Neuropsychological impairment and quality of life after skull base meningioma resection: size and location matter

TO THE EDITOR: We read with great interest the recent article by Zweckberger et al. (Zweckberger K, Hallek E, Vogt L, et al: Prospective analysis of neuropsychological deficits following resection of benign skull base meningiomas. J Neurosurg [epub ahead of print February 10, 2017. DOI: 10.3171/2016.10.JNS161936]). As the authors note, this is an important and timely area of research, given the availability of different treatments for skull base meningioma and the limited understanding of neuropsychological and behavioral outcomes in skull base meningioma patients. In their article, the authors describe the neuropsychological outcomes of a heterogeneous group of skull base meningioma patients to provide results of “the first prospective study of neuropsychological outcomes following resection of skull base meningiomas,” noting that “the majority [of patients] demonstrated stable or improved outcome at follow-up assessments.” Interestingly, the authors did not find a relationship between tumor size or tumor location and pre- or postoperative quality of life. Ultimately, the authors concluded that “surgical removal of skull base meningiomas has positive effects on neuropsychological outcome in a considerable majority of patients.” Taken at face value, this conclusion would have important implications for neuropsychological and behavioral outcomes following resection of skull base meningiomas.

We have a somewhat different perspective, derived from our extensive neuropsychological and neuroanatomical investigations of these types of patients (reported in a recent study, of which Zweckberger et al. may not have been aware). The authors have examined a relatively small and anatomically heterogeneous cohort of meningioma patients, which makes the interpretation of their results difficult. Furthermore, a wealth of neuropsychology literature demonstrates that the anatomical location of lesions associated with meningiomas plays a crucial role in the nature and severity of neuropsychological impairment. Zweckberger et al. examined the neuropsychological effects of skull base meningiomas collectively, grouping together patients with pathology in the anterior, middle, and posterior cranial fossae. Obviously, brain lesions in different cranial fossae impact distinct brain regions that subserve distinct brain function. For example, an olfactory groove meningioma may be associated with alteration in real-life decision making and adaptive functioning, while a posterior fossa meningioma typically is not. Therefore, the specific anatomical location of the skull base meningioma (or any brain lesion for that matter) plays a crucial role in determining the nature of the pre- and postoperative neuropsychological and behavioral impairment and, ultimately, the effects on quality of life. In fact, as has been previously shown, some of the most significant types of impairment seen after olfactory groove meningioma would be missed by routine neuropsychological testing.

Furthermore, the role of lesion size should not be underestimated. On chronic (>6 months postoperative) neuroimaging, some patients demonstrate large areas of encephalomalacia after meningioma resection, while other patients have no encephalomalacia at all. The location and size of structural brain damage caused by the meningioma likely plays an important role in the degree of neuropsychological impairment and, ultimately, quality of life.

Therefore, while the work of Zweckberger et al. explores an important and timely topic, the results must be interpreted with caution, given the anatomical heterogeneity of the meningiomas studied. Further work in this area should consider the specific anatomical structures affected by the meningioma, as well as the size and location of the chronic postoperative lesion (not only the size of the meningioma preoperatively). Finally, neuropsychological testing batteries should be tailored to assess for impairment related to the specific brain regions involved in the meningioma, including disturbances in personality, decision making, and real-life functioning with ventromedial prefrontal involvement.

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response was received from the authors of the original article.

Microsurgery for basilar apex aneurysms in the modern era

TO THE EDITOR: We read with interest the recent manuscript by Bohnstedt et al.1 (Bohnstedt BN, Ziemba-Davis M, Sethia R, et al: Comparison of endovascular and microsurgical management of 208 basilar apex aneurysms. J Neurosurg [epub ahead of print January 13, 2017. DOI: 10.3171/2016.8.JNS16703]). They present their series of consecutive basilar apex aneurysms treated at Indiana University Health Methodist Hospital and St. Vincent Hospital over the last nearly 40 years. They had 47 patients who underwent clipping and 161 who underwent endovascular therapy. We have some comments about this paper.

