p = 0.446). No gender difference in the caseload for cranial or spinal procedures was observed. When asked about their future career intentions, female trainees were less likely to specialize into spine surgery (OR 0.24, 95% CI 0.15–0.40; p < 0.001), but on the contrary were more likely than male trainees to pursue a subspecialization in pediatric neurosurgery (OR 2.22, 95% CI 1.34–3.69; p = 0.002). The intentions to specialize into vascular and skull base, trauma, oncological, and functional neurosurgery were balanced. The survey data revealed that female trainees in Europe were less likely to pursue an academic career at a university clinic (OR 0.61, 95% CI 0.40–0.92; p = 0.019), but more likely to work as an attending in a nonuniversity public hospital than males (OR 1.58, 95% CI 1.05–2.36; p = 0.026). The survey asked neurosurgical trainees whether, after residency completion, they felt confident to work on their own responsibility. Here, female trainees tended to feel less confident than males (OR 0.66, 95% CI 0.42–1.03; p = 0.070). Importantly, female trainees were twice as likely as males to indicate future career anxieties (OR 2.01, 95% CI 1.23–3.28; p = 0.005).

In the 1990s, nearly 4 of 10 female neurosurgical residents did not become board certified, and females were twice as likely as men not to become board certified. While apparently the absolute rate of attrition decreases for trainees of both sexes, reasons for female attrition are currently poorly explored. Lifestyle reasons, greater work-home conflicts, and difficulties that female residents might experience when approaching predominantly male faculty, thereby impeding mentoring relationships, were mentioned previously. It has been pointed out that females start with fewer research resources in academic medicine, and this seems to translate in lesser scientific output of female compared to male trainees. Crowley et al. pointed out that males published more articles than females during neurosurgical residency (mean publications 2.6 vs 0.9; p < 0.004). Male residents were much more likely to have coauthored (OR 6.80, 95% CI 2.63–17.60; p < 0.001) or first-authored more than 1 publication during their training (OR 5.13, 95% CI 1.56–16.85; p = 0.002). While we did not collect data on scientific output, the survey results indicate that European female residents are half as likely to have dedicated time for scientific work by their contract than their male colleagues (OR 0.50, 95% CI 0.27–0.93; p = 0.030), a result that may well influence the difference in academic career plans mentioned above. While trends pertaining to the gender mainstreaming in neurosurgical trainees are considered cautiously optimistic according to the data presented by Renfrow et al., at least in Europe, female trainees are still twice as likely as males to be worried about their future career perspectives. The belief in traditional gender roles that do not reflect actual knowledge and abilities, but influence decision making when it comes to promotions, or the manifestation of subtle or even explicit forms of sexism, and the lack of same-sex mentoring, are factors that have been suggested as responsible for the observed indifferences.

Critically analyzing the results at hand unmistakably reveals continuing gender differences at the trainee level. But also after basic training, females in neurosurgery remain a clear minority: in the US only 5% of board-certified neurosurgeons are females, and in Japan the rate was reported to be as low as 1.8%–3.4%.

<table>
<thead>
<tr>
<th>Type of clinic</th>
<th>Female</th>
<th>Male</th>
<th>p Value</th>
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<tbody>
<tr>
<td>University hospital</td>
<td>94 (74.6%)</td>
<td>297 (73.2%)</td>
<td>0.458</td>
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<tr>
<td>Nonuniversity public hospital</td>
<td>27 (21.4%)</td>
<td>100 (24.6%)</td>
<td></td>
</tr>
<tr>
<td>Private hospital</td>
<td>5 (4.0%)</td>
<td>9 (2.2%)</td>
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Total | 126 (100%) | 406 (100%) |

The WINS has outlined 4 strategies before that should help set the grounds to minimize gender disparity: 1) characterize barriers, 2) identify and eliminate discriminatory practices, 3) promote women into leadership positions, and 4) foster the development of female neurosurgeon role models by training and promoting competent female trainees and surgeons. These strategies should be recalled and implemented in Europe as well as in the US and beyond. Recruiting and retaining talented trainees into neurosurgery,
regardless of their gender, and integrating more females will ensure diversity, and it is “vital to the future success of our evolving specialty.”

It is also pertinent to recognize that the issue of women in medicine is not new. One hundred years ago a group of female doctor volunteers offered their services to the British War Office but were refused. Instead they managed to obtain support from Allied governments and worked in Greece, Serbia, and France. After the war and with a wealth of surgical experience, its Chief Medical Officer, surgeon Louise McIlroy, returned to the male-dominated London medical scene and became the country’s first ever female Professor of Obstetrics and Gynecology. A century later things have certainly improved, yet further progress is still achievable.

