Neurosurgical Forum LETTERS TO THE EDITOR

Ultrasonography of the optic nerve sheath and decompressive craniectomy

TO THE EDITOR: The evaluation of the elevation of intracranial pressure is a relevant issue during the management of patients with traumatic brain injury (TBI). We read the interesting article by Wang et al.¹⁰ in which the authors share their experience with ultrasonography to measure the optic nerve sheath diameter, which they correlate with intracranial pressure (ICP), and identify the process as an accurate noninvasive method in patients with decompressive craniotomy (Wang J, Li K, Li H, et al: Ultrasonographic optic nerve sheath diameter correlation with ICP and accuracy as a tool for noninvasive surrogate ICP measurement in patients with decompressive craniotomy. *J Neurosurg* [epub ahead of print July 19, 2019. DOI: 10.3171/2019.4.JNS183297]).

We have some questions that must be clarified to extrapolate and validate their results. First of all, the authors report that the patients underwent decompressive craniectomy without defining the surgical technique. Why is this topic important? It has been established that the size of the craniectomy influences ICP values in the postoperative period.⁷ It would be interesting to know the details of the surgical technique as this would add to the validity of the results and thus reduce the bias related to the inclusion of patients.

Interestingly, several studies have demonstrated the relevance of evaluating the optic nerve for early detection of intracranial hypertension.^{4,6} These studies are not extrapolated to the general population; cohorts of specific populations are required. Acting as a confounding factor to establish the normal diameter of the optic nerve sheath, ethnicity also needs to be carefully evaluated. Ethnicity can limit interpretation of the results and their applicability in daily practice.^{2,8}

The laterality of the lesion and its correlation with the elevation of the optic nerve sheath diameter are other relevant aspects. This is not reported in the data presented by the authors. Multiple studies have reported these findings and it would be interesting to know if this was evaluated in the study.^{1,3,5}

Compartmentalization of the ICP is another relevant aspect.⁹ It has been established that the parenchymal

ICP measurement corresponds to the evaluation of a local parameter indicative of a regional phenomenon and that evaluation with the intraventricular catheter would be more useful than that with intraparenchymal monitors. What was the reason for not using intraventricular ICP monitoring in the authors' study? On the other hand, the heterogeneity of brain injury should be taken into account, and the authors included heterogeneous intracranial lesions (acute subdural hematoma, acute intracerebral hematoma, cerebral contusion/laceration, and diffuse brain injury), which can alter the results.

Finally, given the potential benefits of the application of optic nerve ultrasound in patients with TBI and especially in those undergoing decompressive craniectomy, we suggest conducting studies in specific populations and multicentric studies to compare results that are relevant in the management of these patients. We congratulate the authors on their study despite the potential limitations.

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Response

We are grateful to Drs. Moscote-Salazar, Joaquim, and Agrawal for their interest and insightful comments regarding our article. Their first question relates to the surgical technique and the size of the craniotomy, both of which may influence ICP. A larger craniotomy produced a larger decrease in ICP⁸ in patients with TBI. The area of the bone window was approximately 12 × 15 cm in unilateral decompressive craniotomy (DC) and about double 12 × 15 cm in bilateral and frontal DC in our unit. The dura mater or artificial dura substitutes loosely covered the brain surface. Three patients with diffuse brain injury underwent bilateral or frontal DC among the 48 TBI patients potentially eligible for our study, and 2 died within 24 hours after DC. Among the 35 ultimately enrolled patients, 1 underwent bilateral and 34 underwent unilateral DC. We did not exclude a bilateral DC patient who had mildly elevated ICP.

