Post-operative Meningeal Thickening Seen on Magnetic Resonance Imaging: tumor spread or transient reaction?

Espessamento Menígeo Pós-operatório Visto na Ressonância Magnética: disseminação tumoral ou reação transitória?

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ABSTRACT
Posterior fossa tumors are relatively common in children, and the meningeal dissemination of these tumors is well established in the literature. Although leptomeningeal dissemination is more common in high-grade tumors, even low-grade tumors can generate meningeal metastases. In this case report, we would like to discuss the importance of leptomeningeal dissemination assessment of posterior fossa tumors in children, in the preoperative period, through the entire neuroaxis magnetic resonance imaging (MRI). This is important since transient meningeal thickening is very common in the postoperative periods of neurosurgical patients, and can be found for up to 5 or 6 years after surgery, causing these patients to undergo prolonged follow-ups and repeated MRIs and lumbar punctures.

Keywords: Intracranial posterior fossa tumors; Transient postoperative meningeal thickening; Meningeal tumor dissemination; Magnetic resonance imaging

RESUMO
Os tumores da fossa posterior são relativamente comuns em crianças e a disseminação meníngea desses tumores já está bem estabelecida na literatura. Embora a disseminação leptomeningea seja mais comum em tumores de alto grau, mesmo os de baixo grau podem gerar metástases meníngeas. Com este relato de caso, gostaríamos de discutir a importância da avaliação da disseminação leptomeningea dos tumores da fossa posterior em crianças no período pré-operatório, por meio do estudo por ressonância magnética de todo o neuroeixo. Isso é importante porque o espessamento meníngeo transitório é muito comum no pós-operatório de pacientes neurocirúrgicos e pode ser encontrado por até 5 ou 6 anos após a cirurgia, fazendo com que esses pacientes sejam submetidos a acompanhamentos prolongados e repetidas ressonâncias magnéticas e punções lombares.

Palavras-chave: Tumores intracranianos de fossa posterior; Espessamento meníngeo pós-operatório transitório; Disseminação de tumor meníngeo; Ressonância magnética

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INTRODUCTION

Posterior fossa tumors are relatively common in children, and the possibility of meningeal dissemination of these tumors is well established in the literature. However, the postoperative meningeal enhancement and thickening seen on magnetic resonance imaging (MRI) can generate diagnostic confusion, especially in the immediate postoperative period, and in patients without a preoperative neuroaxis MRI. Leptomeningeal involvement is more common in high-grade tumors, but it can also occur in low-grade tumors. In this case report, we would like to discuss the importance of leptomeningeal dissemination assessment of posterior fossa tumors in children in the preoperative period, through the entire neuroaxis MRI. This is especially important when the imaging evaluation suggests a high-grade tumor, but also in some cases of low-grade tumors.

CASE REPORT

A 6-year-old boy presented with headache, abnormal gait, and vomiting. Brain MRI revealed a tumor in the midline of the posterior fossa, affecting the cerebellar vermis (Figure 1), with hyperintense signal on fluid attenuated inversion recovery (FLAIR), and T2-weighted imaging, and also, hypointense signal on T1-weighted imaging, without restricted diffusion, and without signs of intratumoral hemorrhage or calcification. The patient’s parents did not authorize the intravenous gadolinium injection in the first MRI.

Regarding the differential diagnosis, due to the hyperintense signal on T2-weighted imaging and the absence of restricted diffusion, the possibility of medulloblastoma was considered as less likely. Because of the patient’s age, the possibility of atypical teratoid rhabdoid tumor was also considered less likely. The main diagnostic possibilities considered using the pre-operative MRI were ependymoma and a circumscribed astrocytic glioma, such as pilocytic astrocytoma. However, the absence of tumoral calcifications and hemorrhage, as well as the absence of a plastic growth of the lesion, through the drainage foramina of the fourth ventricle, made pilocytic astrocytoma to be the main diagnostic hypothesis, in the preoperative period.

The patient was submitted to occipital craniotomy, with partial tumor resection. The histopathological analysis revealed a neoplasm characterized by small monomorphous bipolar cells, with perivascular arrangement, associated with a myxoid background. The immunohistochemical staining showed positivity for GFAP, and S100 protein. The final diagnosis was a cerebellar pilomyxoid astrocytoma.

Two days after the surgery, another brain MRI was performed in order to assess the remaining tumor in the surgical bed. However, the MRI also demonstrated pachymeningeal and leptomeningeal thickening, associated with gadolinium-enhancement, in the cervical spine and preoptine cistern. The meningeal thickening motivated the scanning of the entire neuraxis, which demonstrated diffuse pachymeningeal, and leptomeningeal thickening, associated with gadolinium-enhancement in the cervical, dorsal and lumbar spinal canal, as well as in the nerve roots of the cauda equina (Figure 2 A-C).

The hypothesis of meningeal spread of the tumor was considered, but three lumbar punctures, with an interval of one week between the procedures, after the first surgery, and cytopathological analyses of the cerebrospinal fluid (CSF), were negative for neoplastic cells. The patient underwent a second surgery to resect the entire tumor. Three months after the second surgery, a new neuroaxis MRI was performed and the diffuse pachymeningeal and leptomeningeal thickening, with gadolinium-enhancement disappeared, confirming that the MRI-detected meningeal thickening corresponded to transient postoperative reaction (Figure 2 D-F).
Preoperative brain MRI showing an expansive lesion in the midline of the posterior fossa, with A. hypointense signal on T1-weighted imaging (arrow), B. hyperintense signal on FLAIR (arrow), and C. no restricted diffusion. A preoperative neuroaxis MRI was not performed. The histopathological diagnosis was pilomyxoid astrocytoma.

