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Case Report

Non-hemorrhagic cerebellar contrast enhancement on intraoperative MRI during a supratentorial glioma resection: Concerning finding of no significance ☆,☆☆

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ABSTRACT

Intraoperative magnetic resonance imaging (iMRI) is a powerful tool used to verify maximal safe resection of gliomas. However, unsuspected new or incidental findings can present difficult clinical scenarios. Here we present a case of a large supratentorial glioma resection where new, incidental bilateral cerebellar hemispheric enhancement was noted on iMRI. A 52-year-old male with a large intra-axial mass spanning the right temporal and parietal lobes underwent a craniotomy for tumor resection utilizing iMRI. Imaging displayed new, remote, bilateral cerebellar enhancement. Upon completion of surgery, the patient was extubated and was at his neurological baseline. An immediate CT scan showed no abnormalities in the cerebellum, and the duration of his hospital stay was unaffected by this finding. An MRI 24 hours after the procedure demonstrated complete resolution of the enhancement. New, remote contrast enhancement in the cerebellum raises concerns for the potentially emergent, well-defined pathology known as remote cerebellar hemorrhage (RCH). However, here we describe a case where these findings turned out to be clinically insignificant, CT-negative, and self-limiting. Therefore, here we call this finding remote non-hemorrhagic

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cerebellar contrast enhancement (RNHCCE) to differentiate it from RCE, and we discuss nuances and management considerations for differentiating the two.

Background and importance

Intraoperative magnetic resonance imaging (iMRI) is a powerful tool to verify maximal safe resection of gliomas. Use of intraoperative imaging is associated with improved survival [1], decreased postoperative morbidity [2,3] and reduced need for surgical revision [2], and it has therefore become the standard of care for glioma resections at many institutions. However, unsuspected new or incidental findings noted on an intraoperative scan can present difficult clinical scenarios. For example, the case presented here, new, bilateral, central cerebellar hemispheric contrast extravasation was noted during an iMRI obtained during the resection of a large, supratentorial, high grade glioma. The immediate concern was for remote cerebellar hemorrhage (RCH) [4], a pathology that can occur after supratentorial or even spinal neurosurgery. However, the extravasation in this case was l non-hemorrhagic (i.e., susceptibility weighted imaging [SWI] and computed tomography [CT]-negative), self-limiting (i.e., not present on future scans), and of no clinical consequence. Therefore, here we term this incidental finding remote non-hemorrhagic cerebellar contrast enhancement (RNHCCE) to distinguish it from the more dangerous RCH. The purpose of this report is to describe the details of this case and these findings, and to share our experience with other neurosurgeons and neuroradiologists who use iMRI. To our knowledge, this is the first documented case of RNHCCE on iMRI to be reported.