The second question relates to optic nerve sheath diameter (ONSD) of the general population and ethnicity. Healthy volunteers who met the physical examination criteria underwent ultrasound examination in a calm state, and their ICP was considered normal. These volunteers provided written informed consent before ONSD examination.²

We agree that the laterality of the lesion influences the value of the ONSD. When ONSD measurements were performed, the operator did not find obvious differences in the ONSDs between the two eyes except in orbital injury, which was an exclusion criterion. We just compared the mean differences in left and right ONSDs, which were

0.31 ± 0.05 mm and 0.27 ± 0.03 mm in healthy volunteers and TBI patients, respectively (p = 0.53). The mean ONSD value was considered in the statistical analysis in this study. Both single (left/right)⁶ and mean values of ONSD⁷ were used as the parameters in different studies.

The other relevant aspect is compartmentalization of the ICP. External ventricular drainage (EVD) for ICP monitoring was considered as the gold standard for assessing ICP.⁴ Insertion of an EVD is not always possible when brain swelling causes shift or compression of the ventricles in severe TBI patients.¹ While the Codman MicroSensor for ICP monitoring has good concordance with the EVD⁵ and the MicroSensor ICP is highly accurate and stable in the tissue and subdural space,³ we implanted a MicroSensor transducer into the subdural space to monitor ICP in our unit. Heterogeneity of brain injury definitely influences the ICP values, but this may not affect the correlation between ICP and ONSD.

The aim of this study was to assess the association between ONSD and ICP in TBI patients after a DC operation. There were lots of factors influencing the ICP, such as the surgical technique, the size of craniotomy,⁸ and the heterogeneity of brain injury. We intend to evaluate the impact factors of ICP and ONSD by expanding the sample size and optimizing the study design in the future. We thank Drs. Moscote-Salazar, Joaquim, and Agrawal for pointing out these important issues, and we wish to cooperate with them in the future.

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Errors about the use of the Clinical Rating Scale for Tremor score

TO THE EDITOR: We read with interest the first 5-year single-center experience report by Sinai et al.¹ on MR-guided focused ultrasound (MRgFUS) ablation for essential tremor (Sinai A, Nassar M, Eran A, et al. Magnetic resonance-guided focused ultrasound thalamotomy for essential tremor: a 5-year single-center experience [published online July 5, 2019]. *J Neurosurg*. doi: 10.3171/2019.3.JNS19466). We are delighted to see such significant work.

However, we found a factual error in the authors' use of the Clinical Rating Scale for Tremor (CRST) score. According to their citation for the CRST,² the scores ranged from 0 to 160 points. The CRST scores used by Elias et al.³ also ranged from 0 to 160 points. However, the CRST scores used by Sinai et al.¹ range from 0 to 152 points. The authors might have deleted some parts of the scale, but this was not described in detail in their paper. As readers, we are confused about how they calculated the total CRST scores and whether the difference between the standard CRST and the CRST used in their paper would affect the results. We would like to express our concerns about the use of the CRST.

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Response

We thank Xiong et al. for their interest in our paper. We calculated the CRST score correctly based on a score range from 0 to 160 points. The number 152 that appears in the manuscript is a typing error and we will correct it with an erratum.

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Radiosurgery is a valuable alternative to microvascular decompression for glossopharyngeal neuralgia

TO THE EDITOR: We read with great interest the article by Teton et al.¹ on nerve sectioning with or without microvascular decompression (MVD) for drug-resistant glossopharyngeal neuralgia (GPN) (Teton ZE, Holste KG, Hardaway FA, et al. Pain-free survival after vagoglossopharyngeal complex sectioning with or without microvascular decompression in glossopharyngeal neuralgia. *J Neurosurg*. 2020;132[1]:232–238). The authors reported an 88% pain-free rate at the last follow-up in a small cohort of 18 patients. However, this rate should be balanced against a high rate of secondary side effects, including a 50% (n = 9) rate of persistent symptoms.