![Preoperative brain MRI showing an expansive lesion in the midline of the posterior fossa, with A. hypointense signal on T1-weighted imaging (arrow), B. hyperintense signal on FLAIR (arrow), and C. no restricted diffusion. A preoperative neuroaxis MRI was not performed. The histopathological diagnosis was pilomyxoid astrocytoma.](image1.jpg)

Reactive postoperative pachymeningeal and leptomeningeal thickening. Postoperative brain and neuroaxis MRI, performed 2 days after the first surgery (before the final histopathological examination), showed a remaining tumor, with gadolinium-enhancement on T1-weighted imaging with fat saturation (dashed arrows in A and B), associated with extensive pachymeningeal and leptomeningeal thickening and gadolinium-enhancement in the cervical, dorsal and lumbar regions (white arrows in B and C), as well as in the nerve roots of the cauda equina (red arrow in C). Since the patient did not perform a preoperative neuroaxis MRI, the possibility of leptomeningeal dissemination was considered, but the cerebrospinal fluid cytological analysis was negative for neoplastic cells. D-F. Follow-up MRI, performed three months after the second surgery, for complete tumor resection, showed resolution of the pachymeningeal and leptomeningeal thickening and enhancement. The nerve roots of the cauda equina no longer showed gadolinium-enhancement.

![Reactive postoperative pachymeningeal and leptomeningeal thickening. Postoperative brain and neuroaxis MRI, performed 2 days after the first surgery (before the final histopathological examination), showed a remaining tumor, with gadolinium-enhancement on T1-weighted imaging with fat saturation (dashed arrows in A and B), associated with extensive pachymeningeal and leptomeningeal thickening and gadolinium-enhancement in the cervical, dorsal and lumbar regions (white arrows in B and C), as well as in the nerve roots of the cauda equina (red arrow in C). Since the patient did not perform a preoperative neuroaxis MRI, the possibility of leptomeningeal dissemination was considered, but the cerebrospinal fluid cytological analysis was negative for neoplastic cells. D-F. Follow-up MRI, performed three months after the second surgery, for complete tumor resection, showed resolution of the pachymeningeal and leptomeningeal thickening and enhancement. The nerve roots of the cauda equina no longer showed gadolinium-enhancement.](image2.jpg)
Preoperative brain MRI is essential for the evaluation of posterior fossa tumors in children. The most common posterior fossa tumors in children are medulloblastoma, pilocytic astrocytoma, brainstem gliomas, and ependymoma. When brainstem tumors are excluded, the most common neoplasms of the cerebellum are pilocytic astrocytoma, medulloblastoma, ependymoma, and atypical teratoid rhabdoid tumor. An important factor to be considered is the patient’s age, as atypical teratoid rhabdoid tumor typically occurs in patients younger than 3 years old and may have imaging features similar to medulloblastoma. Medulloblastoma in children usually occurs in the cerebellar vermis, has marked restricted diffusion, is associated with increased perfusion, but can occur in patients older than 3 years old. Ependymoma usually appears in the fourth ventricle, as a heterogeneous tumor, with the presence of hemorrhage and/or calcifications, with extension through the drainage foramina of the fourth ventricle. Although pilocytic astrocytoma usually occurs in the cerebellar hemisphere and has a cystic portion associated with the solid component, it can also occur in the midline, without a cystic component, and generally has no restricted diffusion.

Although these tumors correspond to variable histological grades, according to the World Health Organization classification of the central nervous system tumors, all may be complicated with leptomeningeal dissemination, including pilocytic astrocytoma. It has been reported a prevalence of pilocytic astrocytoma leptomeningeal dissemination in 2%–12% of the cases, especially in those partially resected, and in the pilomyxoid variant.

Pachymeningeal and leptomeningeal thickening with gadolinium-enhancement may result from various benign and malignant processes, including transient postoperative changes, neoplasms, granulomatous inflammatory diseases, among others. Transient postoperative meningeal thickening and enhancement occurs in some neurosurgical patients and may affect the dura-, arachnoid, and/or pia-mater.

Although its pathophysiology is not yet completely known, it is hypothesized that after the dura and arachnoid transection, substances secondary to red blood cells lysis or from surgical materials lead to a meningeal inflammatory reaction. Previous studies have found that postoperative pachymeningeal and leptomeningeal thickening with gadolinium-enhancement can be found for up to 5 or 6 years after the surgery, depending on the type of surgery performed. Therefore, especially in cases in which a preoperative neuroaxis MRI was not performed, the meningeal thickening can lead to long-term MRI follow-up, and/or repeated lumbar punctures.

The gold standard for the diagnosis of leptomeningeal spread of a brain tumor is serial CSF analysis, which has a sensitivity of approximately 55% on the first CSF examination and reaches up to 85% sensitivity when done three times, while maintaining a theoretical specificity of 100%. However, the CSF analysis requires a lumbar puncture, which can be difficult to perform, especially in children and when done repeatedly.

In the current practice, the diagnosis of meningeal tumor dissemination is often made previously to the CSF analysis, using gadolinium-enhanced MRI of the entire neuroaxis, including brain, cervical, dorsal, and lumbar spine, which is reported to have a sensitivity and specificity of approximately 75%. Then, MRI has a greater sensitivity, compared with an unique CSF analysis for leptomeningeal tumor dissemination, which may justify the preoperative performance of the neuroaxis MRI.

The performance of preoperative neuroaxis MRI is important to be considered for leptomeningeal dissemination screening, even in children with a low-grade posterior fossa brain tumor, in order to avoid diagnostic confusion or misdiagnosis in cases with exuberant meningeal thickening seen in the postoperative period.
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