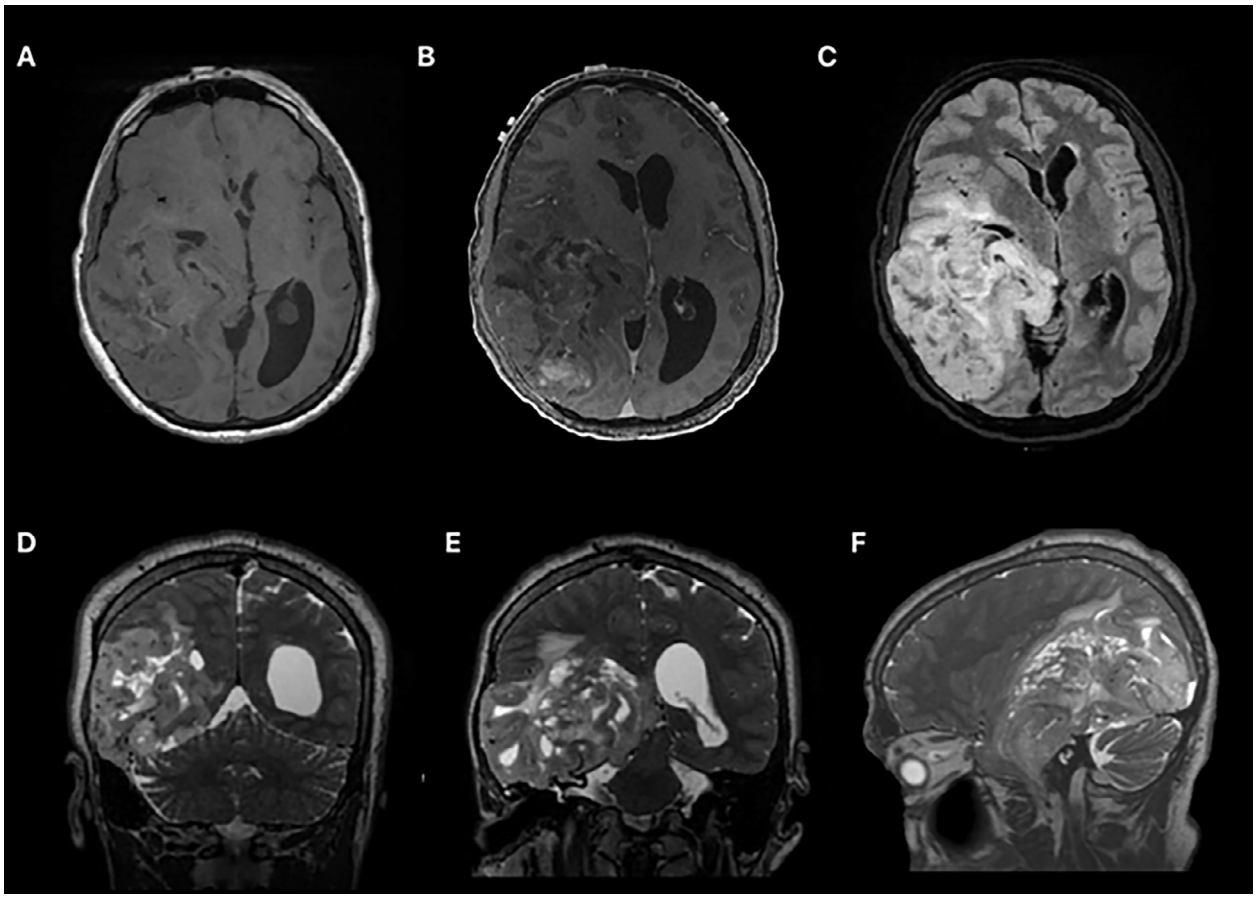

Fig. 1 – Preoperative MRI. (A) Axial T1 pre-contrast scan demonstrates relatively iso to slightly hypo-intense lesion on the right temporal-parietal region. (B) Axial T1 post-contrast demonstrates the large heterogenous mass infiltrating the right temporal-parietal region with scattered foci of enhancement, (C) Axial FLAIR sequence demonstrates significant expansile FLAIR signal. (D and E) Coronal T2 sequences demonstrates multiple flow voids within the tumor, as well as trans-tentorial herniation of the tumor with midbrain compression. (F) Sagittal T2 sequence demonstrating the lesion with multiple flow voids within the mass.