Acknowledgments

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References


Disclosures

The authors report no conflict of interest.

Response

We are delighted at the interest in our article and the additional data provided by Dr. Stienen et al. regarding participation of women in neurosurgical training courses and current perceptions of the practice environment within Europe. Disparities in the recruitment and retention of women in neurological surgery are common to both the US and Europe. Both studies demonstrate that there are cautiously positive trends in enrollment and completion of neurological residencies by women, including participation in EANS courses, which have correlated with an increased number of women sitting for Part I (written) of the European board examination. In the US, 61% of female residents who trained during 1990–1999 obtained board certification, which increased to 70% of the cohort who trained from 2000 to 2009.

As is true in both the US and Europe, despite the increased recruitment and retention of women in neurosurgery, there exist gender disparities. Given the equal number of men and women in US medical schools today, a disproportionate minority of women pursue neurosurgery, even when compared with other competitive specialties such as dermatology and radiation oncology. In the US, the attrition rate of women is 3 times the attrition rate of men in neurosurgery (17% vs 5.3%). Compensation, research support, mentorship, and career advancement remain additional challenges in which disparity is seen. As Stienen et al. found in the EANS survey, women were less likely to pursue academic careers, less likely to have dedicated scientific work time in their training contracts, and were less confident than males in working under their own responsibility after completing training.

Perhaps one strategy to improve retention and academic promotion of the women in neurosurgery is to recognize that women, as a group, may have an inherently different learning style from that of men. While men may respond well to criticism, women often respond better to praise. Women often over-generalize critical feedback as diag-
nastic of their overall self-worth.\textsuperscript{1} Self-evaluation can also differ according to gender. Females tend to be excessively critical of their performance, while males may tend to overestimate their abilities and accomplishments.\textsuperscript{2} In a recent article exploring the success of professional women, the gender disparity in confidence was highlighted.\textsuperscript{3} Perfectionism leading to risk avoidance is not uncommonly seen in women, resulting in gender disparity on a professional level, as men do not tend to avoid risk in the same manner. Women may hold back until they are sure they are perfectly qualified, applying for a promotion only when they met 100% of the qualifications as opposed to men who applied when they met 50%.\textsuperscript{1} An understanding of individual needs and how educators approach each resident is an important part of mentorship, another factor in which there has been gender disparity.

Stienen et al. also highlight the role of women in neurosurgery beyond training in the European practice environment. In Europe, women were found to be more likely to work as an attending in a nonuniversity public hospital and specialize in pediatric neurosurgery. Data forthcoming from our group find that in the US, women enter private practice and academic neurosurgery in proportions equal to men in the field, approximately 70% private and 30% academic. Our data support that pediatric neurosurgery is the most common fellowship pursued by women in the US, as in Europe. In a 2012, statement from the AANS, American Board of Neurological Surgery, Congress of Neurological Surgeons, and Society of Neurological Surgeons to the Institute of Medicine, projections concluded there are too few pediatric neurosurgeons, as well as neurosurgeons to provide emergency and trauma care. Female neurosurgeons entering this subspecialty are addressing an unmet need.

There is still tremendous gender disparity in academic standing, according to a recent reassessment from our group. Among males in neurosurgery there are currently 473 professors.\textsuperscript{3} Currently, there are 17 female full professors of neurosurgery in the US, in addition to 1 chairwoman, 2 vice chairs of neurosurgery departments, and 7 program directors, serving in 105 training programs. Women are, however, increasingly becoming subspecialty directors within their department, and active within organized neurosurgery, with almost a third of the American Association of Neurological Surgeons Board of Directors, including ex officio members, being female.

It has been well documented that there are no differences in overall gender ability or productivity,\textsuperscript{3} yet there continues to be gender disparity internationally, especially within the academic arena. This may be, in part, due to subtle gender differences, such as confidence, that influence career decisions and can be addressed by improving educational strategies and mentorship.

Jaclyn J. Renfrow, MD  
Stacey Q. Wolfe, MD  
Wake Forest University School of Medicine, Winston-Salem, NC

References


To the Editor: We read with interest the article by Tator et al.\textsuperscript{11} describing the presentation of 221 patients treated for postconcussion syndrome at a single center (Tator CH, Davis HS, Dufort PA, et al: Postconcussion syndrome: demographics and predictors in 221 patients. J Neurosurg [epub ahead of print February 26, 2016; DOI: 10.3171/2015.6.JNS15664]). This report contains a great deal of useful information on this challenging syndrome and will be a valuable addition to the literature on concussion. The authors found 10 patients (4.5%) with Chiari malformation (CM) Type I and 8 patients (3.6%) with intracranial arachnoid cyst (AC) and concluded that these findings are significantly overrepresented in individuals with concussion compared with the general population. We would like to present an alternative interpretation for their AC and CM prevalence data and suggest that these rates do not necessarily prove that AC and CM are more common in those with postconcussion syndrome.