In our opinion, minimally invasive alternatives to MVD do exist in this rare pathology and deserve mention in such an important study. Regarding MVD, in 2002, Patel et al. reported a large cohort of 217 patients with a complete pain relief rate of 60% and 5.8% mortality in the initial part of their series, after MVD.²

As an alternative, Gamma Knife radiosurgery (GKRS) has proved to be safe and effective since the first case report published by Stieber et al. in 2005,³ followed by several other reports.⁴ The largest series published by Kano et al. showed a 73% initial good response.⁵ Data from a combined series in Marseille and Lausanne revealed 84% Barrow Neurological Institute (BNI) pain intensity scores I–IIIa at the last follow-up, with only one transient side effect (i.e., paresthesia of the edge of the tongue).⁶ These good results have been confirmed by a small series published by the Lille group, with a short time to clinical improvement after a mean period of 2 months.⁷ More recently, Balossier et al. reported the outcomes of second and third GKRS for recurrent GPN.⁸ These results were comparable to those after a first GKRS even in cases with

a neurovascular conflict. In this small series, 1 patient experienced pharyngeal hypesthesia after a second GKRS.

In sum, we consider GKRS to be a valuable alternative to MVD in this rare condition because of its minimal invasiveness and extremely rare complications. Moreover, previous GKRS does not preclude further MVD, and vice versa. These techniques could be rather complementary in the frame of pain management in these patients.

We congratulate the authors for a very nice study with a long-term follow-up. We believe that tailored management for such a rare condition should take into account the patient's medical condition, previous surgeries, etc., before deciding which therapy fits best for an individual need.

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Disclosures

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Response

We recognize the value of various treatment options in one's armamentarium; however, the use of radiosurgery to treat GPN appears costly.

We noted that cranial nerve sectioning with or without MVD demonstrated 94% relief of symptoms, with just one episode of recurrence despite a follow-up ranging from 5 to 13 years (average > 9 years). It is important to note that the “persistent symptoms” for 50% of the patients noted by the authors was in reference to complications from the procedures, the majority of which were transient and/or deemed tolerable by patients at the longest follow-up. Despite this, of those patients contacted by telephone, all but one said that they would undergo the procedure again.

It should also be noted that while a mortality rate of 5.8% is high for an elective procedure such as this, all deaths noted in the referenced Patel study occurred shortly after the advent of the procedure, between the years of 1973 and 1987, with no deaths noted since.¹

In a large study on stereotactic radiosurgery (SRS) for GPN, as noted by the authors, 50% of patients had initial complete pain relief (23% required pain medications to treat their symptoms) and “initial” only accounted for the first 3 months following their procedure.² Less than half of these patients (22%) would maintain that pain freedom at 7 years, which stands in sharp contrast to the patients in our study, who experienced pain-free survival of 7.5 years, on average. Additionally, follow-up times in the Kano study were significantly limited—as little as 6 months for 1 patient and less than 4 years for the majority. This is especially concerning given that the average time to recurrence following SRS in this study was close to 2 years, suggesting that even more patients may eventually experience a recurrence given longer follow-up. In addition, half of the patients included in the study required another procedure to treat their pain and, nearly 40% of the time, it was an MVD and/or sectioning.

In the Boriis study, there are two items of note.³ First, less than half of the study patients experienced initial pain relief without medication, while half of those with pain relief still required the use of medication to control their symptoms—a particularly important caveat in the age of the opioid crisis. Of note, these findings are similar to those of the Pommier study in which 44% of patients actually achieved pain freedom without medication,⁴ half of the total observed in our study. Second, nearly 60% of the patients in the Boriis study who had experienced initial

pain relief also had an eventual pain recurrence,³ which is 10 times the recurrence rate of the MVD with or without sectioning used in our study. Of those with recurrence, 40% required additional procedures, which notably come with additional risk.³

Finally, the Balossier study on repeat GKRS reports on 6 patients, with just 3 experiencing symptom freedom at the longest follow-up, even after 2 or 3 additional procedures.⁵ In addition, given the short follow-up times (median 12 months) and a treatment known to result in frequent recurrence, this percentage may be an overestimation of efficacy.

We acknowledge, as do the authors, the minimal adverse effects from radiosurgery for the treatment of GPN; however, one should consider the risk of additional procedures, the added cost, and the impact on long-term efficacy.

