

INTRACRANIAL MENINGIOMAS

Magnetic resonance imaging findings in 78 cases

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ABSTRACT - Objective: To present the magnetic resonance (MR) imaging findings of 78 patients with meningiomas diagnosed in a single institution. **Method:** 78 patients with histological proven intracranial meningioma were studied. There were 52 female and 26 male patients (median=56 years). All MR imaging examinations were performed with 1.5-T MR imaging unit with standard protocol. The images were studied by two neuroradiologists, who reached the decisions regarding the findings by consensus. **Results:** Most of the tumors showed low signal on T1- (60%) and high signal on T2- (68%) and FLAIR (69%) weighted images. Also, the lesions showed heterogeneous signal on T1 (60%), T2 (68%) and FLAIR (64%) sequences. After contrast administration, 83% (n=65) of the tumors presented accentuated and 17% (n=13) showed moderate enhancement. The tumors were located in the frontal lobe in 44% of the cases, in the parietal lobe in 35%, the occipital lobe in 19% and the temporal lobe in 12% of the patients. Areas of vasogenic edema around the tumors were seen in 90% of the cases. Twenty six per cent of the cases showed bone infiltration, and the dural tail sign was seen in 59% of the tumors. **Conclusion:** Intracranial meningiomas usually show heterogeneous low signal on T1- and high signal on T2-weighted and FLAIR images, with intense enhancement after contrast administration. The frontal and parietal lobes are commonly affected. In addition, brain edema, dural tail sign and bone infiltration are the most frequent associated findings.

KEY WORDS: meningioma, magnetic resonance imaging, brain tumors.

Meningiomas intracranianos: achados de ressonância magnética em 78 casos

RESUMO - Objetivo: Apresentar os achados de ressonância magnética (RM) de 78 pacientes com meningioma intracraniano diagnosticados numa única instituição. **Método:** 78 pacientes com diagnóstico histológico de meningioma intracraniano foram estudados. Cinquenta e dois eram femininos e 26 masculinos (mediana=56 anos). Todos os exames de RM foram realizados num aparelho de 1.5 Tesla, com protocolo padrão. As imagens foram avaliadas por dois neuroradiologistas, os quais estabeleceram os achados por consenso. **Resultados:** A maioria dos tumores apresentou baixo sinal em T1 (60%) e alto sinal em T2 (68%) e FLAIR (69%). Além disso, as lesões demonstraram sinal heterogêneo em T1 (60%), T2 (68%) e FLAIR (64%). Após a administração intravenosa de contraste, 83% dos tumores apresentaram realce acentuado e 17% moderado. Os tumores estavam localizados no lobo frontal em 44% dos casos, no parietal em 35%, no occipital em 19% e no lobo temporal em 12% dos casos. Áreas de edema vasogênico foram observadas em 90% dos pacientes. Vinte e seis por cento dos casos apresentaram sinais de infiltração óssea e o sinal da cauda dural foi visto em 59% dos tumores. **Conclusão:** Meningiomas intracranianos em geral apresentam sinal heterogêneo, baixo em T1 e alto em T2 e FLAIR, com intenso realce pelo contraste. Os lobos frontais e parietais são com frequência acometidos. Além disso, edema vasogênico, sinal da cauda dural e infiltração óssea são os achados associados mais comuns.

PALAVRAS-CHAVE: meningioma, ressonância magnética, tumores cerebrais.

Meningiomas are the most common primary non-glial intracranial tumors¹⁻³. This neoplasm affects more frequently patients in middle and late decades of life, with a strong female prediction (2:1)¹⁻³. The classical appearance on the computed tomography (CT) scans and magnetic resonance (MR) imaging

usually leads to a correct diagnosis of meningiomas. The CT scan usually demonstrates an extra-axial mass hypo- or isodense, with intense enhancement after contrast administration^{1,4,5}.

On MR imaging, the tumor has variable signal, being most commonly iso- or hypointense on T1-weight-

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ed images and hyperintense on T2-weighted images. However, the lesions may present heterogeneous signal on T1- and more evident on T2-weighted images. After gadolinium administration, meningiomas show intense enhancement, which may be heterogeneous in some cases^{1,4}. Other findings as adjacent edema, cystic foci, calcifications and hyperostosis are also demonstrated in some patients with meningiomas.

