Reoperation for Medulloblastoma Prior to Adjuvant Therapy

**BACKGROUND:** Surgery remains an integral part of the treatment of medulloblastoma. We present our experience with repeat surgery for this tumor before initiation of adjuvant therapy.

**OBJECTIVE:** To report what was found intraoperatively and where at time of second-look surgery and detail any postoperative events or readmissions within 90 days of surgery.

**METHODS:** Two separate institutional databases were queried to identify patients who underwent repeat resection of suspected residual medulloblastoma from January 2003 to January 2017.

**RESULTS:** We identified 51 patients (36 male, 15 female) who underwent repeat surgery. Average age at diagnosis was 8.31 years (range, 1.3-21.2). Imaging prior to repeat surgery demonstrated unequivocal residual tumor in 37 patients, but indeterminate in 14 patients. All but 1 patient had histopathologically confirmed residual tumor (50/51, 98%). The fourth ventricle was the primary site in 39 (76%) cases, compared with hemispheric in 12 cases (24%). Thirty (59%) tumors were non-WNT/non-SHH. All indeterminate cases (except for 1 patient) had residual tumor. Hemostatic agents were found within the resection cavity in 80% of indeterminate cases. The most common sites of residual tumor were lateral (26/39, 67%, lateral recess and/or foramen of Luschka) and roof (25/39, 64%); the superior medullary velum was the most common region of the roof (19/25, 76%). Eight (16%) patients developed new neurological deficits: cranial nerve palsies in 5 patients and posterior fossa syndrome in 3 patients.

**CONCLUSION:** Meticulous inspection of the resection cavity is necessary, paying particular attention to the roof and lateral recess. Hemostatic agents can conceal residual tumor.

**KEYWORDS:** Medulloblastoma, Second-look, Reoperation, Surgery, Residual, Location

The field of medulloblastoma research has evolved dramatically over the last 10 years, with the recognition of distinct molecular subgroups and an ever-increasing number of immunohistochemical markers that aid in characterizing the biological nature of this tumor and its responsiveness to treatment.1-3 Our surgical goal, when feasible, has been (and continues to be) the absence of radiographic nodular disease and the onset of adjuvant therapy within 4 weeks of resection.

Prior publications, which are now in upwards of 20 years old, have determined rather arbitrarily that residual tumor of 1.5 cm² is acceptable.4,5 A recent controversial publication has raised questions about the benefit of gross total resection (GTR). Thompson et al6 reported a retrospective analysis of 787 patients (86 with WNT tumors, 242 with SHH tumors, 163 with group 3 tumors, and 296 with group 4 tumors) accumulated over an almost 16-year period from 35 institutions.6 They concluded the following: (1) a progression-free survival (PFS) benefit for GTR over subtotal resection (STR), but no overall survival (OS) benefit; (2) no PFS or OS benefit for GTR compared with near-total resection (NTR is defined as <1.5 cm² residual disease); (3) no benefit in achieving a GTR compared with STR in the WNT group, SHH group, and group 3 except for a mild PFS benefit.
in the group 4 patients (hazard ratio, 1.97; 95% confidence interval, 1.22-3.17; \(P = .0056\)), but no effect on OS. The authors stated that their data "question the clinical benefit of second-look surgery for small residual WNT, SHH, or group 3 medulloblastomas because of the possible morbidity of surgery and the delay in the commencement of radiation."\(^6\)

The objective of our present study was to describe our experience with reoperation for suspected residual medulloblastoma, which we shall interchangeably call "second-look surgery." This involves detailing what was found at the time of surgery and where anatomically, how the intraoperative findings correlated with the preoperative imaging, and report postoperative complications.

**METHODS**

Prospectively maintained databases (surgical and neuro-oncology) were queried to identify patients who underwent second-look craniotomy for resection of suspected residual medulloblastoma prior to initiation of definitive adjuvant therapy (radiation or chemotherapy) from January 2003 through January 2017. Institutional review board approval was obtained prior to data collection; no patient consent was needed given the retrospective nature of the study.

All new medulloblastoma patients are presented in a multidisciplinary conference. Those who go on to second-look surgery have either unequivocal residual tumor confirmed by imaging, or substantial postoperative changes or signal heterogeneity (eg, due to cautery, tissue manipulation, blood products, hemostatic agents, or combination) that preclude the radiologist from determining whether residual tumor exists. Those patients who undergo a re-exploration have a new preoperative contrast-enhanced magnetic resonance image (MRI) done within days of their repeat surgery.