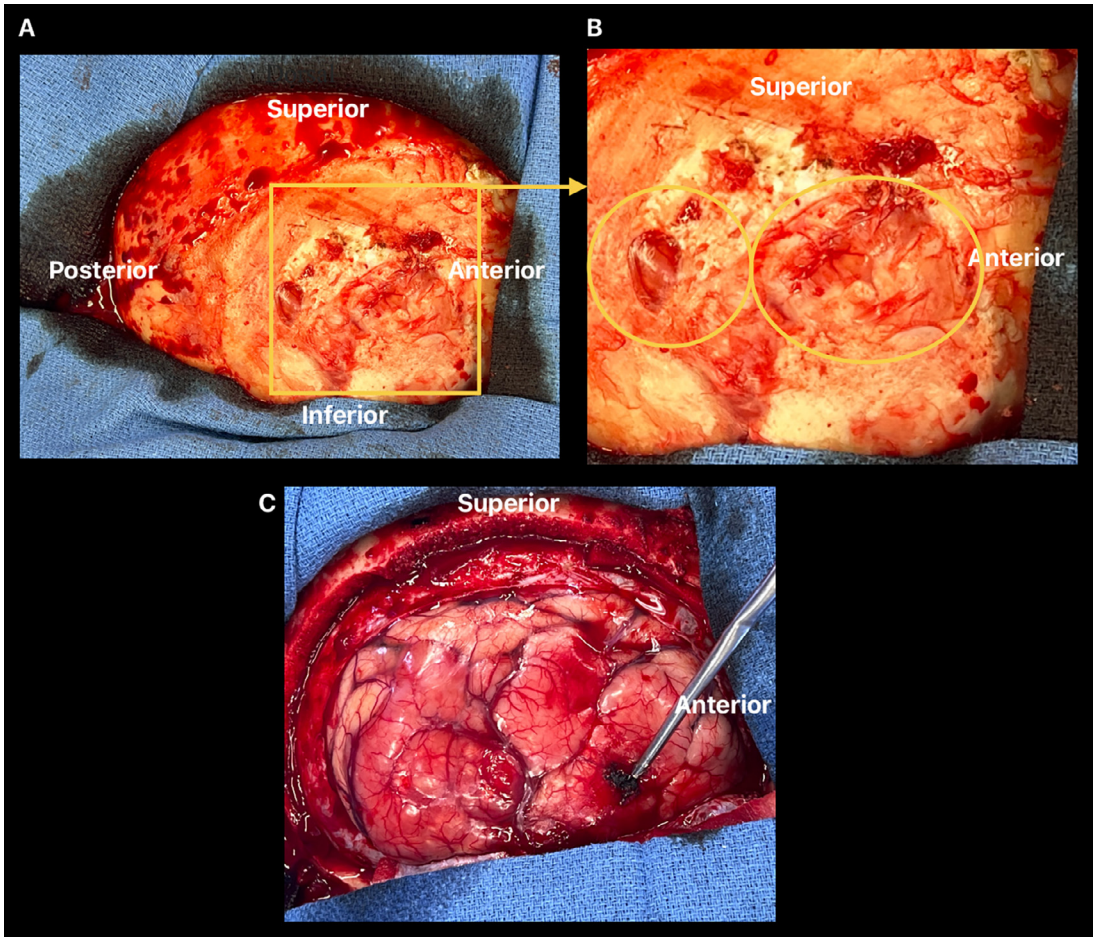

Fig. 2 – Intraoperative photographs. (A) Surgical exposure of the skull demonstrating visibility of cranial contents through bone and dura, highlighted by the yellow square, which is enlarged on (B). The circled portions are holes in which cranial contents are visible through defects in the skull. (C) Surgical exposure of the brain demonstrating the intrinsic pink/red tumor.