We present the MR imaging findings of 78 patients with meningiomas diagnosed in a single institution.

METHOD

This retrospective study included 78 patients with histological proven intracranial meningioma, which were diagnosed between 2001 and 2005. There were 52 female and 26 male patients, with ages ranging between 23 and 81 years (median=56 years, standard deviation=12.7). All patients underwent surgical biopsy or resection of the tumors, and the histological diagnosis of meningioma was defined based on the World Health Organization criteria⁶.

All MR imaging examinations were performed with 1.5-T MR imaging unit (Signa Horizon LX; GE Medical Systems, Milwaukee, Wis). The MR imaging protocol included the following sequences: T1-weighted images (repetition time (TR) ms/echo time (TE) ms, 466/19), T2-weighted images (TR/TE=4500/120 ms; echo train length (ETL), eight), and fluid-attenuated inversion recovery images (FLAIR) (TR/TE/inversion time, 11 002/148/2200 ms). The slice thickness was 5 mm, and the field of view (FOV) varied between 18 and 24 cm. We also obtained axial, coronal, and sagittal T1-weighted images after the administration of 0.1 mmol per kilogram of body weight of a gadolinium chelate. All the exams were recorded in hard disks, zip disks or compact disks. In several cases, only some images of each sequence were available, but in these cases they were enough for the study following our imaging protocol.

The images were studied by two neuroradiologists, who reached the decisions regarding the findings by consensus. The following features were analyzed: signal intensity and presence of homogeneity or heterogeneity in all obtained sequences, presence of contrast enhancement, location of the lesion and presence of brain edema, foci of calcification (low signal on T2*-weighted gradient-echo images and correlation with CT), hemorrhage or cystic components in the tumors. The edema and the contrast enhancement were classified as discrete, moderated and accentuated, according with the extension of the edema and intensity of the contrast enhancement. Evidence of bone infiltration and dural tail sign were also studied.

RESULTS

Considering the signal intensity on T1-weighted images, 60% (n=47) of the tumors showed low signal, 36% (n=28) intermediate signal and 4% (n=3) had high signal. In 47 cases (60%) the lesions were heterogeneous on T1-weighted images, and in 31 (40%) they were homogeneous. In the FLAIR sequences, 69% (n=54) of the tumors had high signal, 22% (n=17) intermediate signal, and 9% (n=7). In most of the cases (64%), the lesions were heterogeneous on FLAIR sequences. On the T2-weighted images, 68% (n=53) of cases showed high signal, 26% (n=20) intermediate signal and 4% (n=5) low signal. Most of the tumors were heterogeneous (68%) on T2-weighted images.

After contrast administration, 83% (n=65) of the tumors present accentuated and 17% (n=13) showed moderate enhancement. The contrast enhancement was heterogeneous in most of the patients (64%).

Taking in account the tumor location, the meningioma was located in the frontal lobe in 44% (n=34) of the cases, in the parietal lobe in 35% (n=27), the