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Double-crescent sign and superficial subarachnoid CSF space expansion

TO THE EDITOR: We read with great interest the research by Miki et al.¹ (Miki K, Abe H, Morishita T, et al. Double-crescent sign as a predictor of chronic subdural hematoma recurrence following burr-hole surgery. *J Neurosurg*. 2019;131[6]:1905–1911). The authors indicated that the space between the dura and brain parenchyma after surgery for chronic subdural hematoma (CSDH) was

sometimes longitudinally divided into two crescents, the inner crescent representing a new individual subdural hygroma, with CT density the same or similar to that of CSF, and the outer crescent showing the original hematoma cavity (Table 1). Miki et al. also reported that the new subdural hygroma indicated by the inner crescent could cause the recurrence of CSDH.

We previously reported the double-crescent configuration on CT after CSDH surgery in a study published 5 years ago.² At almost the same time, Sucu and Akar also reported this sign as a “double-layer appearance.”³ We and Sucu and Akar indicated that this inner crescent (layer) represented a superficial subarachnoid CSF space, not a new hygroma (Table 1). CT may not allow reliable identification of this inner crescent as an isolated hygroma or a superficial subarachnoid space. The only way to distinguish between these entities is “the cortical vein sign” on MRI, not thickness.⁴ Consequently, we did not claim the occurrence of a new isolated subdural edema.

The “double-layer (crescent) sign” as described by us and Sucu and Akar did not affect the hematoma recurrence rate.^{2,3} We speculated that this inner crescent was associated with overnight drainage because this formation was seen shortly after drainage but was rarely seen on day 7 after surgery.² These observations can be explained by the Monro-Kellie hypothesis,⁵ according to which the sum of the volumes of each intracranial element, including the brain, CSF, blood, and subdural content (in this case), remains constant. Loss of volume caused by discharge of the subdural fluid under slight negative pressure should be compensated for by expansion of the other elements. The compressed brain could expand, but brain expansion is often quite slow in the case of CSDH.⁶ Therefore, CSF is the most likely candidate to replace this lost volume. In other words, subarachnoid expansion may compensate for the decreased subdural volume after overnight drainage of subdural fluid.⁵

Miki et al.¹ indicated that the double-crescent sign was positively associated with recurrence, in contrast to our findings. In my opinion, this positive association could also occur for the following reasons. Poor postoperative re-expansion of the brain parenchyma may be related to hematoma relapse. The double-crescent sign is considered to indicate poor postoperative re-expansion of the brain

TABLE 1. Two different interpretations for inner space in the double-crescent sign on CT after CSDH

	Current Study	Previous Studies
Reports	Miki et al., 2019 ¹	Sucu & Akar, 2014 ³ Tosaka et al., 2015 ²
Signs	Double-crescent sign	Double-layer appearance, superficial subarachnoid CSF space expansion, etc.
Outer space	Outer original hematoma cavity	Outer original hematoma cavity
Inner space	Inner new hygroma	Inner subarachnoid CSF space
Results	Positive correlation to hematoma relapse	Negative correlation to hematoma relapse

parenchyma, which could result in this positive relationship. Also, the postoperative double-crescent sign may very rarely include a multiloculated CSDH or new hygroma,^{1,7} which may cause recurrence.

However, CT is still unlikely to provide evidence that all these cavities are new isolated hygromas. In previous reports, the double-crescent sign was considered to be a combination of the expansion of the inner superficial subarachnoid CSF space and the outer original hematoma cavity.^{2,3} Further discussion regarding the previous findings by us and Sucu and Akar in relation to the findings reported by Miki et al. may be required.^{2,3}