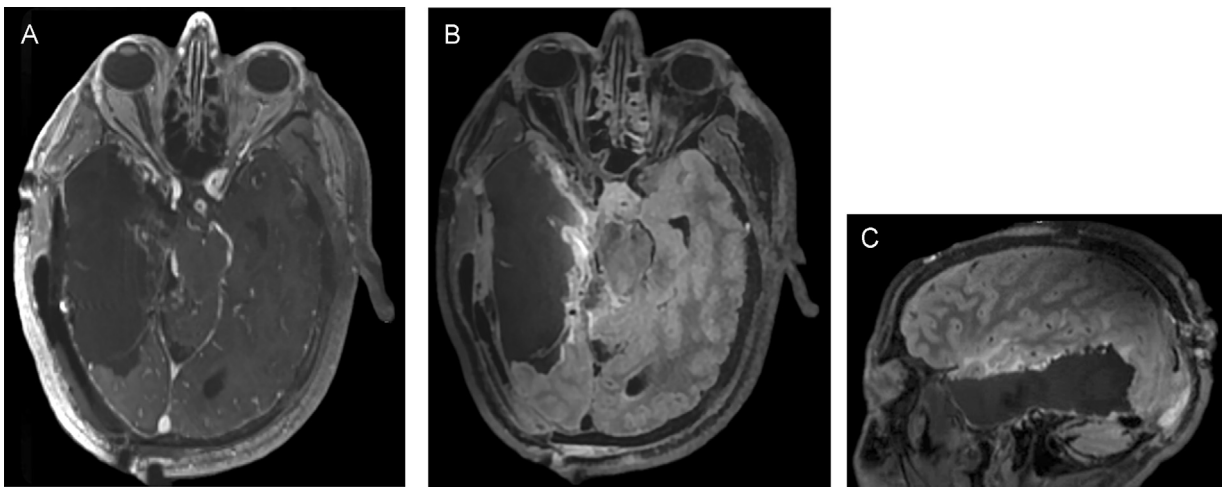

Fig. 3 – Intra-operative MRI. (A) Axial T1 post-contrast, (B) Axial FLAIR, and (C) sagittal FLAIR sequences demonstrate a gross total resection with skeletonized mesial pial borders and blood products.

Clinical presentation

A 52-year-old male with a history of substance use (alcohol and marijuana) and various intermittent visual complaints over the last 10 years presented with ataxia and worsening of his visual complaints. On initial examination, he was alert and ambulatory with a non-focal motor exam, and he was noted to have a left homonymous hemianopsia and asymmetric pupils (anisocoria; right > left). CT head and MRI brain demonstrated a large, heterogeneously enhancing, predominantly intrinsic FLAIR lesion encompassing the entire right temporal lobe and part of the occipital and parietal lobes. The tumor demonstrated significant mass effect with midline shift, transtentorial herniation, and compression of the midbrain (Fig. 1), as well as large intratumoral vascular flow void (Figs. 1D-E). Overall, imaging at the time was consistent with a high grade oligodendroglioma. Given the patient's clinical presentation and radiographic findings, surgical resection was recommended.

After informed consent, the patient was taken to the operating room and placed under general anesthesia with induction (1% lidocaine 5 ml, fentanyl 250 mcg, propofol 550 mg, and rocuronium 50 mg) with endotracheal intubation and maintenance (total: sufentanil 255 mcg, dexmedetomidine 93 mcg, propofol 2.2 g, and phenylephedrine 22 mg). His head was placed in 3-point fixation using a Mayfield head-holder, and he was positioned with a shoulder bump and his head turned to the side. Neuronavigation was registered and the patient was prepped and draped in the standard fashion. Once the scalp and periosteal flaps were raised, the bone was noted to be very thin, consistent with chronically elevated intracranial pressure (ICP), and brain was visualized through a hole eroded through the bone and paper-thin dura (Fig. 2). A standard craniotomy was performed, after which, ultrasound and neuronavigation verified the exposure of the tumor margins. The