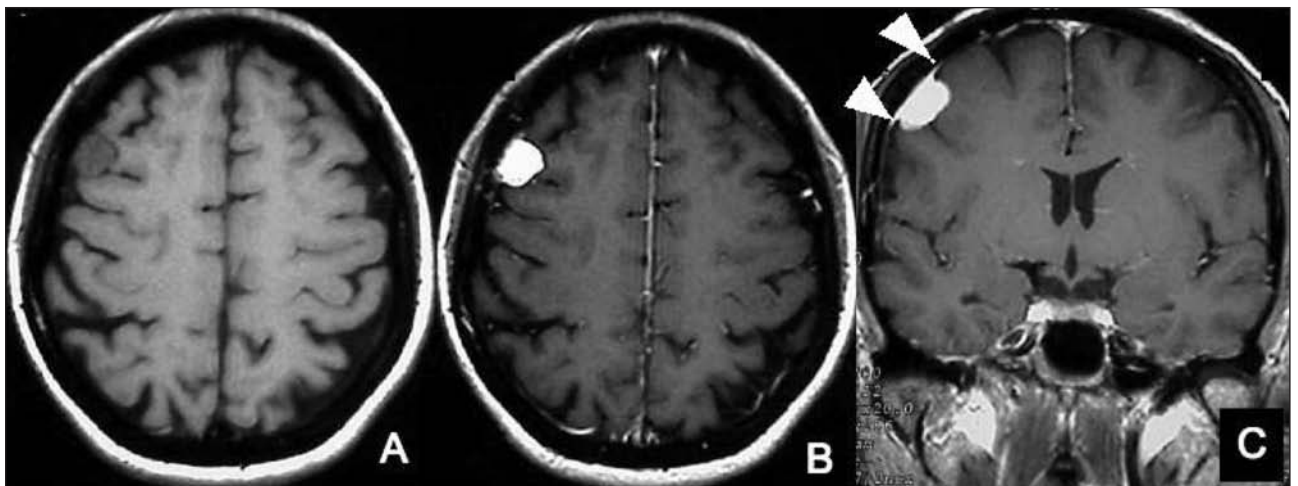


Fig 1. Axial T1-weighted pre- (A) and post-contrast (B) and sagittal T1-weighted post-contrast (C) MR imaging show a right frontal extra-axial mass with low signal and intense contrast enhancement. Note the "dural tail" sign (arrows).

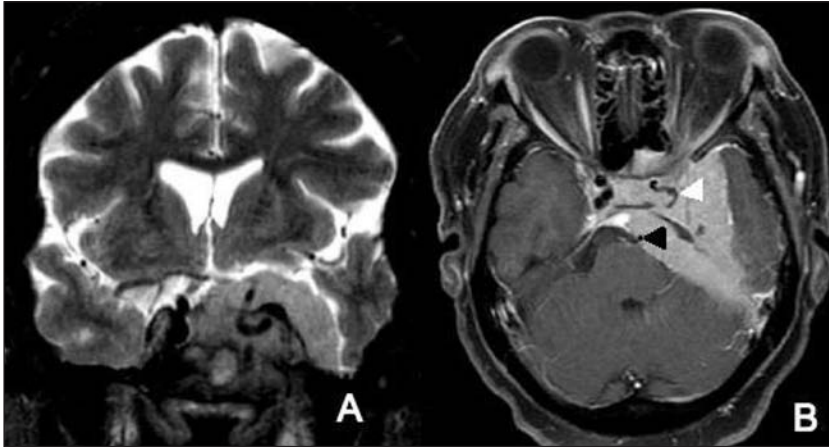


Fig 2. Coronal T2-weighted (A) and axial T1-weighted post-contrast (B) MR imaging demonstrate a left para-sellar mass isointense to the cortex on T2-weighted images and with enhancement after contrast administration. The lesion is involving and narrowing the left internal carotid (white arrow) and basilar artery (black arrow), as well as compressing the brain stem, left cerebellar hemisphere and left temporal lobe.