Surgery was performed by 1 of 3 pediatric neurosurgeons who subspecialize in oncology. The surgical approach used was in part dictated by the prior surgery. For midline tumors, if the vermis was incised (transvermian) with the initial surgery, then we used the same operative corridor without extending the vermian incision and adding the telovelar approach as needed. If the vermis was preserved with the initial surgery, we used the telovelar approach exclusively. For hemispheric tumors, we used the initial approach.

**Data Collection**

The following were recorded per patient: demographic information, details regarding the initial surgery, need for cerebrospinal fluid (CSF) diversion prior to re-exploration (endoscopic third ventriculostomy or shunt), metastatic disease status, molecular subgroup, estimated residual tumor volume, location of primary site (fourth ventricle or intracerebellar/hemispheric), and the neuroradiologist’s opinion of residual tumor (unequivocal or indeterminate).

**Study Outcomes**

The primary endpoints of this study were to report what was found intraoperatively and where. This information was obtained by a review of the operative report in conjunction with pre- and postresection MRI. Intraoperative findings were classified as tumor, blood products, or hemostatic agents.

When the tumor originated from the fourth ventricle, the locations of residual tumor were defined as the following: roof/vermis, floor, central fourth ventricle, lateral recess, and foramina of Luschka. These specific locations were then combined into 3 overall categories: roof, central, and lateral (Figure 1). Roof was defined as tumor involving any portion of the medullary velum (superior or inferior) and fastigium with or without extension into the vermis and medial cerebellar hemispheres. Central referred to the fourth ventricle proper bordered by the aqueduct of Sylvius superiorly, the foramen of Magendie inferiorly, and the ventricular surfaces of the cerebellar peduncles (superior and inferior) and apertures to the lateral recesses laterally. This group combines patients with tumor found within the central portion of the fourth ventricle along with those that had focal sites of tumor adherent to the floor or lateral walls of the fourth ventricle. Lateral location was the lateral recess with or without extension into the foramen of Luschka. If a patient had residual tumor in more than 1 location, all sites were recorded.

If the primary tumor site was intracerebellar, residual tumor was simply categorized as hemispheric. Extent of resection after second-look surgery was categorized as GTR (no definitive residual disease) or STR (anything less than a GTR) based on the intra or immediate postoperative MRI.

The secondary outcome was postoperative events within the first 90 days of surgery, including those occurring during the initial hospitalization, as well as any readmissions.

**RESULTS**

**Patient Characteristics**

A total of 51 cases between January 2003 and January 2017 met inclusion criteria. The fourth ventricle was the primary site in 39 (76%) cases, intracerebellar or hemispheric in 12 (24%). The mean patient age was 8.31 years (range, 1.3-21.2), with 36 (70.6%) male and 15 (27.5%) female patients. Twenty (39.2%) patients had existing shunts at the time of second-look surgery, and 4 patients had prior endoscopic third ventriculostomies. Leptomeningeal metastases were present in 10 (20%) cases prior to second-look surgery.

Thirty-nine patients (76%) had their initial surgery performed within the USA compared with 12 (24%) done outside of the USA. Of the 51 patients, only 1 had their initial surgery done at our facility. The median time from the initial operation to the time of the second-look surgery was 27.3 days (range, 8-70 days) with most (37/51, 72.5%) second-look operations taking place within 30 days from the first surgery. Only 4 patients had their reoperation done more than 45 days from their initial surgery, and these were all international patients who required additional time to arrange travel permits. No patient had MRI-confirmed GTR with their first surgery only to have tumor found on repeat imaging when they arrived at our facility (ie, regrowth of tumor).

**Preoperative Tumor Characteristics**

Out of the 51 cases, 37 (72.5%; 1 patient was ours, 36 came from other facilities) were found to have clear evidence of residual medulloblastoma in the area of prior resection, whereas residual tumor was suspected in 14 (27.5%) cases but could not be
definitely determined by MRI. Of the 12 international patients, 10 had definite residual tumor (83%); of the 38 US patients, 26 had residual tumor (68%). In these 37 cases, the average tumor volume was 32.60 cm³ (range, 0.20-520.00 cm³) with 11 having less than 1.5 cm³.