1) In their Results section they report the rate of cranial nerve palsy as 55.3% in the open-surgery group and 16.2% in the endovascular group (p = 0.000), and then report the rate of mono- or hemiparesis as 27.7% in the clipped group versus 10.6 in the endovascular group (p = 0.008). Oddly, the authors then report the Glasgow Outcome Scale (GOS) score at discharge as statistically equivalent, and state that the 2 modalities therefore offer equivalent functional results. The GOS is a very coarse (and probably inappropriate) measurement of functional status in this cohort, and given the data on cranial nerve deficits and hemiparesis presented here, it is very hard to justify this conclusion. Perhaps an extended GOS or modified Rankin Scale would have been more appropriate and the conclusions different. With the data presented here, endovascular treatment seems to be definitely superior to the surgical arm in their hands. No statistics are given in regard to aneurysm morphology in the 2 groups. They state that there was an “endovascular first” approach, but no morphology numbers are given to support this claim. It would be helpful to the reader to know why the authors believed that some aneurysms should be sent for clipping over coiling.

2) Our institution also published a series not cited by this group.2 In our series of 100 consecutive basilar artery (BA) apex aneurysms treated over 7.5 years, there were 63 ruptured (24 clipped, 39 coiled) and 37 unruptured (13 clipped, 24 coiled) aneurysms. Eleven of 37 clipped BA apex aneurysms (29.7%) experienced third cranial nerve palsy. All but one had recovered completely by the 3rd month of follow-up. Cranial nerve disability was taken into account in assessing the patient’s functional status at 3 months and 1 year. Seventy percent of the patients with ruptured aneurysms and 92% of the patients with unruptured aneurysms had a good outcome as measured by a modified Rankin scale score of 0–2 at 3 months, with no statistical difference between the clipped and coiled groups. Of the endovascularly treated patients, 17.4% required retreatment. In the ruptured, clipped group there were 3/37 patients with residual aneurysms (8%), 1 of whom later required retreatment with endovascular procedures (stent-assisted coiling). There were no residual lesions for unruptured clipped aneurysms.

3) In our series of BA apex aneurysms,2 we used a number of operative nuances that may have been responsible for the better (equivalent to endovascular) results from microsurgery. For the extended transsylvian approach, these included the following: orbitozygomatic osteotomy in most cases, anterior clinoidectomy and optic nerve decompression, posterior clinoidectomy when needed, fibrin glue injection into the cavernous sinus, temporary occlusion of the BA with burst suppression and motor evoked potential monitoring, protection of the perforator-aneurysm plane with a rubber dam once the dissection has been accomplished, and brief periods of adenosine arrest as needed. Very low-lying BA aneurysms were treated by a subtemporal, transfalcine, transcavernous approach. When the aneurysm did not have a clippable neck, terminal BA occlusion was used, usually after a bypass into the posterior cerebral artery to revascularize it (typical V3–P1 with a radial artery graft). There was a statistically significant difference in morphology between the coiled and clipped aneurysms in our group, with the latter having a low dome-to-neck ratio, aspect ratio, and a very broad neck.

4) Expertise in surgical clipping of BA apex aneurysms is rapidly declining. This is due to the rapid advancement of less invasive endovascular technology that is easier to learn and deploy. These devices do a very good job of obliterating the vast majority of BA aneurysms, and provide good patient outcomes—with the caveat of needing more short-term monitoring and accepting higher retreatment rates at low risk for further morbidity. Because of this, present-day cerebrovascular surgeons have even less experience and expertise with microsurgical treatment, which favors an endovascular technique in almost all cases. There are still BA aneurysms that are better treated by microsurgical techniques, and microsurgery still offers durability, which may be important for patients who live far away from major medical centers and may not be likely to come back for follow-up angiography. In many countries, clipping of aneurysms is still cheaper due to the costs of endovascular devices. How to train future surgeons to...
perform high-quality microsurgery is a real problem without an easy solution.

5) We appreciate the review performed by these authors, which has highlighted many of the points raised for discussion.

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Disclosures
Dr. Kim has direct stock ownership in Spi Surgical, Inc.; is a consultant for MicroVention, Inc.; and received support of non-study-related clinical or research effort from the NIH.

Response
We have reviewed the comments from Drs. Morton, Kim, and Sekhar and would like to make a few clarifying points. Although our database extends back to 1977, our study was for the selected period between 2000 and 2012. It is important to note that an independent reviewer recorded complications prospectively during the period of the study to assure detection of the most minor deficits that may go unnoticed or be considered unimportant by the surgical team.