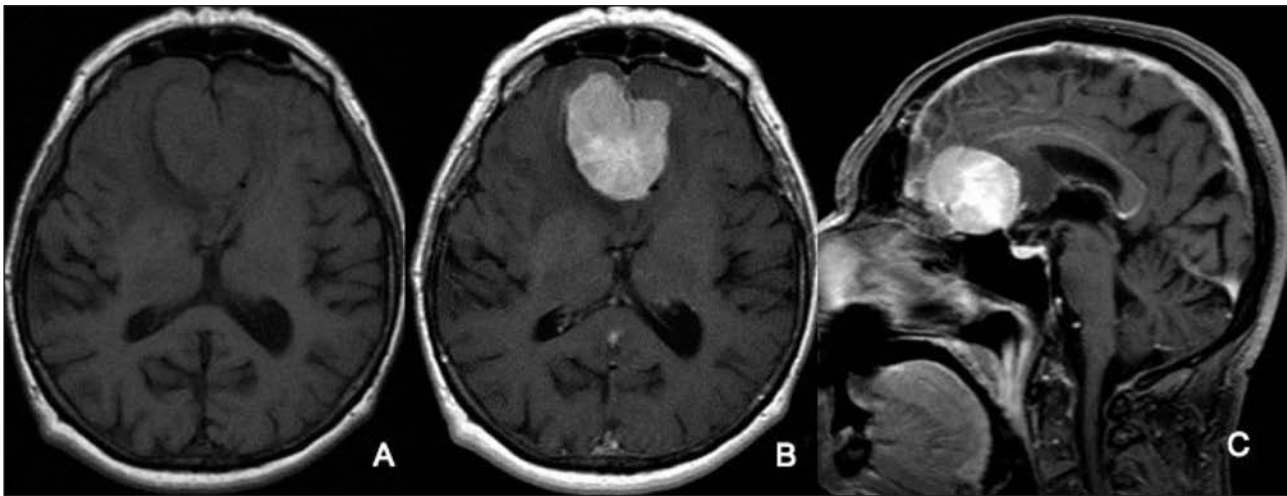


Fig 3. Axial T1-weighted pre- (A) and post-contrast (B) and sagittal T1-weighted post-contrast (C) MR images show a frontal extra-axial mass at the olfactory groove with isointense signal to the cortex on T1-weighted images and intense contrast enhancement. The lesion is compressing the frontal lobes, lateral ventricles and corpus callosum and there is an area of low signal on the right frontal white matter representing vasogenic edema.

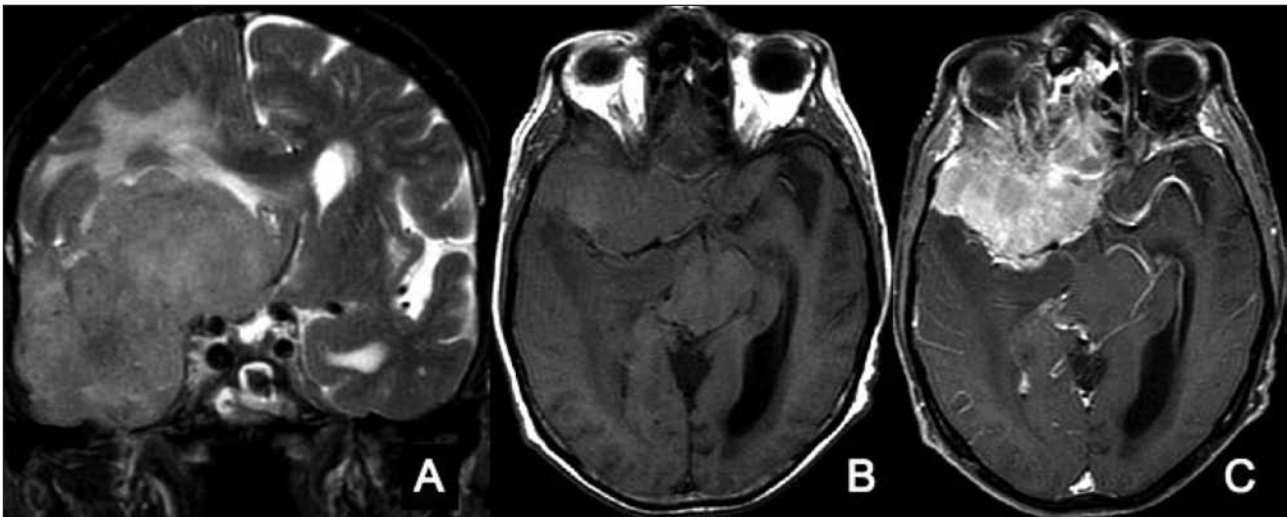


Fig 4. Coronal T2-weighted (A) and axial T1-weighted pre- (B) and post-contrast (C) MR imaging demonstrate a right para-sellar mass isointense to the cortex on T1- and T2-weighted images and presenting intense enhancement after contrast administration. The lesion is compressing adjacent structures, involving and narrowing the right middle cerebral artery and causing middle line shift. Note the discrete lateral ventricles enlargement.

occipital lobe in 19% (n=24) and the temporal lobe in 12% (n=9) of the patients. Lesions at the ventricles, posterior fossa and para-sellar region were seen in four, three and three cases, respectively.