Molecular subtyping was available for all patients with the following results: 5 were WNT, 16 were SHH, and 30 were groups 3 or 4 (ie, non-SHH/non-WNT). Of the latter group, there were at least 3 patients with anaplastic/large cell tumors and 3 with either amplification or gain of MYC.

**Intraoperative Findings**

**What Was Found**

As expected, tumor was found intraoperatively in all 37 patients with unequivocal residual tumor by preoperative MRI. In the 14 indeterminate cases, only 3 (21.4%) patients had no gross visualization of residual tumor intraoperatively, but 2 did have neoplastic elements found within specimens (tissue admixed with hemostatic agents or blood products) submitted to pathology—the third patient had only hemostatic products (Surgicel [Ethicon Inc, Somerville, New Jersey] and/or Gelfoam [Pfizer, New York City, New York]). Therefore, there was only 1 true negative exploration. Of the 50 cases with residual tumor (see below), GTR was achieved in 48 patients (96%).

Hemostatic products were found in 23 cases (44.2%), 2 of which had no gross visualization of tumor, and 1 case—as previously mentioned—was found to have no tumor present on pathological evaluation of submitted tissue. Eleven cases (47.8%) with hemostatic products were radiographically indeterminate for tumor preoperatively, representing 79% of all indeterminate cases. Two cases were found to have blood products within the prior resection cavity along with tumor. One case was indeterminate for tumor on preoperative MRI, whereas the other had clear evidence of residual disease.

**Where Tumor was Found**

Of all cases with definitive residual tumor within the fourth ventricle (n = 39), 8 cases (21%) had a single site of residual tumor, whereas the remaining 31 (79%) had multiple sites. Because the majority of patients had residual tumor in more than 1 site, the stated percentages in this section will total more than 100%.

The most frequent site of residual tumor was along the roof of the fourth ventricle (25 cases [64%]). Other sites (in descending order) were the foramina of Luschka (unilaterally or bilaterally, 14 [36%]), the lateral recess (unilaterally or bilaterally, 12 [31%]), focally adherent on the floor of the fourth ventricle (12 [31%]), and within the central portion of the fourth ventricle (7 [18%]). The denominator used to calculate the percentages is 39.
Cases with residual tumor located on the roof of the fourth ventricle were further subdivided into superior (superior medullary velum), apex/middle (fastigium), or inferior (inferior medullary velum). The majority of the roof category patients had tumor located superiorly (19 [76%]), followed by apex/middle (6 [24%]) and inferiorly (4 [16%]). The denominator used to calculate the percentages is 25.

When these various locations were coalesced into the 3 broad categories of central, roof, and lateral, the frequency of residual tumor were the following (in descending order): lateral (26 [67%]), roof (25 [64%]), and central (18 [46%]). The denominator used to calculate the percentages is 39.

There were 12 hemispheric or intracerebellar medulloblastomas with residual tumor located within the previous resection cavity.

### Postoperative Events

During the initial hospitalization, 11 patients (21.5%) sustained 1 or more postoperative events or neurological changes (Table). A new postoperative neurological change occurred in 8 patients (15.7%, patients 1-6, 10, and 11): injury to cranial 6 or 7 (5 patients), posterior fossa syndrome (3 patients), and unilateral upper extremity weakness (1 patient). In all 5 patients with new cranial nerve deficits, residual tumor was located on the floor of the fourth ventricle (ie, central location). None of the 3 indeterminate cases with no gross tumor visualized at the time of surgery suffered neurological complications, and only 2 of the 11 (18%) children with less than 1.5 cm³ residual tumor sustained new neurological deficits.

In the 3 patients with isolated cranial nerve 6 palsy, 1 had full recovery and 2 still had mild lateral gaze diplopia. There were 2 patients with combined cranial 6 and 7 palsies (‘floor of the fourth syndrome’). One patient underwent multiple facial reanimation operations with mild movement thus far. There were 3 patients who developed posterior fossa syndrome. The residual tumor volumes in these 3 patients were substantial: 18, 20, and 32 cm³.

Seven patients (13.7%) were readmitted within 90 days of surgery. Four patients (8%) presented with hydrocephalus and required ventriculopercutaneous shunt placement. One of these patients initially required a wound revision and lumbar drain placement for suspected wound infection and pseudomeningoele with CSF leak prior to shunting, while another patient required a wound revision and external ventricular drain (EVD) placement prior to definitive shunting for the same reasons. One patient with an existing shunt was readmitted for a shunt revision. Another patient was readmitted for repair of a pseudomeningoele without need for a shunt. Finally, 1 patient who underwent second-look surgery and ventriculopercutaneous shunt placement concurrently required readmission for bilateral subdural fluid collections and was managed with placement of a subdural-peritoneal shunt. There were no deaths within 90 days of second-look surgery.