In our study, postoperative deficits refer to any alteration in neurological status that presented after the procedure, even though they could have been related to the syndrome of subarachnoid hemorrhage. Conclusions about specific relationships of a deficit to the procedure, vasospasm, or preexisting conditions can be difficult to determine in a retrospective fashion. We believe it is most appropriate to present the data unaltered and in a transparent manner, rather than trying to draw conclusions historically. We agree that the GOS is a coarse measure of outcome; it assesses the patients' overall functional status rather than representing a tally of individual complications.

In essence, some of our patients suffered from only a minor oculomotor palsy or a slight pronator drift, and still were able to function at a very high level (GOS 5). We consider this a complication. On the other hand, a patient may have no specific neurological deficit following his or her subarachnoid hemorrhage and yet be unable to work or perform normal daily activities (GOS 3).

We congratulate Dr. Sekhar on his publication and apologize for not citing his work.3 We used posterior cli

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Rectus capitis lateralis muscle: anatomical relationships in posterior and anterior approaches to the jugular foramen

TO THE EDITOR: We read with keen interest the article by Cohen et al.,1 in which they discussed the importance of rectus capitis lateralis (RCL) muscle as a landmark in posterior and lateral approaches to the jugular foramen (Cohen MA, Evans AI, Lapadula G, et al: The rectus capitis lateralis and the condylar triangle: important landmarks in posterior and lateral approaches to the jugular foramen. J Neurosurg [epub ahead of print January 27, 2017. DOI: 10.3171/2016.9.JNS16723]). They have described the anatomical relationships and surgical utility of the RCL for safe exposure of the jugular foramen area by cadaveric dissection and drawings. In addition, the authors defined a triangular area bounded by superior oblique and RCL muscles and a line connecting their insertions on occipital bone, and named it the condylar triangle.

We congratulate the authors for directing attention to this important muscle as a surgical landmark in skull base approaches to the jugular foramen. Although they acknowledge the contributions of Katsuta et al.,3 Wen et al.,4 and Rhoton et al.,5,6 in describing this muscle in previous cadaveric studies, the authors state that their cadaveric study is the first comprehensive review of neural, vascular, and musculoskeletal relationships of RCL muscle. Here we would like to draw their attention to our contribution to
the subject and our illustration of the RCL muscle in our recent publication titled “Craniovertebral junction 360°: A combined microscopic and endoscopic anatomical study,” which unfortunately was not cited.2

While describing the craniovertebral junction anatomy from anterior, lateral, and posterior corridors, we have emphasized the importance of the RCL muscle as a useful landmark in approaches to the jugular foramen and adjoining areas.2 Apart from the posterior and lateral corridor, during our expanded endoscopic anterior approach we were able to demonstrate and describe important neurovascular and osseous relationships of RCL muscle.

Muscles around the neck can be divided into 3 groups of layers; namely, superficial, middle, and deep. Because superficial and middle-layer muscles are reflected with skin flap or are not dissected separately, their detailed description is surgically not important. But deep-layer muscles have a constant relationship to neurovascular and bony anatomy, and thus can be useful landmarks in surgical approaches even if the anatomy is distorted by underlying pathology. The rectus capitis muscles are a group of muscles connecting the occiput with the axis and atlas vertebrae. The rectus capitis anterior (RCA) is a short muscle immediately behind the longus capitis; it arises from the anterior surface of the lateral mass and root of the transverse process of the atlas, passing obliquely upward to be inserted between the inferior clival line and foramen magnum in the supracondylar groove.4 The RCL muscle can be seen as a short, flat muscle; it arises from the upper surface of the transverse process of the atlas, and it is inserted into the undersurface of the jugular process of the occipital bone. This muscle covers the internal jugular vein (IJV) and lower cranial nerves when approaching from the posterior or posterolateral aspect.

Most of the common pathologies in the jugular foramen region can extend both intra- and extracranially and displace neurovascular structures. Although the authors have demonstrated the extracranial relationship of the lower cranial nerves to RCL muscle, their origin and intracranial path is not clearly demonstrated. We made a panoramic exposure from the posterior aspect, showing the path of the lower cranial nerves from their origin to their extracranial course, with relation to the pharyngeal internal carotid artery (ICA), RCL muscle, and vertebral artery (VA). The eustachian tube (ET) is a useful landmark for the pharyngeal ICA, behind which are lower cranial nerves. The ET runs parallel and anterior to the petrous ICA, and it enters the petrous bone just medial to the ascending pharyngeal ICA before it enters into the petrous canal. The ET is removed to allow exposure of the pharyngeal ICA and petroclival synchondrosis, which lead to the jugular foramen.