To prove that these findings are overrepresented, it is necessary to properly determine their expected imaging prevalence in a valid comparison group. Unfortunately, the article does not contain internal control groups with respect to CM or AC prevalence, necessitating the use of prevalence estimates drawn from other previously published studies. This technique does not allow for age or sex matching and does not control for differences in methodology among studies. We believe that the imaging prevalence of AC and CM in the control population was underestimated in this article and, as a result of this, the prevalence difference, if any, between those with postconcussion syndrome and the general population may have been substantially overestimated.

Tator et al.\textsuperscript{11} use a population prevalence estimate for CM of 0.00078% and compare this prevalence to the CM imaging prevalence in their own cohort. They cite two articles as the basis for this estimate. In the first article, Meadows et al.\textsuperscript{4} found a higher prevalence of CM on imaging (175 patients with CM out of 22,591; 0.77%) in a
cohort of mostly adult patients undergoing MRI at a single referral center. Furthermore, there is some evidence that the prevalence of CM on imaging changes with the age of the population being studied \(^9\) and that the prevalence of CM is higher in a population of children and young adults than in the general population or a population that includes a large number of older adults. Age differences are especially relevant when comparing to a group experiencing postconcussive symptoms since a group of patients experiencing concussion is likely to be younger than a cohort undergoing imaging for any reason. The second article that is referenced for CM prevalence is a review article that attempted to derive CM prevalence by back-calculating from early estimates of syrinx prevalence.\(^9\) This calculation assumed that early syrinx prevalence estimates were correct and syrinx was found in 68%–80% of those with CM.\(^9\) Although this rate of syrinx in CM patients is the most frequently reported range for those undergoing surgery, there is no basis for assuming this is accurate for all patients with CM, including those not selected for surgery. Since a syrinx is frequently cited as a surgical indication for CM decompression,\(^6,7\) it is likely that its prevalence in those with CM is overestimated in surgical series and that the syrinx prevalence in patients with CM is lower when those not undergoing surgery are also included.\(^10\)

We believe that a substantial amount of evidence supports a much higher prevalence estimate for CM on imaging than the 0.00078% estimate that was used as a basis for comparison in the article, especially in the younger age groups that were most represented in the concussion study. An age-matched comparison group is essential for comparing CM prevalence between groups since its prevalence may be higher in younger patients than older adults.\(^3,8,10\) Recent analyses that focus on younger patients have shown imaging prevalence rates between 2.1% and 3.6% in these age groups.\(^3,8,10\) Even the Rotterdam study—which focused on older adults—found a 0.9% prevalence of asymptomatic CM.\(^12\) Taken together, the vast majority of recent evidence supports the fact that the prevalence of CM on imaging is substantially higher than 0.00078%, especially in young patients. For this reason, we believe that further study is required before any conclusions can be reached on any purported overrepresentation of CM in those with concussion.

Regarding ACs, Tator et al. compared AC prevalence in the concussion group to a population prevalence estimate for AC ranging from 0.006% to 1.7%. The authors did not cite references for these estimates. They concluded that ACs were significantly more prevalent in those with postconcussive symptoms. Using the higher estimate for AC prevalence that was provided, no statistically significant difference was seen compared to their concussion group. More recent estimates of AC prevalence on imaging range between 1.1% and 3.3%\(^1,2,12\), supporting a prevalence estimate on the higher side of the range that was stated in the article. In addition, the highest prevalence of AC may been found in young males,\(^3\) a group that is overrepresented in most concussion cohorts. For these reasons, we suggest that the AC prevalence in the group of patients with postconcussive syndrome is not likely significantly different than those in a valid comparison population.

Once again, we congratulate the authors on their valuable contribution to the literature on concussion.

References

Disclosures
The authors report no conflict of interest.

Response
We appreciate the comments on our paper made by Drs. Strahle and Maher and agree that we may not have used the appropriate control population for comparing the incidence of CM and ACs in our series of patients with postconcussion syndrome (PCS). The authors indicated that our PCS patients were likely younger than the general populations to which we compared them, because CM es-
pecially, and perhaps AC as well, may be more prevalent in younger patients. Thus, PCS patients may not have a higher incidence of either of these congenital anomalies than appropriately matched general populations. Now that we have raised the issue of a possible relationship between PCS and CM or AC, it remains for future studies to examine these issues in larger populations of PCS patients who have either CM or AC and to make the comparisons with age-matched segments of the general population.