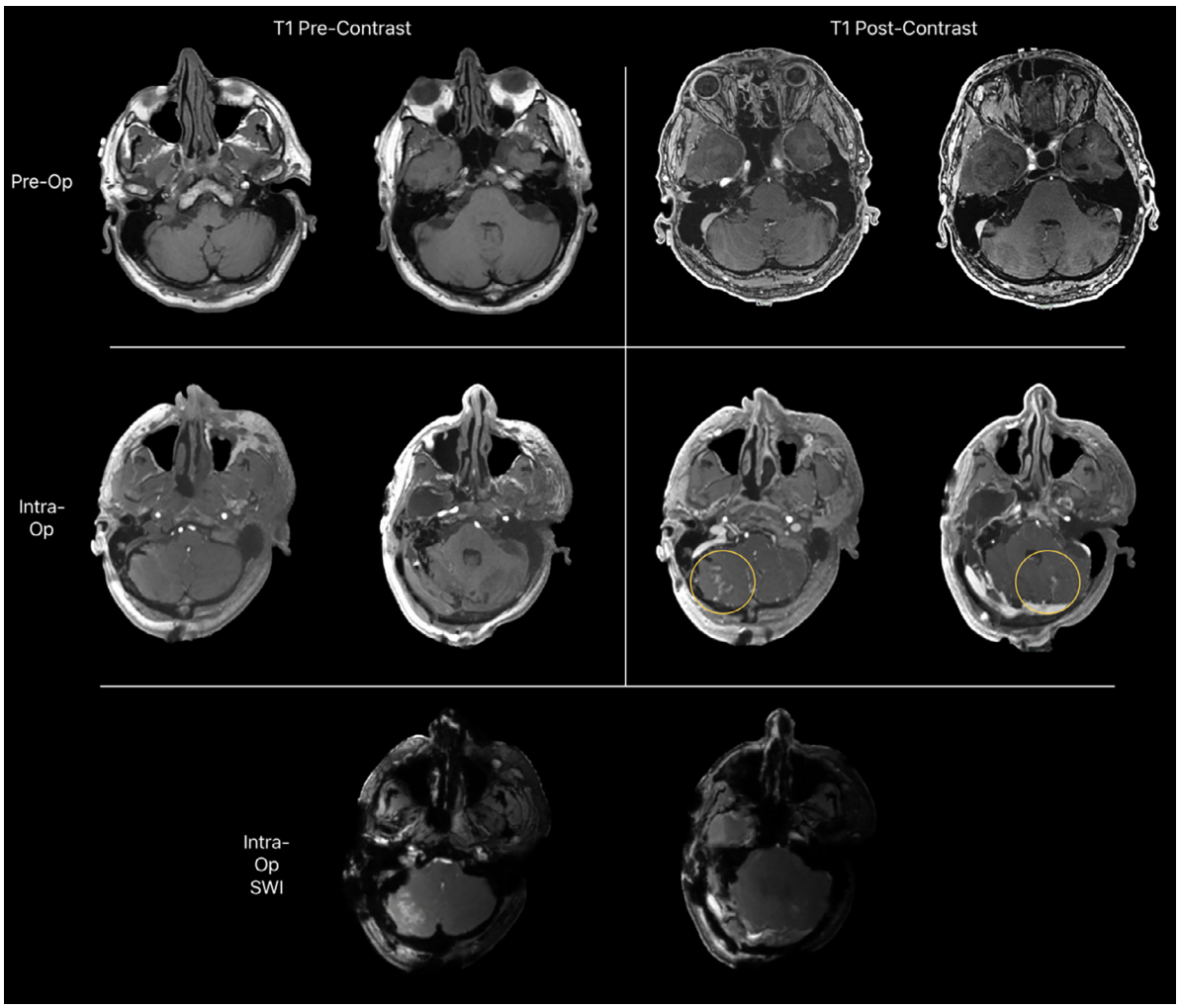

Fig. 4 – Intra-operative MRI demonstrating active contrast extravasation. First row demonstrates pre-operative MRI non-contrast (first 2 axial images on the left) with their post-contrast T1 sequences (equivalent axial sections) on the right half. Second row demonstrates intra-operative MRI pre- and post-contrast T1 sequences with evidence of contrast extravasation on 2 separate axial slices within the cerebellum bilaterally encircled in yellow. Third row demonstrates 2 equivalent axial sections susceptibility weighted image (SWI) without evidence of signal, suggesting no evidence of blood products at the location of contrast extravasation.