Dissection lateral to the occipital condyle and between it and the pharyngeal ICA provides exposure of another muscle extending posterior to the lower cranial nerves. This is the RCL muscle, and it can be differentiated from the RCA by the direction of muscle fibers. The RCA muscle fibers are directed superiorly and medially from the transverse process of the atlas, whereas RCL muscle fibers are directed more posteriorly toward the jugular ridge from the transverse process of the atlas. The supracondylar groove is a useful landmark after removal of the RCL muscle, which gives the position of the hypoglossal canal.5

We drilled the occipital condyle and lateral mass of the atlas to expose the course of the VA from the extracranial to intracranial compartment in our dissection. After that, lower cranial nerves were dissected further to expose each individual nerve. In our dissection from the anterior aspect, the hypoglossal nerve was visible coming out of the hypoglossal canal before it joins other lower cranial nerves in relation to the ICA and IJV. The VA can be seen posterior and medial to the RCL muscle, and lower cranial nerves can be seen anterior to this muscle and joining the ICA from the anterior aspect. Thus, the RCL muscle can be demonstrated from both the anterior and posterior aspects in relation to the VA and lower cranial nerves.

Although Cohen et al. described the transmastoid lateral and far-lateral posterior approach to the jugular foramen in relation to the RCL muscle in a beautiful way, we think that to better understand and orient to the neurovascular anatomy in proximity to the RCL muscle, one needs to have a view of the extracranial and intracranial course of these structures. The anterior endoscopic view adds another 3D perspective to this region.

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Disclosures
The authors report no conflict of interest.

Response
We thank Jhawar and colleagues for their interest in our article. As our article was accepted for publication in September 2016, as is clearly printed on the footer of the paper, we thus could not have cited their article, which was first published digitally in November 2016.

Jhawar and colleagues state that our article does not clearly demonstrate the “origin and intracranial path” of the lower cranial nerves in relation to the RCL. This is, of course, correct and by design, because the RCL has absolutely no clinically relevant relationship with the intracranial aspect of the jugular foramen. The jugular tubercle serves as a well-established landmark for identification of the intracranial aspect of the jugular foramen—and the proximal lower cranial nerves in the cerebellomedullary angle—and indicates where to drill in order to expose these structures. In contrast, the RCL overlies the neurovascular structures exiting the jugular foramen extracranially and allows for their identification in posterolateral approaches, especially in the presence of anatomically displacing tumors.

Furthermore, we dismiss the claim of Jhawar and colleagues that there exist any surgically useful relationships between the RCL and surrounding neurovascular structures in the endoscopic endonasal approach to the jugular foramen. As clearly stated in our Discussion section, “When approaching the jugular foramen anteriorly, the contents of the jugular foramen are encountered prior to the RCL; thus, the relevance of the RCL as a surgical landmark is limited to the posterolateral approaches.” Additionally, “the RCL remains a valuable and protective landmark for identifying the jugular process and the VA from lateral and anterolateral trajectories” but not from anterior or anteromedial trajectories, where the RCL is the most lateral structure, or from a posterolateral trajectory, where the VA is previously identified in the suboccipital triangle. Hence our proposal of the condylar triangle for identification of the terminal segment of the hypoglossal canal as well as the superior aspect of the VA at its exit from the C-1 foramen transversarium.

Although the endoscopic endonasal approach to the jugular foramen has gained academic interest in recent years, the surgical practicality and ethics of such an approach to lesions of the extracranial aspect of the jugular foramen—especially to an extent that would involve the RCL, which lies less than 1 cm below the skin—must be carefully considered because it is very difficult to justify the long and difficult endonasal corridor required, as specified in detail by these authors. Jhawar et al.’s discussion of the complexity of the associated parapharyngeal and ET anatomy and traversal of the carotid sheath region to extend exposure to the extracranial aspect of the jugular foramen underscores the unnecessary difficulty of this endoscopic approach. Clinical application of such a procedure as an academic exercise with little to no benefit for the patient and a high potential for morbidity should be discouraged.

In all, we find an endonasal endoscopic approach to the extracranial aspect of the jugular foramen to be currently unjustifiable, and we encourage Jhawar and colleagues to distinguish between intra- and extracranial aspects of the jugular foramen region, because an endoscopic endonasal approach to the medial intracranial portion of the jugular foramen is certainly feasible.

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