### DISCUSSION

One of the most frequently cited articles that supports aggressive resection was authored by Albright et al. The authors found that leaving less than 1.5 cm² of residual disease in noninfantile children (>3 years of age) without metastatic disease significantly improved the 5-year PFS (77% vs 53%, \( P = .03 \)). As a result, it has become standard practice for pediatric neuro-oncologists to upstage patients with STR to high-risk therapy. High-risk therapy signifies higher dose craniospinal therapy, which correlates with higher rates of neurocognitive decline and long-term endocrinopathy. While this practice promotes a near complete resection, aggressive resection of tumor invasive into the brainstem should never be pursued given the high neurological risk and lack of benefit in PFS. As previously discussed, Thompson et al found no significant benefit in OS or PFS when comparing GTR (no residual disease) vs NTR (<1.5 cm² residual tumor) across the 4 molecular subgroups. Hence, they appropriately caution against overly aggressive surgery. However, the findings of no significant benefit between GTR and STR for WNT, SHH, and group 3 tumors must be measured against the fact that these patients more than likely received different treatments based on the extent of resection. Moreover, the fact that GTR did provide a mild statistically significant improvement in PFS for group 4 patients continues to support the practice of maximal safe resection whenever possible. As of now, molecular subtype has not influenced our decision to take a child back to surgery or our surgical goal, but as further information about these subtypes comes forward, our strategy may change.

### Our Results

Residual medulloblastoma is either intentional or unintentional. If intentional, the surgeon presumably did not feel comfortable resecting more, or did not feel further resection was indicated. If unintentional, tumor was either hidden or camouflaged (by blood products, contused or cauterized cerebellum, or hemostatic agents) or left in anatomic areas that were not fully exposed and explored. In this series of 51 patients, approximately three-quarters of our patients had their primary tumor in the fourth ventricle (76%), had their initial surgery done within the USA (76.5%), had their subsequent reoperation within 30 days of the initial resection (72.5%), and had unequivocal evidence of residual tumor by MR preoperatively (72.5%). The average tumor volume was 32.60 cm³ with a broad range (0.2-520 cm³). Molecular grouping was available in all cases and the majority (59%) was non-WNT/non-SHH.

Of the 14 indeterminate cases, in which the term "second-look surgery" is most appropriate, 11 had clear tumor under microscopic magnification and 3 had no gross tumor intraoperatively, but only 1 was a true negative exploration. Hemostatic agents were found in 79% of indeterminate cases, which reinforces the principle that every effort should be made to refrain or minimize leaving these products within the resection cavity as they make interpretation of subsequent imaging problematic.
The decision to take a child back to the operating room for exploration is done with much deliberation, and is balanced with discussions of potential neurological consequences. Children with mild or minimal postoperative changes and no obvious residual tumor are started on adjuvant therapy with those areas of concern followed closely with serial imaging. However, in children with abnormal imaging findings that are beyond our collective comfort level in areas where tumor was located preoperatively (as depicted in Figures 2 and 3), our threshold to recommend second-look surgery is low. The imaging heterogeneity caused by significant amount of non-neoplastic substances (hemostatic agents, blood products) not only makes current and follow-up imaging difficult to interpret but can also obscure residual tumor, which can greatly impact the patient's risk of disease recurrence/progression, and thus OS. Moreover, for patients without metastatic disease who would otherwise be considered average risk, if the equivocal area of measures more than 1.5 cm², then this patient would be upstaged to receive more intensive and more potentially damaging therapy. In fact, in practice we typically find more residual tumor than anticipated and can truly justify that some children who would otherwise be stratified to high risk were then stratified to a lower risk adjuvant...
therapy regimen, reducing short and long-term treatment related toxicity.