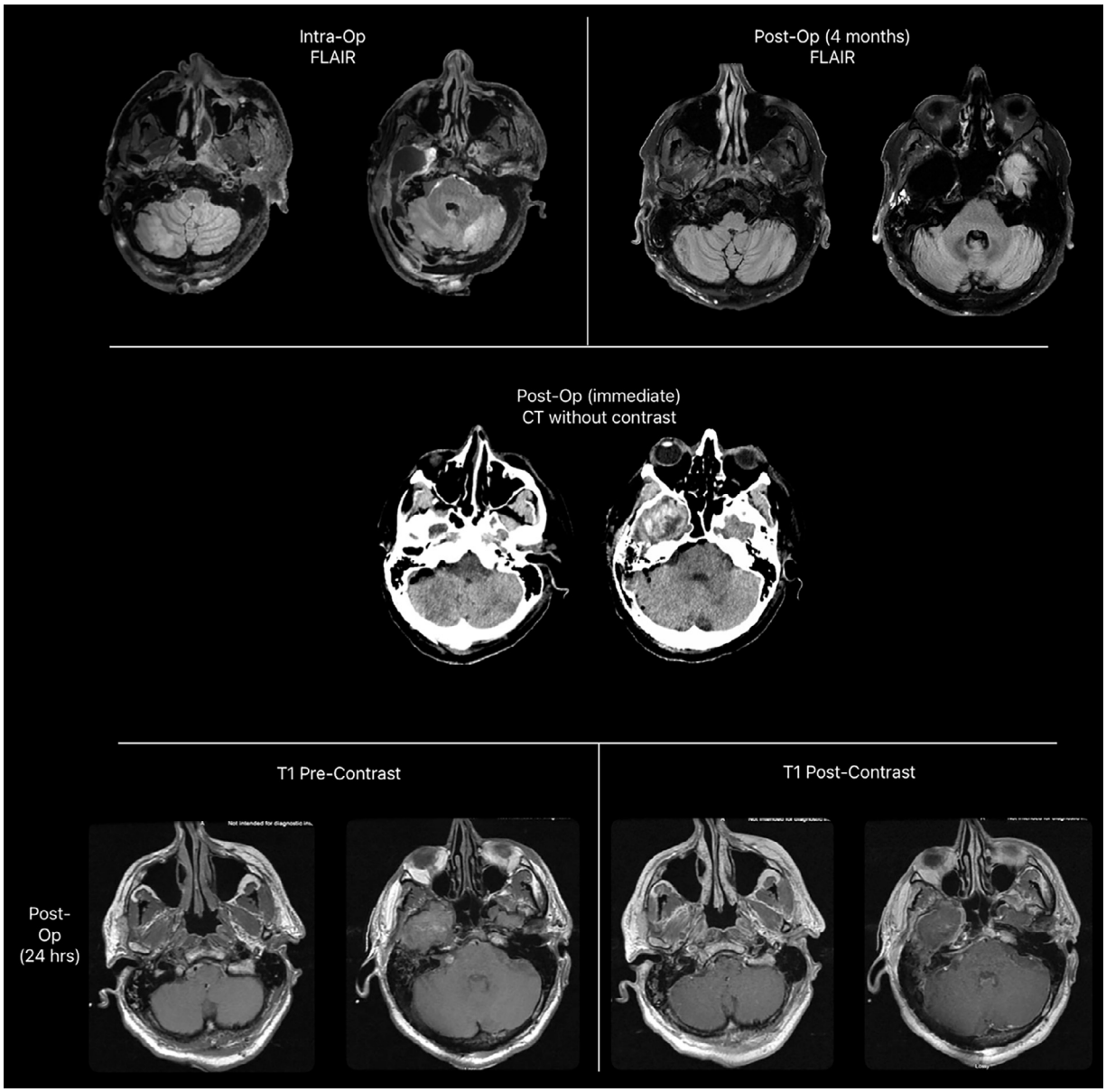

Fig. 5 – Postoperative imaging. Top left demonstrating intra-operative FLAIR signal correlating with the same location as the contrast enhancement. Top right demonstrating 4-month post-operative FLAIR sequences which no longer have signal in those regions. Center of the figure is immediate post-operative CT scan without contrast which does not demonstrate any hyper-densities in the regions of enhancement. Bottom row demonstrates T1 pre- and post-contrast MRI 24-hours postoperatively with resolution of the areas of enhancement.

dura was opened, exposing pink/red tumor with a clear border (Fig. 2C). This border was followed along the posterior margin first. Multiple large feeding vessels were encountered which did not respond to bipolar cautery (similarly to those found in arteriovenous malformations [AVM] without protein in their walls), and vascular hemoclips were required for hemostasis. Estimated blood loss prior to iMRI was 2.5 liters due to the predominance, size, and multitude of these vessels, prompting replacement with 6 units of packed red blood cells, 2 units of fresh frozen plasma, and 1 unit of platelets. Upon removal of the vascular portion, ultrasonic aspiration was used to remove the mesial portion of the tumor subpially. An improvement in motor endplate potentials (MEPs) were noted upon brainstem decompression.