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Response

We greatly appreciate the interest in our study expressed by Dr. Tosaka. His opinion is valuable to understanding the origin of our proposed sign, the double-crescent sign, after chronic subdural hematoma (CSDH) surgery. Although our study showed an association between the double-crescent sign and the postoperative recurrence of CSDH, the distinctive origins and mechanisms predisposing patients showing this sign to recurrence were unclear despite the fact that we suspected that the inner layer of the sign we observed (deep to the residual hematoma) constituted a new hygroma. Tosaka et al. and Sucu and Akar previously reported radiological findings similar to our sign and con-

FIG. 1. Axial CT images of a CSDH recurrence case with our sign (double-crescent sign). A preoperative CT image (A) shows a left-lateralized CSDH. Serial CT images were obtained at postoperative days 1 (B), 6 (C), and 12 (D). Over the course of 12 days, the density of the inner layer (asterisks) deep to the residual hematoma (arrowhead) changed and increased compared with that of the CSF while the volume of the inner layer gradually increased.

sidered that the inner layer may have presented expansion of the subarachnoid space.^{1,2}

As Dr. Tosaka pointed out, we examined the inner layer of the double-crescent sign using only CT scans and could not evaluate its structure in detail. Therefore, our cohort potentially included cases with the etiologies reported by Tosaka et al.¹ However, in our study there were also several cases in which patients with CSDH recurrence demonstrated etiologies that could be differentiated from those hypothesized by Dr. Tosaka and his colleagues. In these patients, CT scans showed that the density of the inner layer changed and increased from that of the CSF (Fig. 1), and this phenomenon was not explained by the expansion of the subarachnoid space. Although these patients underwent burr-hole surgery for the recurrence, we did not identify any postoperative CSF leakage through the drain, which would have been observed if the recurrence was due to the expansion of the subarachnoid space.

The double-crescent sign may appear in cases that are heterogenous in nature. The origin of the inner layer may be elucidated via pathological analyses or further radiological examination by MRI. As Tosaka et al. explained in their article, this finding may be a passive phenomenon induced by overnight drainage and delayed brain re-expansion.¹ In our series, approximately 70% of the patients with the double-crescent sign had not experienced recurrence after surgery at the time of this writing. We agree with Dr. Tosaka that the poor re-expansion of the brain after surgery may predispose patients to recurrence along

with the double-crescent sign. We suspect that our sign may tend to be observed in the patients with poor brain re-expansion; however, this hypothesis remains unproven. We only investigated and observed the short-term brain re-expansion, and further examination by other methods may be required.

Contrary to our results, Tosaka et al. and Sucu and Akar reported that in their studies double-crescent-like findings were not associated with CSDH recurrence,^{1,2} and the recurrence rates were lower (9.7%) in the Tosaka et al. study¹ than in our study (18.1%). Differences in patient characteristics, surgical procedures, and/or perioperative management may have contributed to the discrepancies in results between these studies. The significance of the double-crescent finding and its relationship with recurrence may be better understood through further research with a larger patient population and detailed imaging studies to elucidate the process of recurrence in patients showing the double-crescent sign after CSDH surgery.

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Utilization of health personnel in developing countries during the COVID-19 pandemic

TO THE EDITOR: We read with great interest the article by Sun and Mao¹ on the response to COVID-19 in Chinese neurosurgery (Sun Y, Mao Y. Editorial. Response to COVID-19 in Chinese neurosurgery and beyond. *J Neurosurg*. 2020;133[1]:31–32). We greatly appreciate the work performed by the Chinese team in containing the disease in their home country.

However, we really want to draw the attention of the world community to the scenario and modus operandi in developing nations, where hitherto there has been 1) a shortage of available personal protective equipment (PPE), powered air-purifying respirators (PAPRs), and ventilators, as well as 2) a limited number of health personnel, particularly neurosurgeons.