The anatomic locations of residual tumor made sense surgically. The central portion of the fourth ventricle, being the largest anatomic space and easiest to access and visualize, was the least frequent area of residual tumor (36%). In contrast, it is more challenging to expose and resect tumor completely from the lateral recesses, foramina of Luschka, and the roof of the fourth ventricle. Hence, these areas were more likely to harbor tumor (lateral 52%, roof 49%). Of those cases where tumor was left in the roof, the superior roof was by far the most frequent (76%). The superior medullary velum of the roof is a particularly demanding area to resect tumor from because it is the farthest away from the surgeon and in close proximity to the periaqueductal region of the brainstem, and it is a vascular rich area with adjacent cerebellar grey matter, both of which can make it difficult to discern tumor from normal tissue.

Eight patients (16%) did sustain new neurological deficits in the form of cranial nerve injury (n = 5) or features of posterior fossa syndrome (n = 3). It is important to note that of these 8 patients, only 2 had a tumor volume <1.5 cm³. In all patients with new cranial nerve palsy, residual tumor was adherent to the floor of the fourth ventricle. Our goal in these cases is to thin the tumor down as much as possible without extending the resection below the plane of the ependyma. Of the 5 patients with new cranial neuropathies (2 dual sixth/seventh nerve palsies, 3 isolated sixth nerve palsies, Table), 4 had either complete recovery or mild residual deficits. One patient with unilateral complete facial palsy has undergone multiple reanimation procedures with mild improvement.

Posterior fossa syndrome or cerebellar mutism syndrome only occurred in patients with large volume of residual tumor within the fourth ventricle. In our opinion, the risk of posterior fossa syndrome is largely unavoidable if a large amount of tumor remains in the midline, or if there is preexisting damage or involvement of the proximal dentate-thalamo-cortical pathways, but this risk does not alter our surgical aggressiveness.10,11 The potential benefit of increased survival with tumor resection

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**FIGURE 2.** Indeterminate case example 1. Fourteen-year-old female with a fourth ventricle WNT tumor. The patient underwent first resection 32 days before second-look operation. She had an EVD placed at the time of her first surgery, which could not be weaned postresection, and she was eventually shunted. Hemostatic material and tumor was found during her second-look surgery. GTR was achieved and her shunt was removed 1 week later. Pre–second-look surgery images: A, sagittal T2; B, sagittal T1 with contrast; and C, axial T1 with contrast. Postoperative images: D, axial T2; E, axial T1 with contrast; and F, sagittal T1 without contrast.
outweighs the deleterious effects of posterior fossa syndrome that invariably improves with time.

**Strategies to Prevent Leaving Tumor Behind**

We employ a number of strategies to achieve our surgical goal. First, for the standard prone midline suboccipital craniotomy, the primary surgeon and assistant stand across from each other (ie, “180 degrees” or “4-hand technique”). Along with tilting of the bed and angling of the microscope, this 180º setup allows for maximal assistance and the ability of the surgeon to look ipsilateral and “cross-court.” This is particularly helpful with tumors that extend out into the lateral recess and foramen of Luschka.

Opening the telovelar membrane allows the cerebellar tonsil to be elevated and retracted superiorly and laterally (“up-and-out”), giving an unimpeded view of the cerebellomedullary cistern and lateral recess from medial-to-lateral and inferior-to-superior. The telovelar approach also allows access to the central portion of the fourth ventricle from the obex to the aqueduct without having to split the vermis, although Tanriover et al found that an incision through the lower third of the vermis afforded a modest increase in the operator’s working angle, compared with the telovelar approach when accessing the rostral half of the fourth ventricle. Therefore, the telovelar and transvermian approaches may both be necessary in order to gain optimal access to the tumor. It should be noted that there is no definitive evidence that splitting the vermis will place the child at risk for posterior fossa syndrome, but we avoid any sustained retraction on the walls of the fourth ventricle to avoid injury to the deep cerebellar nuclei and associated tracts.

Intraoperative imaging is important in these cases. While not part of our practice, intraoperative ultrasound and the use of...
5-aminolevulinic acid are both relatively inexpensive and provide real-time assessment.17-21 The intraoperative MRI (iMRI) is the most powerful tool in our armamentarium. All second-look surgeries are performed in our iMRI suite. We have previously reported our global experience with it.22 In the 1 patient whose initial resection was done at our facility with clear residual tumor on the postoperative scan, the iMRI had not yet been installed (overall second look rate at our institution estimated to be 3%).

Limitations

We may have missed some children from 2003 to 2010 because the surgical database at one institution—while complete—only dates back to 2010. Imaging done before and after the first resection was hard to come by, especially for international patients. Without this information, we cannot comment on how much tumor was resected with the first operation and what, if any, tumor growth there was between operations. Finally, until long-term OS and PFS results on our patients are analyzed and published, the question regarding how aggressive the surgeon needs to be with this particular neoplasm will remain unanswered given the conflicting published reports and our own institutional bias, as previously discussed.