Charles H. Tator, MD, PhD, FRCS
University of Toronto and Toronto Western Hospital, Toronto, ON, Canada

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Resection of olfactory groove meningiomas

TO THE EDITOR: We congratulate Banu et al.1 on their article comparing 2 minimally invasive approaches for dealing with olfactory groove meningiomas (Banu MA, Mehta A, Ottenhausen M, et al: Endoscope-assisted endonasal versus supraorbital keyhole resection of olfactory groove meningiomas: comparison and combination of 2 minimally invasive approaches. J Neurosurg 124:605–620, March 2016). The authors concluded, “the supraorbital eyebrow approach, with endoscopic assistance, leads to a higher extent of resection and lower rate of complications than the purely endonasal endoscopic approach.”

The study, however, has some inherent methodological shortcomings to which we would like to draw the authors’ attention. The mean tumor volume was 19.6 cm³ in the endonasal group, 33.5 cm³ in the supraorbital group, and 37.8 cm³ in the combined group. It is not methodologically appropriate to compare 2 techniques in patients with different tumor volumes. Moreover, the derived conclusions may be an overestimate, as the number of cases in each group is small: purely endonasal (6 cases), supraorbital eyebrow (microscopic with endoscopic assistance, 7 cases), and combined endonasal endoscopic with either the bicoronal or eyebrow microscopic approach (6 cases). The conclusions regarding the superiority of any one approach cannot be deduced from a series based on such a small number of patients. The authors have not mentioned when postoperative MRI was performed, within 48 hours of surgery or later, to determine whether there was residual or recurrent tumor.

The reported infection rate of 15% with use of the endoscope is quite alarming in this era of advanced endoscopic techniques. In various series reported in the literature, the incidence of meningitis in patients undergoing endoscopic supraorbital approaches and endoscopic skull base surgery ranges from 1.03% to 1.8%.2,3 The numbers in Table 3 do not tally.

It is unclear why the patients in Case 14 (tumor volume 3.24 cm³) and Case 19 (tumor volume 14.78 cm³) were treated by means of a combined approach. Tumors of that size or larger may be operated on via either an endonasal or an eyebrow approach alone, thereby reducing the morbidity of the combined procedure.

Ankit Bansal, MCh
Sumit Sinha, MCh
All India Institute of Medical Sciences, New Delhi, India

References

Disclosures
The authors report no conflict of interest.

Response
We thank the authors for their thoughtful comments on our article. They make several points, and we will respond to them individually. The first comment is that the number of cases in this series is small and the size of the tumors removed endonasally was smaller than those removed through an eyebrow incision or through a combined approach. With regard to the first point, olfactory groove meningiomas are relatively uncommon tumors, and most single-center series are relatively small. However, even with this small number of patients we found a statistically significant result, which means that the finding is robust. A negative result should be suspect with such a small series. As for the size of the tumor, there is clearly a selection bias, and we chose smaller tumors for the endonasal approach since those tumors did not extend laterally past the lamina papyracea and were suitable for this approach. This inherent bias would have favored better results in the endonasal endoscopic group; however, we found just the opposite, namely worse results in this group.

The authors also note that we failed to mention the timing of the postoperative scans. This was clearly an oversight in our paper. We generally obtain postoperative scans within 48 hours after surgery and use these scans to determine the extent of resection. Moreover, we know of no evidence—and the authors do not provide any—indicating that the timing of the postoperative scan (48 hours after surgery or later) makes a difference in estimating the extent of resection for meningioma surgery. Thus, our oversight in not reporting the timing of the scan should have no bearing on the reliability of the results.

Finally, the authors feel that the 15% infection rate we
report in our small endonasal series is too high compared with the rates reported in the literature and reference a paper on 1000 endonasal endoscopic surgeries performed at the University of Pittsburgh that found an infection rate of 1.8%.1 The majority of the surgeries in that paper, however, were pituitary adenomas, which are known to be associated with a much lower rate of meningitis and other infections than more complex cases like meningiomas. In fact, in that very same article, the complexity of the case was a risk factor for infection, and according to my calculation, their infection rate with more complex cases was actually 5%. Moreover, when this same group reported their complication rate in a series of 50 olfactory groove meningiomas removed through an endonasal endoscopic approach, their infection rate was 8% for meningitis and intracranial abscess with an additional 10% of patients having a sinus infection.2 Hence, our 1 case of infection, which resulted in a 15% infection rate, is probably not far from the rates at other centers. More importantly, the overall complication rate for endonasal olfactory groove meningeoma surgery in our series was 83%. While this may appear high, in a series of 50 olfactory groove meningiomas removed by the University of Pittsburgh group, these authors report that 70% of their patients required 2 surgeries, there was a complication rate of approximately 90%, the anosmia rate was 100%, and the average length of stay was 11 days.2,3