Areas of vasogenic edema around the tumors were seen in 90% (n=70) of the cases. The edema was considered discrete in 50% (n=39) of the cases, moderated in 37% (n=29) and severe in 23% (n=10) of the patients. Foci of hemorrhage were observed only in three tumors, and areas suggestive of cystic components in six cases. Foci of calcification were observed also in six patients and evidence of bone infiltration in 26% (n=20) of the patients. The dural tail sign was seen in 59% (n=46) of the tumors.

Figures 1 to 4 illustrate our findings.

DISCUSSION

There are several studies discussing the signal characteristics of the meningiomas at the MR imaging. The signal intensity of the tumor mass may be rather variable on both T1-, T2-weighted and FLAIR images^{1,4,7}. On T1, most tumors are isointense to the cortical grey matter (from 56% to 94%). Hypointense meningiomas account from 20% to 48%, and hyperintense tumors on T1-weighted images are rare. On T2-weighted images, about 50% of the tumors remain isointense with the brain cortex. Hypointense tumors are less common, from 4% to 18%, whereas hyperintense lesions account for 35% to 44%^{1,4}. In the present series, on T1-weighted images, 60% of the tumors showed low signal, 36% intermediate signal and 4% had high signal. On the T2-weighted images, most tumors (68%) were hyperintense and 26% isointense to the cortical grey matter.

Meningiomas characteristically show intense enhancement after contrast administration both on CT scans and MR imaging^{1,4,8}. This enhancement may be either central or ring-like, and it is explained to the fact that meningiomas capillaries have no blood-brain barrier. The tumor enhancement in patients with meningiomas may help to identify anatomic boundaries of larger lesions that may be isointense to the brain on T1-weighted images¹. In our study, all the meningiomas showed enhancement after contrast administration, which was accentuated in 83% of the cases, and heterogeneous in 64% of the patients.

Cystic foci, hemorrhage and calcifications may be seen in approximately 20% of the patients with meningiomas¹. In the present study, cystic components and foci of calcification and hemorrhage were seen in 8%, 8% and 4% of the patients, respectively.

The presence of brain edema is frequently reported in patients with meningiomas^{1,5,7}. Several studies tried to elucidate the tumor characteristics associated with the presence of edema. The tumor size, location, signal intensity on T2-weighted images and invasive pattern of brain-tumor interface were related to the presence of edema in patients with meningiomas. However, the histological subtypes were not related with the this finding^{5,7}. In the present study, 90% of the patients showed brain edema, which more commonly was discrete (50%).

Nakau et al.⁹ studied the correlation of the MR imaging and histopathological findings in nine cases of meningiomas with dural tail sign. They suggested that tumor cell nests in the dura mater of those patients, making the surgical resection of these areas mandatory. Almost 35% of the patients with meningiomas may present the dural tail signal on post-contrast T1-weighted images¹. In the present series this sign was seen frequently, being identified in 59% of the patients.

Our study shows that meningiomas usually present heterogeneous signal intensity in all the pre-contrast sequences, demonstrating more commonly low signal on T1- (60%) and high signal on T2-weighted (69%) and FLAIR images (68%). Most of the tumors shows accentuated enhancement after contrast administration (83%), which is frequently heterogeneous (64%). The frontal and parietal lobes were the most commonly affected regions (44% and 35% respectively). Edema was seen in 90% of the cases, which usually was discrete (50%). The dural tail sign was frequent in our series (59%), as well as 29% of the tumors showed evidence of bone infiltration. Foci of cystic components, hemorrhage and calcifications were rarely seen.

The present study has several limitations. First, this retrospective study was based on the analysis of images recorded in hard disks, zip disks and compact discs. As a result, in several cases, only a few images of each sequence were recorded and analyzed. Finally, only cases with histological diagnosis of meningioma were included in the study, which could result in bias of selection, as some patients with lesions presenting imaging findings highly suggestive of meningiomas stay for long periods in the follow-up evaluation without surgical intervention.

In conclusion, intracranial meningiomas usually show heterogeneous low signal on T1- and high signal on T2-weighted and FLAIR images, with intense enhancement after contrast administration. The

frontal and parietal lobes are commonly affected. In addition, brain edema, dural tail sign and bone infiltration are the most frequent associated findings.

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