The surgical site was temporarily closed to obtain an iMRI. Imaging confirmed gross total resection of the mass without evidence of stroke or other immediate complication (Fig. 3). However, the iMRI did demonstrate new bilateral cerebellar contrast enhancement with associated FLAIR hyperintensity (Figs. 4 and 5). Susceptibility weighted imaging (SWI, Fig. 4) demonstrated no susceptibility artifact to suggest hemorrhage. Diffusion-weighted imaging (DWI) with apparent diffusion coefficient (ADC) portrayed T2 shine-through suggesting the presence of vasogenic edema without diffusion

restriction. Although the contrast enhancement was concerning, without SWI signal, the decision was made to continue with closure and allow re-emergence from general anesthesia to monitor for changes in exam.

After routine completion of the operative closure, the patient was extubated without complications and was transferred to the intensive care unit (ICU). His neurological exam was unchanged from preoperative. A CT scan obtained 60 minutes after the iMRI showed no evidence of cerebellar hemorrhage, as did a repeat scan 3 hours later (Fig. 5). After 24 hours from the operation, a postoperative MRI showed complete resolution of the bilateral cerebellar enhancement (Fig. 5). The patient had an excellent clinical recovery and was discharged to inpatient rehabilitation on post-op day 7. Final pathology demonstrated a grade III oligodendroglioma with an IDH mutation and 1p/q19 co-deletion. At the 4 month follow up appointment, MRI T2 Flair sequence confirmed complete resolution of the cerebellar findings and no evidence of residual or recurrent disease (Fig. 5). The patient subsequently underwent radiation followed by chemotherapy (temozolomide 250 mg 28 day for 12 cycles) with good therapeutic response.

Discussion

Remote cerebellar hemorrhage (RCH) is a rare but well-documented complication of intracranial or spine surgery [5]. The phenomenon is described after large decreases in blood pressure or cerebral spinal fluid (CSF) [5]. RCH can be asymptomatic, but it can present with changes in consciousness and cerebellar symptoms [5]. One study found that out of 209 patients, 44.6% of cases were associated with loss of consciousness, 12.6% had cerebellar signs, 8.6% had seizures, and 28.9% were asymptomatic [4]. RCH is typically a self-limiting pathology; however, fatal cases are documented [4]. On MRI, RCH has a pathognomonic bleeding pattern known as “the Zebra Sign,” attributable to blood in the sulci of one or both cerebellar hemispheres [6].

To our knowledge, we present the first documented case of remote non-hemorrhagic cerebellar contrast enhancement (RNHCCE) seen on iMRI. Although this case of RNHCCE presented similarly to RCH (i.e., after large volume intraoperative blood loss and ICP shift), lack of SWI artifact or CT evidence of hemorrhage and complete resolution on 24-hour postop might suggest a different mechanism and more benign course. It is possible, in this case, the contrast extravasation was due to leaky cerebellar capillaries that were acutely decompressed after chronically elevated ICP, but did not reach the level of true hemorrhage. Awareness of this imaging pattern and natural history may help neurosurgeons and neuroradiologists choose the best course of action in similar situations.

Conclusion

RNHCCE appears to be a separate pathological process from RCH, both of which may occur during cases of large volume blood loss or ICP shifts. It can be differentiated from RCH through SWI/CT and repeat MRI. In our case, RNHCCE was self-limited and non-hemorrhagic, ultimately amounting to a radiographical finding of no clinical consequence. Awareness and distinction between RNHCCE and RCH may help neurosurgeons and neuroradiologists involved in iMRI cases make the best intraoperative care decisions possible.

Patient consent

Patient consent was obtained for publication as well as for all relevant procedures included in the aforementioned manuscript.

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