The care of emergent cases and surgery requires 24-hour in-house coverage, which is usually provided by resident physicians at most centers. However, with the limited COVID-19 testing, resources, and health personnel in most developing countries, what is of utmost importance in these places is the safety and conservation of human resources to cater to the demand when needed. Hence, we are strongly in favor of dividing the duties of neurosurgeons into nonoverlapping teams. All the different units and subspecialties should be merged into a single unit including trauma. Two nonoverlapping teams and a reserve team of consultants can be made. The teams should not have any overlapping time. Each team rotates in 6-day cycles, from Monday to Saturday; that is, each team covers 6 days and then has 6 days off. Sunday will be covered by a reserve team led by a single consultant only. Residents and fellows in each team need to be divided equally. It ensures adequate coverage and minimizes hand-off issues and transmission risk. The reserve team acts as an “alternate” that will substitute for those showing COVID-19 symptoms. No personnel 65 years of age or older should be included in the team or visit the hospital. All staff not essential to clinical duties should remain at home. This includes research faculty, research fellows, and students.

We firmly believe that the peak has not yet been reached in developing nations, and appropriate and safe utilization of available health personnel should act as a key determinant in our fight against this pandemic.

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Disclosures

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Response

We appreciate Dr. Ansari's sincere concern for developing nations and his suggestions of potential solutions for maintaining a productive neurosurgical workforce during the COVID-19 pandemic. The pandemic has indeed caused an acute shortage of PPE, medication, ventilators, and medical workers, not only in developing nations but also in more-developed countries.^{1,2} In China, Wuhan was once the worst-hit area and experienced severe shortages of medical supplies and workforce. It is generally agreed that healthcare providers and government leaders should cut through bureaucratic barriers and adopt regulations to reinforce the medical workforce for the duration of the pandemic. For example, Shanghai Huashan Hospital

has sent a medical team of 273 people, including doctors, nurses, administrators, technicians, security personnel, and chefs. To ensure the operation of the medical team, we brought a large number of respirators, PPE, ventilators, extracorporeal membrane oxygenation, and food to relieve the pressure of too few material supplies in the epicenter.

For neurosurgery, the impact of the pandemic may delay the rescue of critically ill patients. Also, it may interrupt a significant number of patients who require sequential treatments such as radiotherapy, chemotherapy, and follow-up visits.³ If there is a shortage of neurosurgeons in developing countries during the pandemic, it may imply a low density of local neurosurgeons, which requires coordination and replenishment by the government and the consideration of training more neurosurgeons after the outbreak. During the pandemic, hospital leadership should assess the risk in the workforce and materials supply on a daily basis in an effort to support the operation of the emergency department. The following operational measures can be considered to mitigate the impact on patients, ensure medical efficiency and safety, and protect medical workers from COVID-19 infection.

1. Establish efficient COVID-19 screening and triage protocols in the emergency department. For patients who require emergency treatment (such as those with severe brain trauma or aneurysm rupture), screening procedures such as the epidemiological investigation, blood antibody examination, and lung CT should be completed as soon as possible.
2. For diagnosed cases of COVID-19, treatment including surgeries should be performed under the conditions of strict prevention of cross-infection. If there are no appropriate treatment personnel or facilities, patients should be transferred to an appropriately designated hospital as soon as possible.
3. Postpone nonemergency neurosurgical care. Expand telehealth coverage and promote E-visits for needs such as prescriptions and follow-up visits. Reintegrate and divide personnel including those in research facilities.
4. The psychosocial impact of this pandemic remains unclear but will undoubtedly be profound for both medical workers and patients.^{4,5} Those patients with neurosurgical diseases are already psychologically strained and are generally insufficiently screened and treated

for related mental health concerns. On the other hand, medical workers in the current crisis may have unique issues and perspectives given higher potential exposures to COVID-19. Psychological resources will be particularly critical during this period and, where possible, can be provided remotely.

In sum, to cope with the crisis, government leaders need to help expand capacity and maximize utilization of the medical workforce. Each neurosurgical team should reorganize its work and staff to ensure proper treatment of critical patients as well as the safety of our colleagues. Each hospital should tailor its specific protocols to the needs of the pandemic and pay close attention to the physical and mental health of its medical workers.

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