CONCLUSION

In this study, several key observations were made. Hemostatic agents—and to a lesser degree, blood products—can obscure residual tumor. Hemostasis is essential, however, the virtue by which hemostasis is obtained should be without hemostatic agents as much as possible to prevent postoperative radiographic concerns. Residual tumor was most commonly found in the roof of the fourth ventricle (particularly in the region of the superior medullary velum) and lateral recess. Surgeons need to combine anatomic knowledge with dissection techniques and intraoperative technologies to minimize the risk of leaving tumor behind.

Disclosures

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COMMENTS

I n this manuscript, the authors outline a treatment approach recommending re-operation for residual medulloblastoma found on postoperative imaging studies prior to adjuvant therapy. This study comes from one of our country’s busiest and most outstanding pediatric neurosurgery programs, and a high proportion of referrals to this center come from other centers both in the United States and from other countries. As such, the recommendations made in this manuscript may not apply broadly to other institutions. It is likely that many of the patients included in this manuscript underwent sub-par operations at the
SECOND-LOOK SURGERY FOR MEDULLOBLASTOMA

This study, from an institution with significant surgical experience with medulloblastoma, highlights the benefits of second-look surgery for residual disease within 90 days of the original surgery, while incorporating a large number of patients from outside institutions. While specific factors contributing to the presence of residual tumor are not always clear (bleeding, anatomical limitations, surgical experience, etc), the authors point out the inherent difficulties with hemostatic agents potentially obscuring “postresection” tumor as well as offering surgical strategies for minimizing the presence of residual tumor. Whereas extent of surgical resection is well-recognized to improve overall survival, this does not come without a cost and one needs to consider overall benefit in the setting of any additional morbidity with repeat surgery. Nonetheless, the authors demonstrate the value of reoperation for suspected residual medulloblastoma, particularly in hope of reducing subsequent adjuvant therapy.

Robert Keating
Washington, District of Columbia

This study examined the utility, safety, and recommendations for performing a second-look surgery to obtain a maximal surgical benefit for the treatment of medulloblastoma. Maximal surgical resection aids in the durability of long-term tumor control and can potentially reduce the amount of toxic chemotherapy and radiation therapy needed to treat a residual, if any. This study highlights again the benefit of maximal—yet safe—surgical reduction of medulloblastoma.

Michael L. Levy
San Diego, California

The authors present what is surely the largest modern North American experience with early 'second look' surgery for medulloblastoma patients prior to chemoradiation. The large number of second look surgeries presented in this paper is likely due to a combination of the unique referral pattern of the authors' institution and their aggressive approach to ensuring maximal resection of the tumor in all patients.

Approximately half of the patients in this series (26/51) presented with large residuals greater than 1.5 cm² and would likely be offered second look surgery at many institutions, as patients with large residuals have both worse overall survival and undergo higher risk treatment. However, the authors practice of performing second look operations in patients with leptomeningeal metastases (20% of the patients in this series) and with small residual tumors is of unclear benefit and was not free of morbidity. The overall immediate surgical morbidity not inclusive of patients who required second operations was 21%. Sixteen percent of patients in this series suffered new neurologic deficits following second look surgery, and this percentage was similar (18%) in the 11 patients operated on with small residual tumors. Six patients (12%) required additional operations during their postoperative course (4 new VPS, 2 wound revisions, 1 subdural shunt, and 1 pseudomeningocele). While not commented on by the authors, second-look surgery can also delay the initiation of definitive adjuvant therapy and requires a child and their family to endure an additional major surgery in all cases.

This paper provides an important contribution to the literature by describing the short-term surgical outcomes associated with early second look surgery for children with medulloblastoma. The treatment paradigm described in this paper is similar to that of our own institution and others but now will be questioned due to unclear benefit. Thompson et al recently demonstrated no difference in overall survival in medulloblastoma patients who underwent gross total vs near total (less than 1.5 cm² residual) resection.

We congratulate the authors on this series and look forward to future reports on the oncologic outcome of this unique patient population. Based on the data currently available, the additional surgical morbidity from a second look surgery may not be justified in patients with metastatic, small, and questionable residual tumors due to unclear survival benefit.

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