Given these suboptimal results of endonasal surgery for olfactory groove meningeomas, we propose the supraorbital eyebrow incision with endoscopic assistance as a more suitable minimally invasive alternative that provides the benefits of minimizing brain retraction, preservation of the sagittal sinus with the possibility of preserving olfaction, and the potential for equally high rates of gross-total resection. In our opinion, the endonasal endoscopic approach can be offered to patients with olfactory groove meningeomas as an additional minimally invasive approach for those tumors that invade into the sinuses or through the cribriform plate.

Theodore H. Schwartz, MD
Weill Cornell Medical College, NewYork-Presbyterian Hospital, New York, NY

References

“Cured” intracranial dural arteriovenous fistulas

TO THE EDITOR: We read with great interest the recent paper by Ambekar and colleagues1 (Ambekar S, Gaynor BG, Peterson EC, et al: Long-term angiographic results of endovascularly “cured” intracranial dural arteriovenous fistulas. J Neurosurg 124:1123–1127, April 2016). The authors report their center’s experience with Onyx embolization of 26 dural arteriovenous fistulas (DAVFs) from 2006 to 2013. They define angiographic “cure” as occlusion of a fistula with the absence of early venous drainage immediately postembolization. They report exceptional short-term results as they found that all 26 lesions met their criteria for postembolization cure. The authors then determined that their overall rate of DAVF recurrence following initial complete occlusion was 14.3%, according to repeat angiography performed on 21 treated DAVFs at a mean time of 14 months postembolization.

We believe that a clear distinction must be drawn between the true recurrence of a cured fistula and the re-emergence of a fistula that is only partially occluded but rendered angiographically occult. This distinction is not just semantic but is critically important when comparing the efficacy and long-term durability of the different procedures available for the treatment of DAVFs. It is our opinion that the authors’ method of defining “cure” over-estimates the success of their initial embolization. In our practice, we do not believe that a DAVF can be deemed “cured” based on an initial postembolization angiogram. We suggest that a repeat angiogram approximately 3 months later would more likely distinguish between a true cure and an initially angiographically occult, but not completely obliterated, DAVF.

The authors’ number of initially occluded fistula cases that later demonstrated recurrent shunting is not surprising given the known properties of Onyx. This agent facilitates the successful embolization of DAVFs because of its ability to penetrate the fistulous site from either the arterial or venous side. In some cases, however, Onyx may only angiographically “silence” the fistula while leaving the fistulous point and draining vein patent. Onyx laminates along the vessel circumference as it is pushed forward. As this occurs, the central lumen is not initially obliterated, but rather small channels persist. This quality of Onyx allows for very effective radial distribution, as emphasized by the authors. However, as Onyx is not exquisitely pro-thrombotic (in contrast to N-butyl cyanoacrylate), any remaining channels through the fistula may serve to recruit additional arterial supply, resulting in perceived recurrence of an initially angiographically occult fistula.2 This also explains the observation of a recanalized fistula when incomplete penetration into the draining vein is initially observed.

Authors of several recent series have examined the recurrence rate of cranial DAVFs embolized with Onyx. There remains a lack of standardization in follow-up imaging among endovascular centers, with most studies reporting a single follow-up angiogram obtained at various intervals. For instance, Panagiotopoulos et al. reported on a series of 11 patients who exhibited immediate postem-
bolization DAVF occlusion and a similar 11% rate of residual DAVF on follow-up angiograms obtained at a mean of 3 months. However, this group noted a lower rate of venous penetration during the first embolization attempt. Few studies have examined cases occluded at 3 months that remain so at a later time point, but our suspicion is that the number of such true recurrences would be vanishingly small when framed in this context. This is exemplified by Chandra et al.’s study of 41 consecutive DAVFs. Immediate angiographic occlusion was 95%. Of the 35 patients who exhibited initial angiographic occlusion, 6% were found to harbor a residual DAVF at a median 4-month follow-up. The other 33 patients exhibited persistent occlusion of their fistula when they underwent repeat angiography at a median of 28 months.

Michael M. McDowell, MD
Andrew F. Ducruet, MD
University of Pittsburgh, Pittsburgh, PA

References

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Response
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